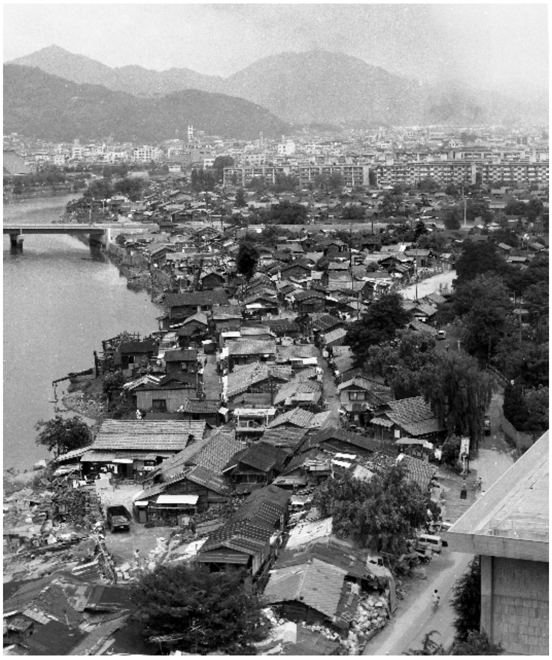
Japan International Cooperation Agency

Japan's Experience on Water Resources Management



March, 2022

Japan International Cooperation Agency

Nippon Koei Co., Ltd.

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Cover Photos

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1. : Flood Occurred in 7th 2018 (Mabi City, Okayama Prefecture), MLIT
2. : Emergency Water Supply during the drought in 1964, Tokyo Waterworks Historical Museum
3. : Atomic Bomb Slum in Hiroshima, the Hiroshima City Archives (Photographer: Research Group of Community)
4. : Tama River in 1970 (Water Pollution) MLIT

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Table of Contents

Page

EXECUTIVE SUMMARY

Page

THEME 1-3 PUBLIC PARTICIPATION AND DECISION-MAKING PROCESS

THEME 2 PLAN-BASED MANAGEMENT

THEME 2-1 MANAGEMENT PLANNING

Page

THEME 2-2 RIVER BASIN PLANNING

THEME 3 FINANCE

Page

THEME 4 WATER POLLUTION AND ENVIRONMENTAL MANAGEMENT MEASURES

THEME 5 URBAN WATER MANAGEMENT

THEME 10 DEVELOPMENT OF HUMAN RESOURCES AND TECHNOLOGY

List of Tables

Page

THEME 2 PLAN-BASED MANAGEMENT

THEME 2-1 MANAGEMENT PLANNING

THEME 2-2 RIVER BASIN PLANNING

THEME 3 FINANCE

THEME 4 WATER POLLUTION AND ENVIRONMENTAL MANAGEMENT MEASURES

Page

THEME 5 URBAN WATER MANAGEMENT

THEME 6 RIVER MANAGEMENT

No Table

THEME 7 GROUNDWATER MANAGEMENT

THEME 8 DAM MANAGEMENT

THEME 9 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS IN LARGE-SCALE PROJECTS

THEME 10 DEVELOPMENT OF HUMAN RESOURCES AND TECHNOLOGY

No Table

List of Figures

Page

EXECUTIVE SUMMARY

Page

THEME 1 GOVERNANCE

THEME 1-1 LEGISLATION AND ORGANIZATION

THEME 1-2 WATER RIGHTS

Page

THEME 1-3 PUBLIC PARTICIPATION AND DECISION-MAKING PROCESS

THEME 2 PLAN-BASED MANAGEMENT

THEME 2-1 MANAGEMENT PLANNING

Page

THEME 2-2 RIVER BASIN PLANNING

THEME 3 FINANCE

THEME 4 WATER POLLUTION AND ENVIRONMENTAL MANAGEMENT MEASURES

Page

THEME 6 RIVER MANAGEMENT

Page

THEME 7 GROUNDWATER MANAGEMENT

THEME 8 DAM MANAGEMENT

Page

THEME 9 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS IN LARGE-SCALE PROJECTS

Page

THEME 10 DEVELOPMENT OF HUMAN RESOURCES AND TECHNOLOGY

SUPPORTING

EXECUTIVE SUMMARY

CHAPTER 1 INTRODUCTION

Resolving water-related issues is crucial to achieving sustainable development. Water-related issues resulting from economic growth, urbanization, and an increasing population are becoming more severe around the world, particularly in developing countries. It is predicted that issues such as water shortages, floods, droughts, water pollution, and ecosystem degradation will intensify in severity along with climate change. Water-related issues are not only related to Goal 6 "Clean water and sanitation" but also to other Sustainable Development Goals (SDGs) (Figure 1.1). Improper and insufficient management of water use, floods, and the water environment could slow down the pace of growth and poverty reduction (Goals 1 and 8), increase tensions among regions and countries, and lead to conflicts (Goal 16). Access to clean water and sanitation services is related to infectious diseases, health, gender, and education (Goals 3, 4, and 5), while water is used for food production, renewable energy, and industrial manufacturing (Goals 2, 7, and 9). Furthermore, it is necessary to promote the development of flood-resilient cities, take measures against climate change (Goals 11, 13), and contribute to environmental protection and improvement (Goals 14, 15). These issues must be resolved through collaboration between the public and private sectors (Goal 17).

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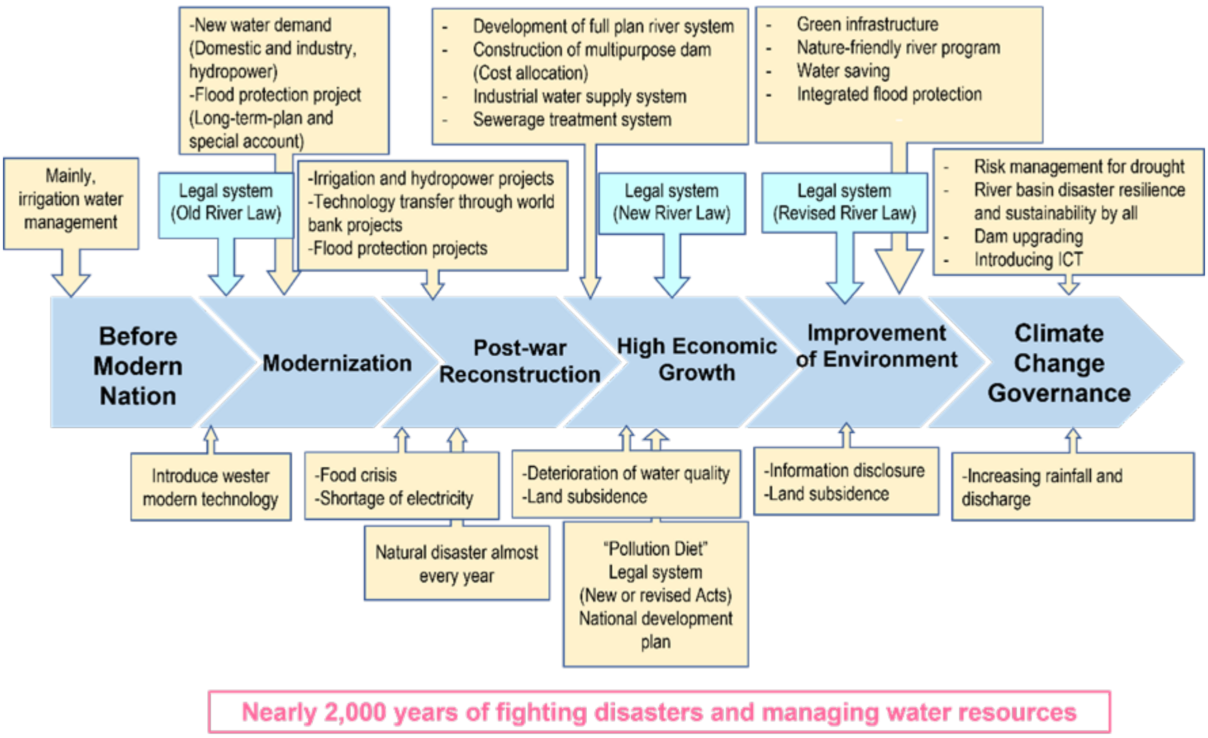
Source: Project Research Team

Figure 1.1 Relation between the Management of Water Resources and the SDGs

This report describes case studies and lessons learned from Japan's experience in water resources management, particularly in the public sector. It could contribute to assisting developing countries, which face various water-related issues in policy-making, developing institutions, and building their capacities. After the establishment of a modern nation in the late 18^{th} century, Japan recognized that floods were the severest among water-related issues and focused on flood protection measures. Following World War II (WWII), which ended in 1945, Japan has resolved various water-related issues such as urbanization, shortage of water due to industrialization, land subsidence due to excessive use of groundwater, and water quality deterioration and health hazards caused by domestic and industrial wastewater. There is no one-solution-fits-all model for water management because each country faces different issues and backgrounds. Some countries in arid areas face difficulties such as water shortages, and some recognize groundwater depletion or pollution in water bodies as a top priority. In addition, each country or region has different customs, social cultures, and histories. Each country or region may develop its strategies by referring to appropriate experiences from the Japanese residents to meet their requirements.

1.1 Evolving Management of Water Resources to Meet the Emerging Needs along with Socioeconomic Change

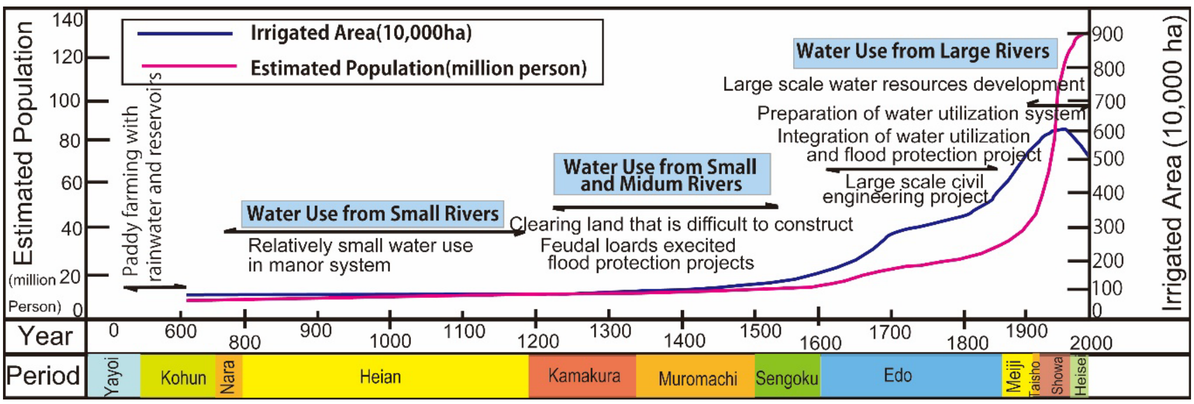
Japan has achieved quality growth to form a resilient, inclusive, and sustainable society by managing its water resources. Since its modernization, Japan has managed the changing water-related issues by introducing new systems built on traditional water management developed throughout its nearly 2,000-year history (Figure 1.2). For water management purposes, the government has developed legislation and institutions, such as formulating long-term development plans and introducing a cost-sharing method for project implementation. In response to the abovementioned issues, Japan has made efforts to introduce appropriate technologies per era.



Source: Project Research Team

Figure 1.2 Efforts for Water Resources Management in Japan

Over the past 2,000 years, Japan has fought against disasters, such as floods and droughts, and has managed its water resources. Since ancient times, people in Japan have developed land to produce food with irrigation water from rivers and implemented flood protection measures. People started constructing intake weirs, canals, levees, and irrigation ponds for over 1,500 years. Local communities (village communities) managed irrigation-water distribution and maintained facilities, constructed levees to protect communities from floods, and engaged in flood fighting. The communities created rules for water management to resolve conflicts with water. Water resource management overcame the Malthusian trap wherein the population cannot increase due to food shortages (Figure 1.3).



Source： A partial excerpt and revision of the "Farmland and Water in Japan, Ministry of Agriculture, Forestry and Fishery"

Figure 1.3 Changes in the Population and Cultivated Area

Based on its history, Japan has developed the system and practices for water resources management. When the nation was modernized through the Meiji Restoration at the end of the 19th century, the national government began to resolve water-related issues from the perspective of national growth. The government implemented river works for navigation, which was the primary transportation system. As modernization progressed and flood damage became more severe, the government started a national program of flood protection. In addition, the government established water management systems by recognizing irrigation use as a customary water right established through its long history and background of past development. Local communities managed water through the distribution of irrigation water, facility management, and flood-fighting. The government initiated projects for water supply and sewerage to improve urban public health against infectious diseases.

Japan has evolved mechanisms of managing water resources to meet the emerging water-related issues along with the nation's growth and socioeconomic changes. Since 1945, following WWII, the government recognized water resources as an important sector for rehabilitating devastated national land. The government developed irrigation systems to increase food production and to support hydropower generation as the main source of electricity. In addition, the government implemented intensive flood protection and forest conservation because the forests suffered from natural disasters, causing more than 1,000 casualties almost every year.

During high economic growth, the national government accelerated the development of water resources, reduced flood damage, and supplied water for domestic and industrial use. As a result of the high economic growth, issues such as pollution-related diseases, urban flooding, water pollution, and land subsidence due to overuse of groundwater appeared one after another, and the national government was forced to tackle these issues. Following the high economic growth in the 1990s, a maturing society and the diversification of people's sense of values awakened people's interest in environmental issues. The government organizations thus embarked on improving the water environment.

River management offices (RMOs), as river administrators, are responsible entities that implemented water resources management in cooperation with relevant agencies. The river administrators were originally prefectural governors who executed river management based on the old River Law enacted in 1896. They are currently the Minister of Land, Infrastructure, Transportation, and Tourism (MLIT) for major rivers, and the prefectural governors for other rivers, as stipulated in the River Law amended in 1964.

The Water Resources Department in the government coordinates with multiple government organizations at the national level to create policies and plans. Committees at the river basin level are involved in the coordination for decision-making process as well. In 1962, the Water Resources Bureau (presently the Water Resources Department) was established to coordinate all related ministries and departments regarding water resources policies and to formulate and promote basic plans for water resources management. At the river basin level, RMOs formulate river improvement plans by reflecting the views of academic experts and residents of river basins at river basin committee meetings. The forms of river basin committees differ from basin to basin, according to the characteristics and backgrounds of each basin.

The government-formulated water resources development plans are entirely government plans with a long-term perspective and are implemented through coordination with relevant sectors and stakeholders. The National Comprehensive Development Plan (NCDP) aims to develop the country's economy and welfare, promote the development and use of stressed water resources, and build flood protection while maintaining consistency in other sectors. The cabinet decided on water resources development plans as plans above the ministry level. The government formulated plans for each major river basin to manage the water resources based on relevant data, science, and engineering evidence.

Roles and responsibilities are defined to secure finance. The national government established a system to clarify their roles and responsibilities. Local governments share the costs of national projects as project beneficiaries. The national government provides subsidies for local projects to support balanced development across the country. Farmers and users share some costs for irrigation and water supply systems. Companies have also constructed hydropower projects. Since water resources development and flood protection projects require a long period and a high cost, the government formulated long-term plans for each area with project-cost estimates towards the commitment of the long-term budget. The government promoted flood protection projects using the special account for flood protection established in 1960.

Modern science and technology have been applied to resolve water-related issues. In the Meiji era, Japan introduced modern Western technologies for water supply to cities, and flood protection by constructing continuous high levees. To date, Japan is continuing to develop and utilize technologies, including information and communications technology (ICT) such as radar and simulation technologies. Government technical officials commit not only to developing these technologies but also to policy- and decision-making.

The approach of consensus building for project implementation has continued to change (Figure 1.4). Movements against dam construction changed from opposition by affected residents to a controversy regarding the policy of water resources management. In the "Beehive Castle Dispute" over the construction of the Matsubara and Shimouke dams on the Chikugo River, dam-affected residents opposed the dam construction from 1958 to 1971.

Source: Project Research Team

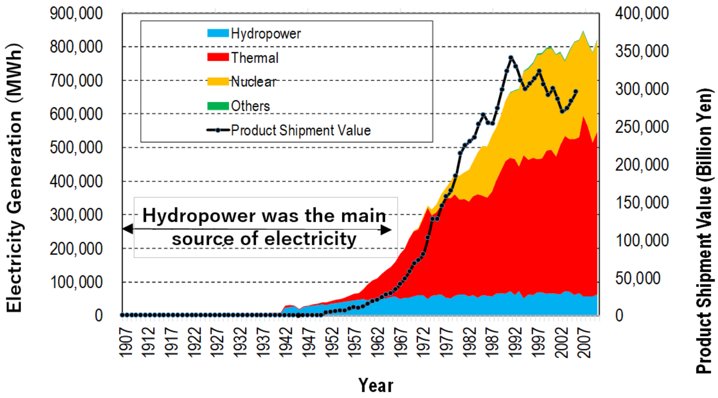
Figure 1.4 Three Public Works Projects that Affected the Water Governance

Based on the lessons learned from this opposition, the government developed legislation and financial mechanisms to support the rehabilitation of submerged communities and residents in reservoir areas. After a high economic growth, the citizens' sense of values improved since the 1980s, and infrastructure projects such as dam and weir construction became a social issue, debating the necessity of construction and environmental impacts. In the opposition movement over the Nagaragawa River Mouth Barrage, civil society groups involved political parties and the mass media and expressed their concern about the deterioration of the environment and ecosystem. This movement triggered a change in water governance, leading to progress in the transparency of the decision-making process, information disclosure, and enhanced accountability. The River Law, amended in 1997, introduced the policy of the participation of residents in planning projects. The Yanba Dam was proposed for flood protection and to provide a water supply to the Tokyo Metropolitan Area. The national government prepared its construction plan in 1967. The primary local community opposed the project and the opposition movement became a political issue. In 2009, the national government announced the cessation of construction projects. However, they re-evaluated the effects of dams on flood protection and water supply based on scientific data. The government finally decided to continue the construction in 2011, which was completed in 2020.

1.2 Japan's Accomplishment in Water Resources Management

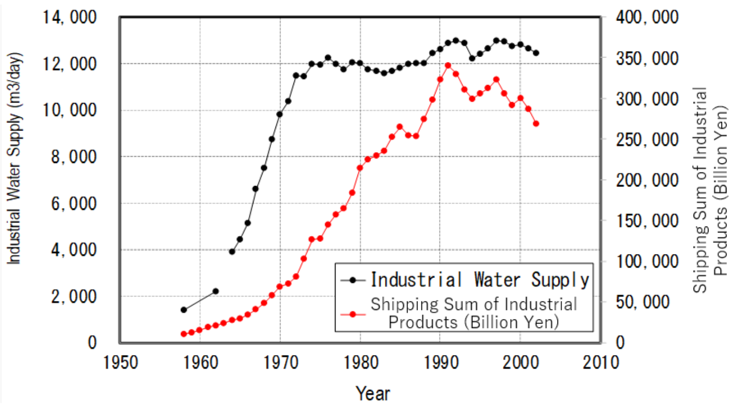
Water resources management contributes to quality growth of the nation by resolving water-related issues. This management made the country more resilient to floods, droughts, and epidemics, reduced inequality, and contributed to creating an inclusive and sustainable society in harmony with the environment. Water resources played an important role in the modernization of Japan from the end of the 19th century, reconstruction from the damage caused by World War II, and promotion of high economic growth.

Water resources management supported economic growth. To cope with food shortages after World War II, the national government developed water resources for irrigation and improved farmland and irrigation-drainage systems. Food production was stagnant due to the lack of production materials. Japan then suffered a food crisis and received food aid from the United Nations. In the energy sector, hydropower was a major energy source for reconstructing the country following World War II. Hydropower covered 80% of the electricity source in 1950. Japan developed large-scale hydropower plants to meet the rapid increase in electricity demand during its high economic growth. Hydropower generation was the main source of electricity until 1965 (Figure 1.5). The government has provided indispensable water for industrial activities by establishing an industrial water supply system from the 1950s, which is separate from the municipal water supply system and a few similar systems in the world (Figure 1.6).



Note: Product shipments and other data are from establishments with four or more employees.
Source: Compiled by the project research team based on the Japan Electric Power Industry History Database (Japan Institute of Management), statistics for 60 years of the electric power industry (Federation of Electric Power Companies of Japan), and data in the Industry Section of the Industrial Statistics Data Library, Ministry of Economy, Trade, and Industry.

Figure 1.5 Electricity Generation by Type and Product Shipment Value



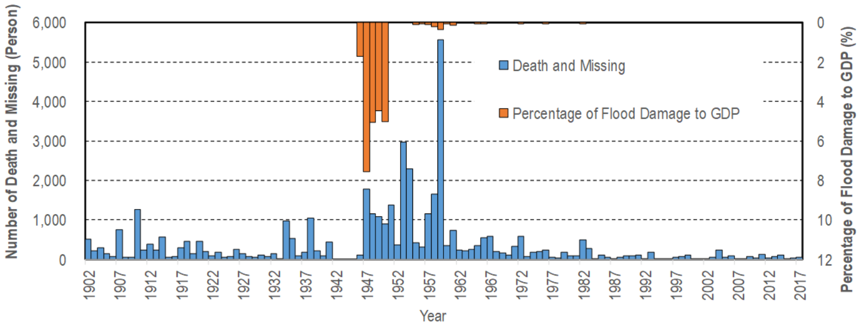
Note: The data is of establishments with 30 or more employees.
Source: Based on data from the Industry Section of the Industrial Statistics Data Library, Ministry of Economy, Trade and Industry.

Figure 1.6 Trend of Industrial Water Supply and Shipping Sum of the Contribution of Industrial Products towards Resilient, Inclusive, and Sustainable Growth

(1) Social Resilience

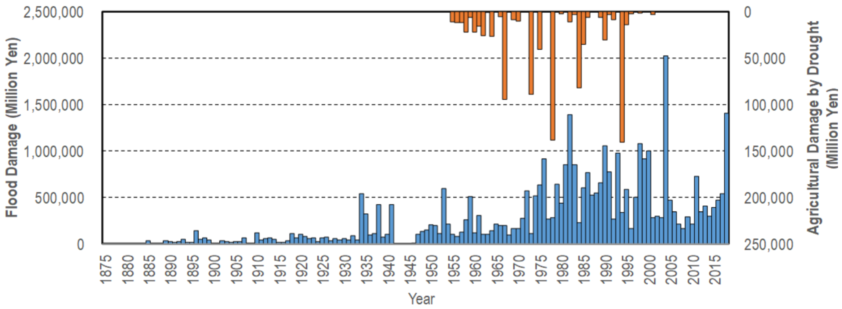
Investment in flood protection reduced flood damage. Japan is vulnerable to floods because major cities are located downstream of major rivers, and the population and assets are concentrated in these major cities. After establishing a modern nation in 1868, the government enacted the River Law and formulated long-term plans to promote flood protection projects. After World War II, flood damage frequently occurred until the 1950s with more than 1,000 casualties, and annual economic loss amounted to 1% to 10% of the gross domestic product (GDP) almost every year (Figure 1.7). The government allocated limited investments to flood protection due to the expanded military preparedness and wars since the 1930s. The flood discharge in the downstream areas increased due to the concentration of river discharge, resulting from the construction of continuous high levees on the river reaches. From the 1960s to the 1990s, the national government invested 1% of the GDP in flood protection, which succeeded in reducing the death rate due to floods. However, even today, a certain level of flood damage continues to occur, accompanied by the further congestion of the population and assets in urban areas. The country developed water resources to have a sufficient water supply, resulting in the reduction of drought damage to agriculture (Figure 1.8).

Infectious diseases were reduced through the development of water-supply systems. From the 1850s to the 1890s, Japan experienced major epidemics of cholera and dysentery. In 1879 and 1886, the number of deaths from cholera increased to over 100,000. The government established water supply systems to prevent waterborne diseases and improve sanitary conditions in cities (Figure 1.9).



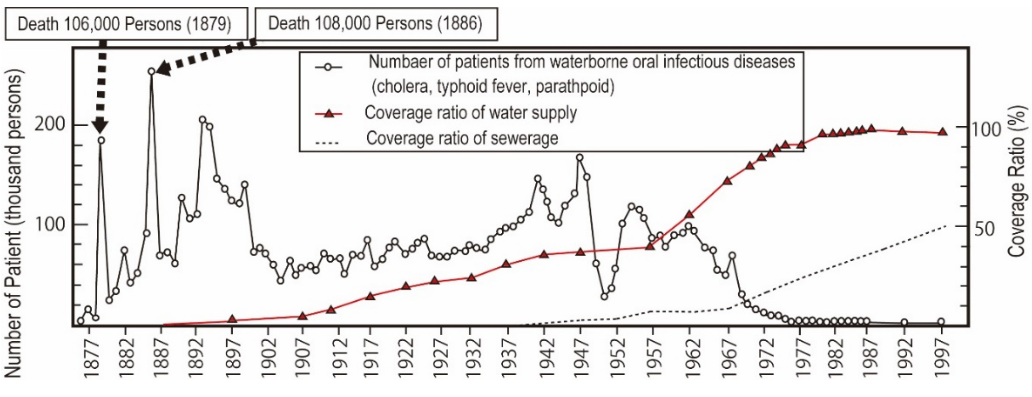
Note: Nominal GDP and amount of damages
Source: GDP data, "Changes in Japan's Postwar Finances and Future Challenges" 1946–1950, Ministry of Finance, "Annual economic report," long-term economic statistics from 1955 to 2019. Amount of flood damage and number of casualties: "Statistical survey on flood damage" 2018 MLIT

Figure 1.7 Number of Casualties due to Flooding and Flood Damages



Note: Amount of flood damage from 1875 and drought damage from 1955 (nominal damage)
Source: Amount of flood damages "Statistical Survey on Flood Damage" 2018 MLIT, Amount of drought damages "Crop Statistics Survey," Ministry of Agriculture, Forestry, and Fishery

Figure 1.8 Amounts of Flood and Drought Damages



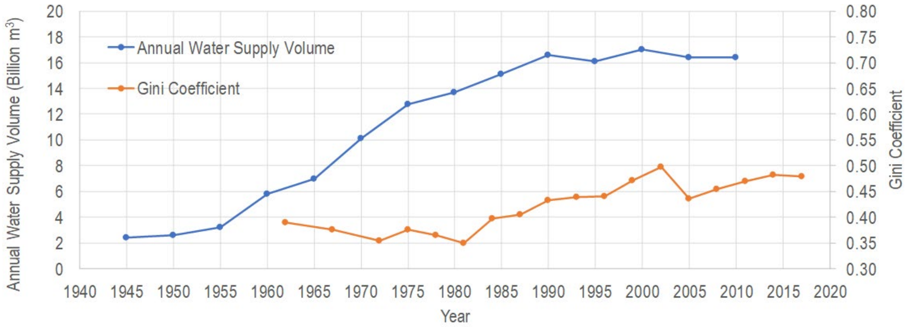
Source: "Urban Development and Public Health" Nakatsuji Hideji WHO in sight No. 44 (2010)

Figure 1.9 Number of Patients with Waterborne Oral Infections and Water Supply and Sewerage Coverage

(2) Inclusive Services

The improved water supply and flood protection supported urban development and mitigated regional disparities. During the period of high economic growth, there was a population influx from rural areas to three major metropolitan areas (Tokyo, Nagoya, and Osaka). Approximately 50% of the national population in 1980 was concentrated in these metropolitan areas. Industrialization created additional demand for workers in these areas. With the increase in urban employment opportunities, the Gini coefficient[1] dropped from 0.40 to 0.35, the income inequality was reduced, and the poverty ratio decreased (Figure 1.10). Local governments improved their water supply systems to cope with the rapidly increasing urban population. The population in the Tokyo metropolitan area doubled in 1980 compared with that in 1951. The water supply volume increased by 3.3 during this period (Figure 1.10).

Thus, access to safe drinking water and health has improved. Water supply and sewerage systems were first developed in urban areas, and subsequently in rural areas. In 1980, the water supply coverage ratio in Japan exceeded 90% (Figure 1.11). The coverage ratio of the sewerage system increased from 10% in 1965 to 80% in 20191.

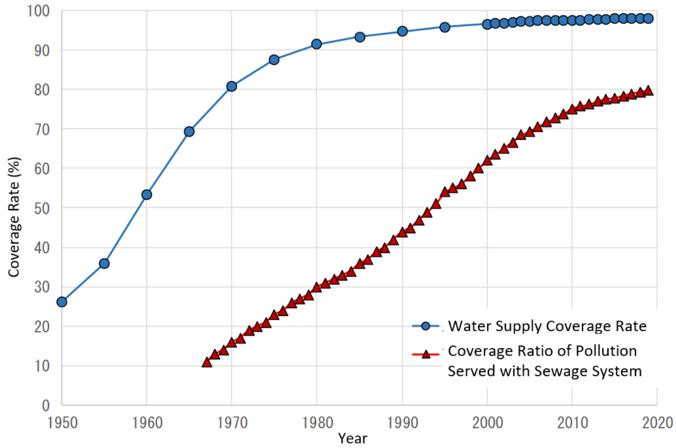


Source: Gini coefficient "Income Redistribution Survey" Ministry of Health, Labor and Welfare, Water supply volume" Introduction to Water Supply, 6th edition 2015 Water Supply Association, "Water Supply System in Japan 2007" Ministry of Internal Affairs and Communication

Note: The Gini coefficient in Japan after the redistribution of income was in the range of 0.3643 in 1990 and 0.3721 in 2017 (MHLW, https://www.mhlw.go.jp/stf/wp/hakusyo/kousei/19/backdata/01-01-08-09.html).

Figure 1.10 Annual Water Supply and Corresponding Gini Coefficients

[1] The Gini coefficient is a measure of inequality or disparity in income and assets. The Gini coefficient is 0 for a fully equal society and 1 for a fully unequal society. e.g., Indonesia 0.378, Philippines 0.423, Thailand 0.364, Vietnam 0.375 (World Bank data base, 2018)

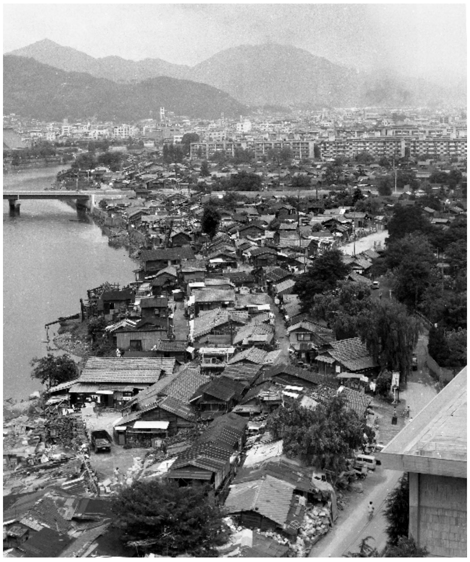


Note: Coverage ratio of water supply = total water supply population/total population. Total water supply population = tap water supply population + small-scale water supply system population + private water supply population. Coverage ratio of the population served with the sewerage system = Population of areas with sewerage systems in place/total population

Source: Project Research Team based on data from MLIT.

Figure 1.11 Water Supply and Sewerage Coverage Ratio

The living conditions of the urban poor also improved in conjunction with river improvement. The government implemented projects to support the urban poor living in and near the river area. For example, in Hiroshima, the victims and repatriates lived on the land in the Ota River, forming a slum known as the "Atomic Bomb Slum" (Figure 1.12). In the Ota River flood protection project, the government constructed public housing for low-income people and provided them with poor resettlement.



Source: "Motomachi Aioi Street as seen from the Rooftop of the Chamber of Commerce" Photo in the Bulletin of the Hirosima City Archives, No. 30, 1

Photographer: Research Group of Community Structure/Provider: The Hiroshima City Archives

Figure 1.12 Atomic Bomb Slum in Hiroshima

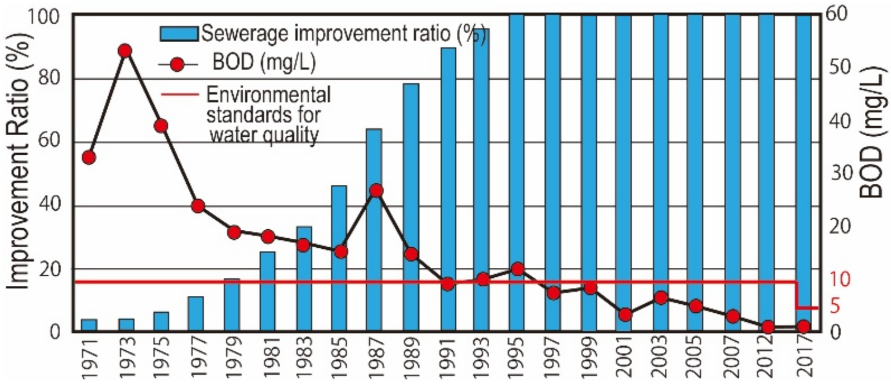
The government improved support for communities affected by projects. Adverse impacts such as loss of livelihood would occur due to resettlement caused by large-scale projects such as dam construction. Furthermore, dam projects have the characteristic that entire communities in the planned reservoir area would be submerged, which is different from those of other public works projects such as roads. To mitigate the social impact of large-scale projects, the government is required to implement measures to rebuild local communities in addition to compensation for losses. These included the development of relocation sites, support for livelihood restoration, and vitalization of tourism using the dam reservoir.

(3) Sustainability

Japan improved the quality of river water by establishing drainage regulations and constructing sewage systems. With economic growth, health hazards have worsened due to pollution-related diseases caused by factory effluent, and the water quality deteriorated due to domestic wastewater. Water resources development and flood protection works worsened the water environment and the ecosystem. Laws and system regulations for monitoring and penalties improved the water quality. Pollutant loads from factories were reduced by one-fifth from 1970 to 1989. Factories improved their production processes and wastewater treatment. Sewerage facilities and on-site facilities (Jokaso: domestic wastewater treatment tanks at household level) can reduce household pollutant loads. For example, the water quality of the Yanase River, which flows through Saitama Prefecture and the Tokyo Metropolitan Area, was improved by introducing a water purification system and expanding the sewage systems (Figure 1.13).

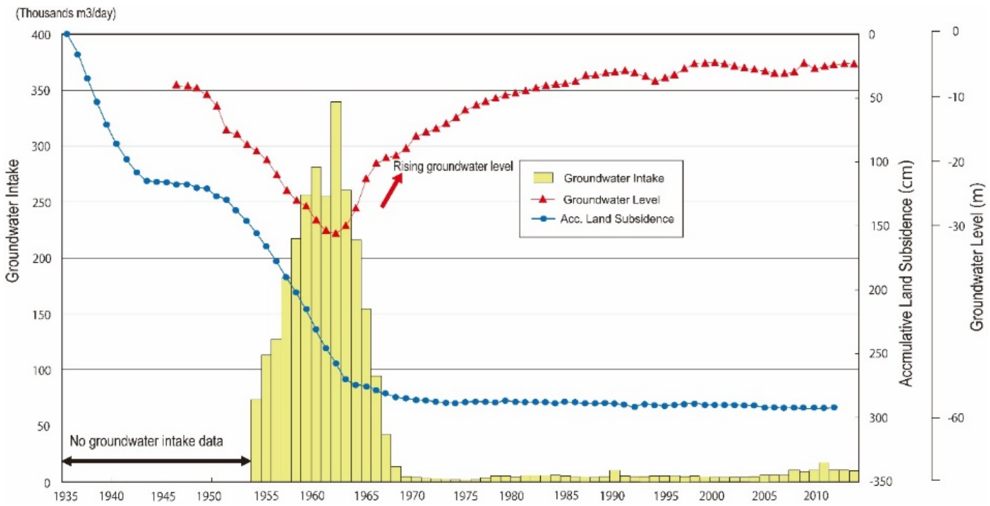
Industrial water supply systems have contributed to the cessation of land subsidence and salinization by substituting groundwater. This system can provide a large quantity of water at a lower cost. Figure 1.14 shows the changes in the amount of groundwater extraction, land subsidence, and groundwater level in Osaka City. Industrial water sources accounted for approximately 80% of groundwater extraction in Osaka City until 1960. By 2019, it had dropped to approximately 20%.

Green infrastructure is being promoted, with the expectation of contributing to ecosystem conservation and environmental protection. Green infrastructure or nature-based solutions could provide multiple benefits, such as disaster risk reduction, habitat creation, and local economy stimulation.



Note: The coverage ratio is from one of the right bank treatment areas of the Arakawa River, and BOD is the annual value (75% water quality value) at the Seiryu Bridge.
Source: Tokyo and 50 Years of Regional Sewerage System, Tokyo Metropolitan Government, Bureau of Sewerage

Figure 1.13 Water Quality of the Yanase River and Sewerage Coverage Ratio

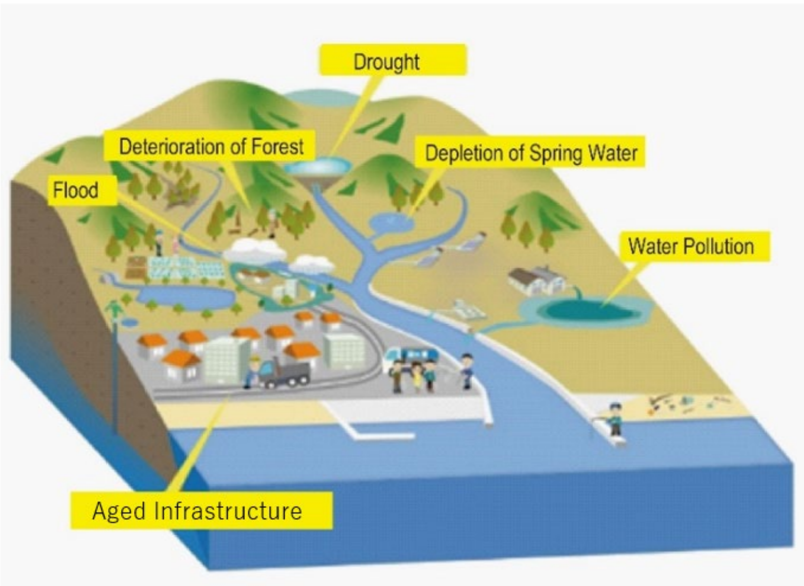


Note: Groundwater extraction data: Minato station until 1964 and Minato station II from 1965 onwards.
Source: "Report on the effective use of groundwater in consideration of the ground environment in the Osaka City area," Study Council on the Effective Use of Groundwater in Consideration of the Ground Environment in the Osaka City Area February 2019

Figure 1.14 Groundwater Extraction Volume, Groundwater Level, and Cumulative Land Subsidence

1.3 Issues for Water Resources Management in Japan

The water resources management in Japan supported the quality growth but left some issues unaddressed (Figure 1.15).



Source: Website of Cabinet Office

Figure 1.15 Issues in Water Resources Management

(1) The quick responses and flexibility were limited. Since the 1950s, pollution-related diseases, such as Minamata disease, caused health hazards. Japan prioritizes economic growth. Factory effluents are regulated in a limited manner, resulting in water pollution. The national government strengthened measures to mitigate pollution and health hazards after the Diet in 1970, called the "Pollution Diet," which convened to intensively discuss pollution control measures. In addition, it took a long time to review facility capacities to match the actual demands. Because the water demands stabilized after the high economic growth, the capacities planned for water resources development projects were overestimated.

(2) Establishment of water governance: The issue is to establish a water governance system that can quickly respond to the diverse needs of an ever-changing society. However, technology and engineering approaches are insufficient to address this issue. The various needs of the environment, ecosystems, and adaptation to climate change cannot be met by governments alone. Therefore, it is necessary to establish legal and organizational mechanisms for unified water resources management. Mechanisms are required to overcome the deficiencies existing in vertically divided administration systems and achieve cross-sectional management. A wide range of stakeholders should be involved in sharing roles and responsibilities, including other sectors, such as urban and disaster management, the private sector, and civil society organizations (CSOs). A basin water cycle council[2] should be established to maintain and restore a healthy water cycle in a river basin. Efforts are also necessary to build a mechanism to develop and implement a basin water-cycle plan.

(3) Adaptation to climate change and socioeconomic change: It is necessary to enhance the resilience and sustainability of river basins by all stakeholders who contribute to socioeconomic growth by strengthening countermeasures against water-related disasters that are becoming more severe with climate change. All parties involved in the river basin from the upstream catchment area to the downstream inundation area should collaborate to implement countermeasures. With declining birth rates and an aging population, the water resources sector should contribute to maintaining the vitality of communities, improving productivity and national growth, and promoting inclusive disaster management. In recent years, there has been an increase in flood damage to medical institutions and welfare facilities that are vulnerable to disasters, including hospitalized patients, the elderly, and the disabled. It is necessary to regulate the construction of medical institutions and welfare facilities for the elderly and disabled in high-risk areas that are prone to flooding and difficult to support and evacuate. In addition to existing structural measures, the promotion of urban development and the strengthening of disaster management are required. Risk management for water shortages is also required.

[2] Water cycle council was established to prepare basic plan for conserving the water cycle following Basic Act on Water Cycle.

CHAPTER 2 OUTLINES OF EACH THEME

This report explains the water resources management system in themes 1 to 3, the issues in each field important in developing countries discussed in themes 4 to 9, and the development of human resources and technology (Table 2.1).

Table 2.1 List of Themes and Issues in Each Field

Theme		Section	Flood Protection	Water Use	Environment
1. Governance	1-1 Legislation and Organization	2.1	O	O	O
	1-2 Water Rights	2.2		O	O
	1-3 Public Participation and Decision-Making Process	2.3	O	O	O
2. Plan-based Management	2-1 Management Planning	2.4	O	O	O
	2-2 River Basin Planning	2.5	O	O	O
3. Finance		2.6	O	O	O
4. Water Pollution and Environmental Management		2.7			O
5. Urban Water Management		2.8	O	O	O
6. River Management		2.9	O	O	O
7. Groundwater Management		2.10		O	O
8. Dam Management		2.11	O	O	O
9. Environmental and Social Considerations in Large-Scale Projects		2.12			O
10. Development of Human Resources and Technology		2.13	O	O	O

Note: "O" shows issues explained in this report.
Source: Project Research Team

2.1 Legislation and Organizations to Coordinate Sectors and Regions

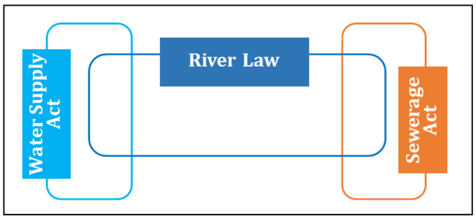
The government should establish legal systems and organizations to coordinate among stakeholders and water users, between upstream water source and downstream beneficiary areas, and between development and environmental conservation. These conflicts and confrontations are involved interests, regional conflicts, shared roles, and shared costs among many stakeholders and sectors. Water abstraction from rivers and flooding may induce conflicts between the upstream and downstream reaches, and flooding may induce conflicts between the left and right banks of the rivers. Environmental and ecological perspectives are also important for addressing conflicts.

Over the past 2,000 years, Japan has resorted to river management to make use of the water and to reduce flood damage. Since ancient times, the government has developed surface water from rivers for the irrigation of paddy fields. Activities against frequent floods are also necessary to protect residential areas and cultivated lands. Rivers are also used for transportation purposes. Based on history, laws and organizational systems were established after the establishment of the modern nation at the end of the 19th century. River water utilization and flood damage reduction are important issues. The River Law was enacted to manage river water, apart from the Water Law, which generally deals with water resources.

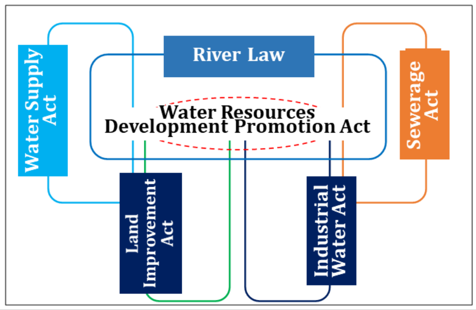
Japan transformed institutions to meet the changing needs of the country along with the nation's growth, socioeconomic changes, and climate change (Figure 2.1).

(1) **Modernization:** To promote modernization, the Meiji government, established in 1868, improved river channels for navigation systems, which functioned as the main transportation system at that time. The River Law was enacted in 1896 to mitigate the increase in flood damage caused by modernization. Local governments managed flood protection projects. In 1896, the government initiated a national flood protection project. The government enacted the Water Supply Act in 1890 and the Sewerage Act in 1900 to improve public health and prevent waterborne diseases, such as cholera, which killed over 100,000 people in 1879 and 1886.

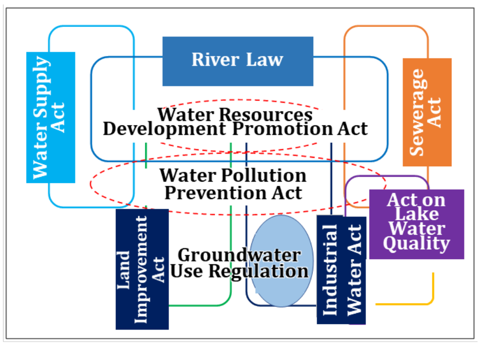
(2) **Post-WWII Reconstruction (after 1945):** Since the late 1940s, to restore the nation's devastated land, the government promoted hydropower generation and food production by developing water resources, which is one of the limited natural resources in this resource-poor country. In 1949, the government enacted the Land Improvement Act to develop irrigation facilities. Various river basins suffered unprecedented damage due to a series of floods that occurred after 1945. The government intensively implemented national land conservation projects for flood protection and watershed management.



Modernization: End of 19th Century-Mid 20th Century, Flood Prevention and Public health



High Economic Growth: Mid 20th Century to 1970, Water Resources Development



Sustainable Growth :1970-Present, Environment

Source: Modified Figure of Team Water-Japan by Project Research Team

Figure 2.1 History of the Legal System Related to Water in Japan

(3) **High Economic Growth:** The government developed water resources to meet the rapidly increasing demand for electricity and domestic and industrial water. In 1964, "water utilization" was added to the objectives of the River Law, and the government targeted river management based on the integrated river system principle. Japan established the Water Resources Development Promotion Act and institutions to promote multi-purpose facilities to develop water resources and mitigate flood damage.

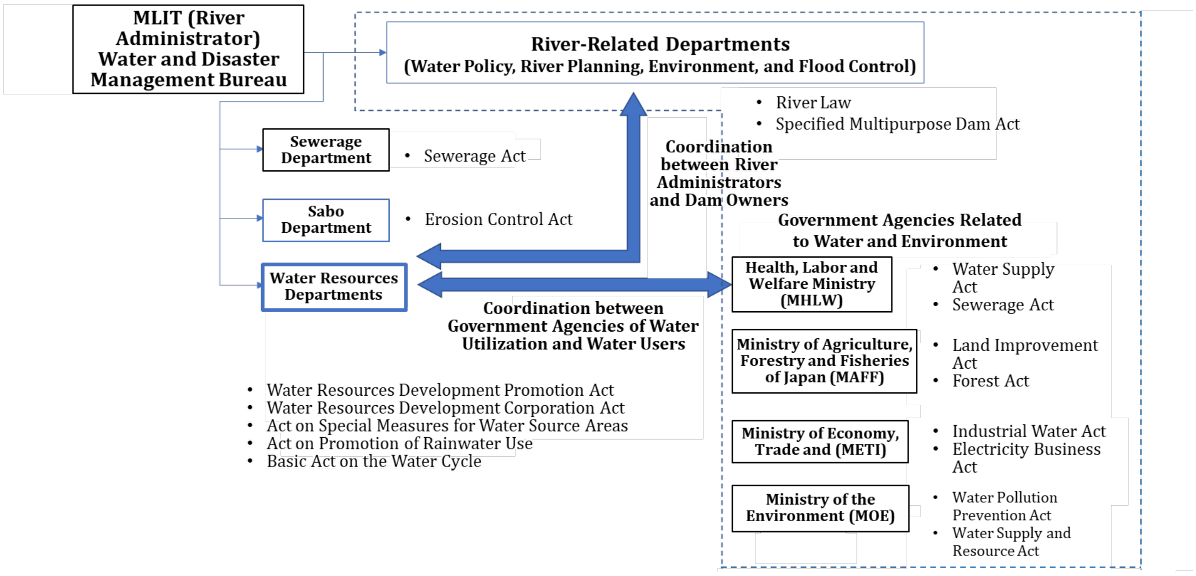
(4) **Resolving environmental issues caused by high economic growth:** Since the 1960s, the adverse effects of industrial and mine wastewater pollution became more significant. The environments of rivers and oceans deteriorated and severe health problems occurred, causing approximately 40,000 pollution victims. Many people continue to experience and suffer from pollution. This is the negative impact of Japan's high economic growth. Water Pollution Prevention Act was formulated, and the government established systems to prevent water pollution. Although the old Sewerage Act was enacted in 1900, the development of sewerage systems did not progress. Full-scale

development began after the new Sewerage Act was enacted in 1958. In 1956, the Industrial Water Act was enacted to regulate groundwater extraction and stop land subsidence, which became increasingly prominent. By the end of the high economic growth, interest in the water environment has increased due to the diversification of society values. Environmental preservation was added to the objectives of the River Law in 1997. A system was established to reflect the opinions of river basin residents when formulating river improvement plans to meet diverse needs. The water management system is being transformed, via management of the water resources by the government, to a governance system that involves relevant institutions, basin residents, and academic experts. The Basic Act on the Water Cycle was enacted in 2014 to ensure a healthy water cycle, including the use of groundwater in a comprehensive and integrated manner.

(5) **Adaptation to climate change**: With climate change, the frequency and intensity of damage caused by floods are increasing. As rivers alone cannot cope with such intensified flooding, efforts are being made to accelerate advanced disaster-prevention measures in cooperation with the national government, local governments, and the private sector. The RMOs and related agencies implemented basin-wide flood protection measures for the entire urban area and basin, based on the policy of river basin disaster resilience and sustainability. Approaches for managing water shortages have shifted from providing sufficient water to managing drought risks.

The Water Resource Bureau[3] (presently the Water Resource Department) was established in 1962 to coordinate all related ministries and departments regarding water resources policies and to formulate and promote basic plans for water resources management. The main national government agencies related to water resources are the MLIT with jurisdiction over flood protection and sewerage; the Ministry of Agriculture, Forestry and Fisheries (MAFF) with jurisdiction over irrigation water; the Ministry of Health, Labor and Welfare (MHLW) with jurisdiction over domestic water supply; the Ministry of Economy, Trade and Industry (METI) with jurisdiction over hydropower and industrial water supply; the Ministry of the Environment (MOE) with jurisdiction over ecology and water pollution; and the Ministry of Internal Affairs and Communications (MIC) with jurisdiction over local government projects (Figure 2.2).

[3] It was established in 1962 as a bureau of the Economic Planning Agency, and later moved to the National Land Agency in 1974 and to a department of the Ministry of Land, Infrastructure, Transport, and Tourism in 2001.



Source: Project Research Team referring to website of MLIT

Figure 2.2 Entities Involved in Water Resources Development and Concerned Law and Acts

The Water and Land Management Bureau of MLIT manages major rivers, and local governments manage other rivers. The Minister of Land, Infrastructure, Transport, and Tourism and prefectural governors are referred to as river administrators. The MLIT established RMOs in each river basin with the responsibility of river-improving policies and planning, river maintenance work, providing water and land occupation, and issuing permits and approvals for the construction of river structures.

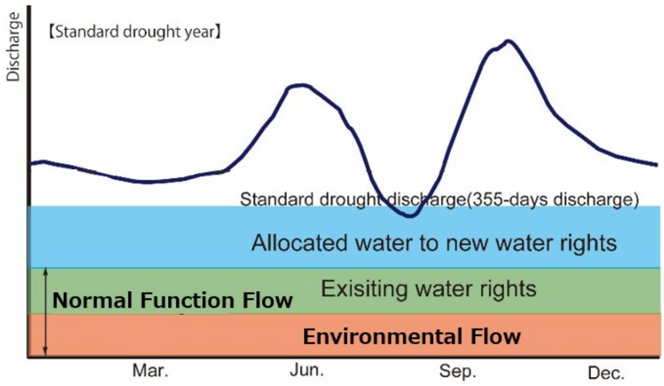
2.2 Water Use Order with Water Rights System based on Customaries and Characteristics

The government should establish a water-using order by introducing a water rights system based on past water management and the background of past development, customs, and history. Water distribution can increase the tension between areas and may lead to disputes. In Japan, violent disputes occurred regarding the distribution of irrigation water. At the time of establishing the modern legal system, the government introduced licensed water rights based on the potential of water resources. The River Law dealt with irrigation water that was already developed as customary water rights.

The RMOs manage water rights and issue licenses. In Japan, river water is a public good[4] and water users may use it to promote public welfare. Water rights are not fixed or vested but are obliged to change along with social changes, such as urbanization and increased weight of the environment value. Land ownership and water rights are separated under the River Law. The RMOs (the river management offices stipulated by the river administrator in the river law: MLIT or prefectural governor) approve water abstraction based on the following viewpoints: (1) promotion of public welfare, (2) soundness of project implementation, (3) ratio of the water abstraction volume applied to

[4] Water that is used for public purposes. Water in a lake or river that is regulated by public law.

the total river flow volume, and (4) effects on public interests. The MLIT usually sets the safety level of drought[5] "once in ten years." The flow applied for new water rights may be approved if the ten-year drought flow can cover the environmental flow[6], the flow required to meet existing water rights, and the additional flow applied (Figure 2.3). The permit period is generally ten years and should be renewed every ten years. Water users pay water rights fees. The river law stipulates penalties for illegal water abstraction.



Source: Project Research Team

Figure 2.3 Range of New Available Permits

During drought, water users coordinate their abstraction volumes at drought-coordinating committees in the spirit of co-assistance, which is fostered through the practices and history of each river basin. Coordination rules vary according to the past development history and practices in each river basin. Some examples are to set a rule of uniform saving rate in water abstraction among water users, prioritizing customary water rights, or prioritizing domestic water supply. RMOs provide the necessary information and set up meetings to ensure smooth coordination among water users.

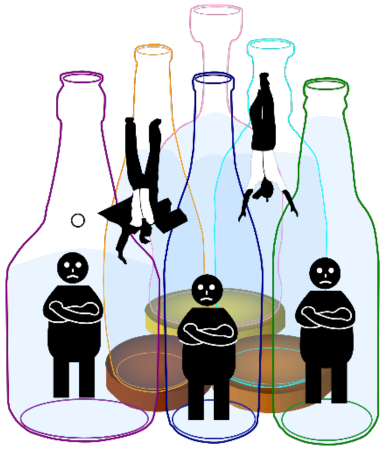
By establishing systems for the transfer of water rights[7], water resources can be managed effectively. Water rights are being transferred from agricultural use, with declining water demand, to urban use, with increasing water demand. In the Tokyo Metropolitan Area, with further increase in population, water rights were transferred to urban water from irrigation users through renovation projects of irrigation canals. The water supply offices bore the cost of these renovations to obtain water rights. Water trading with financial compensation has not been practiced in Japan.

Farmers' associations (irrigation area improvement and management associations) manage irrigation facilities. The farmers set rules for water allocation within the irrigation area and manage irrigation facilities. Public institutions operate their facilities to ensure fairness and effectiveness. The operating funds of the farmers' associations are levied by members.

[5] Drought flow is the river flow that does not fall below this value for 355 days a year.
[6] The maintenance flow is the discharge (flow rate) that must not impair the normal functioning of the river, such as the environment and ecosystem, and is determined in consideration of the protection of flora and fauna, fisheries, scenery, and maintaining the cleanliness of the flowing water.
[7] When, for some reason, the full amount of the permitted water right is not needed, the difference between the required amount and the permitted amount is reduced, and the reduced amount is diverted to other purposes. The party reducing the water abstraction should go through the procedures for reduction and the party increasing the water abstraction should apply for the additional water right.

2.3 From Government Management to Building Water Governance

In promoting water resources management, water governance[8] should be established according to the actual conditions of each river basin and the local community. It is difficult to meet the diverse needs of an increasingly complex society when the government manages consensus building among the stakeholders. Some needs cannot be met by a vertically segmented administration system in which the responsibilities of each ministry and the laws under their jurisdiction are clear (Figure 2.4). Building water governance requires the participation of residents and CSOs in the decision-making process, disclosure of information on projects for this purpose, clarification of the role and responsibility of related agencies, and accountability of the government.



Note: The bottles are governments. Citizens fall through the gap in the bottles.
Source: Japan Water Forum, Takemura Koutaro

Figure 2.4 Vertically Segmented Administrative Model

The controversy over the Nagaragawa River mouth barrage provided an opportunity for water governance reform. With the end of the period of high economic growth and the diversification of citizens' values since the 1980s, there has been an increase in the number of cases in which the environmental impacts of public works, such as dams and barrages, became major social issues. Opposition to the construction of the Nagaragawa River mouth barrage gained momentum with their concern about deteriorating the environment and ecosystem, involving political groups and the mass media, and became well known throughout Japan. The MLIT, as the river administrator, decided to disclose relevant data on water quality, hydrology, and the environment. Eight roundtable meetings were held in public to discuss the issue, but the parties did not compromise, and the operation of the barrage was launched. These have enhanced the transparency and accountability in the decision-making process of infrastructure projects.

In Japan, the river basin committee is established in each river basin to formulate "river improvement plans" for flood protection, water utilization, and environmental conservation. The 1997 River Law stipulates a river improvement plan that indicates the goals and specific contents of river improvement to be implemented over the next 20 to 30 years. The opinions of academic experts are collected, and public hearings are held to reflect the opinions of residents in the river basin. River basin committees operate under a variety of institutional designs so that the committees vary among river basins.

[8] Water governance is a concept that includes water management for flood protection and water use and a basic sense of values and principles based on organizations and communities, such as respecting the will and human rights of the people, legality, reliability, and transparency.

Innovative efforts were made to establish water governance in the Yodo River. The Yodo River flows into the metropolitan areas of Osaka and Kyoto, which have been the center of growth in Japan since ancient times. The river basin committee was established in 2001, and experts and residents proactively participated in discussions on an equal footing (Figure 2.5). The national government usually serves as the secretariat of the committee by selecting committee members, preparing draft plans, and directing discussions. However, in this committee, the secretariat role was entrusted to a private company as a third party, and the preparatory committee selected committee members. A wide range of issues related to floods existed in the river basin, and the committee discussed environment conservation and water utilization instead of discussing specific projects to avoid unnecessary conflicts among members. This approach provided an opportunity for expert members to learn the need for environmental as well as engineering viewpoints. A conflict of opinions occurred in dam construction between the national government and the committee, and the river improvement plan was not formulated. This committee was suspended in 2007.

Source: Yodo River Basin Committee

Figure 2.5 The 85th Committee (April 8, 2009, Hirakata City)

Information disclosure is essential to establish water governance through citizen and stakeholder participation. Information disclosure enables government agencies to communicate with CSOs. The Information Disclosure Act, enacted in April 2001, allows anyone to request the disclosure of all administrative documents. The MLIT provided guidelines for resident participation in 2003 and formulated appropriate infrastructure plans by applying the guidelines in cooperation with residents and stakeholders while disclosing information on infrastructure projects from the planning stage. Outlines of infrastructure projects and their annual budget implementation are accessible on websites.

There may be more than one correct answer to resolve issues by coordinating stakeholders' opinions, and the attitude to keep looking at the most preferable answer is most required. Residents' participation in the process of decision-making for infrastructure projects is often lengthy because of the various opinions of the residents. Even though it is quite difficult to reach a unanimous agreement, efforts to find the most preferable solutions for all residents and stakeholders are required, expecting that the project will contribute to the region's interests and for which accept.

A review of the projects is necessary for keeping with socioeconomic changes. In particular, large-scale projects often require a long period of implementation, and socioeconomic conditions may change. Thus, each country should introduce adaptable and flexible mechanisms. In Japan, at the re-evaluation stage, the government decides to "continue" or "discontinue" the project at three major stages: application for a new project, re-evaluation during implementation, and post-evaluation after completion.

It is important to strengthen the cooperation between the public and private sectors and local communities for environmental conservation and disaster prevention (Figures 2.6 and 2.7)**.** The government can support these activities through financial support, training, and awards. Local communities and residents need to prepare for disasters in accordance with local conditions. The private sector can provide solutions to various issues by utilizing its resources.

Source: Outline of Typhoon No.18 in September 2013, Kinki regional development bureau, March 2014

Figure 2.6 Overflow in the Downstream River

2.4 Water Resources Management positioned in a National Development Framework

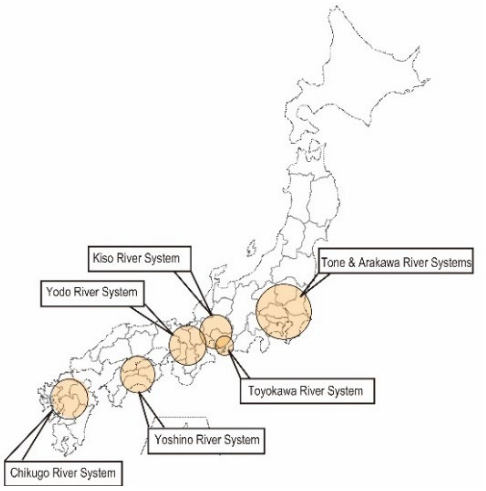
The water resources development plan should be a consistent framework of higher-level plans, such as the national development plan. Water resources management is essential to achieve resilience, sustainability, and inclusive growth. If water resources management is not undertaken properly, problems such as floods, droughts, and environmental deterioration may occur and affect the growth of the nation. In Japan, water resources development was promoted as the core issue of comprehensive regional development for reconstruction after World War II. After 1945, population pressure was so strong that the supply of basic commodities, such as food and energy, was short. Because water was the only available natural resource, the government developed it for hydropower and irrigation. During the high growth from the 1950s, the Japanese government formulated the National Comprehensive Development Plan (NCDP) to indicate the basic direction of national land development from a long-term perspective. Each revised NCDP include water resources management as the key issue of national development.

Source: Tree Planting for Fish Breeding Campaign Regain the 100-year-ago natural beach

Figure 2.7 Tree Plantation

National plans for water resources management can contribute to efficiently implement projects. Water resources-related projects require a long period from planning to construction. In addition, after completion, the project operation and effects (benefits) last for a long time. Plans with a long-term perspective are essential. The plans regarding water resources may be formulated as an upper-level plan for a country above the ministry level. These plans are not just to present a list of projects but should also explain the goals, effects, and inputs to solve the issues based on the actual data to ensure policy implementation.

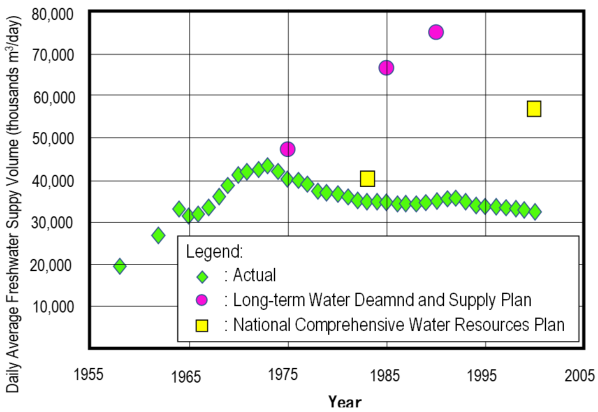
The Japanese government formulates the Basic Plan for Water Resources Development (full plan) for designated river systems. The plan provides comprehensive water resources management, indicating (1) the demand projection of each water and target of water supply, and (2) the necessary facilities to be developed to achieve the supply target. A cabinet attended by water-related ministers, finance ministers, and planning ministers approves this as the national plan above the ministry level. During the high growth, the water demand increased drastically due to the significant development of industries, the rapid increase and concentration of the urban population, and the improvement of living standards. In accordance with the Water Resources Development Promotion Act (1961), the national government designated seven river systems as water resources development systems that require wide-area coordination of water supply and water resource development (full plan river systems) (Figure 2.8). Approximately 50% of the population and industrial activities are concentrated in the full planning of the river systems, which cover approximately 17% of the country's area. The Water Resources Department,[9] which belongs to the MLIT, prepares draft plans as the secretariat for coordinating with related ministries and prefectures.



Source: Prepared based on MLIT Website data

Figure 2.8 Location Map of the Full Plan River System

All plans require a review mechanism. Water demand changes along with socioeconomic changes and technological progress. Planned projects also require changes. In Japan, the high economic growth ended in the 1970s, and, owing to the efforts of reusing industrial water and decreasing water consumption, the deviation between the long-term projection of the water demand and the actual demand became significant (Figure 2.9). It was pointed out on the long-term sector development plans that "the resources allocation tends to be almost fixed, and it is difficult to timely reflect the economic trends and financial status to the development projects."



Source: Analysis and Evaluation of Japan's Water Demand Forecasting System, Nishioka Takashi, Nasu Shingo

Figure 2.9 Comparison of Projected and Actual Water Demand in Japan

[9] Burau that develop plans for water resources

Formulating a long-term plan contributes to securing a budget for long-term project implementation. Since water resources development projects and flood protection projects take a very long time to complete, it is necessary to get a commitment to the long-term budget in place of allocating the budget for each fiscal year. In Japan, the national government formulated its first long-term plan for flood protection after experiencing a great flood in 1910. Budgets were estimated for each river basin and flood protection projects were implemented. To manage the accounting work for these projects, the national government created the Special Account for Flood Protection, independent of the general account. In 2003, this long-term plan was integrated into the Priority Plan for Social Infrastructure Development along with eight other sector plans.

Under climate change, the flood management with a comprehensive and multi-layered approach by various stakeholders throughout the river basin (Figure 2.10), and the "risk management" for droughts are required. Conventional structural measures such as levees and dams are no longer sufficient to intensify flood disasters under climate change (Table 2.2). The Japanese government has initiated the "river basin disaster resilience and sustainability through all" programs using the following approaches:

(1) Flood protection: structural measures, irrigation ponds, rainwater infiltration, and flood storage in urban areas
(2) Exposure reduction: regulate urban development in hazardous areas, and
(3) Disaster resilience: cooperation with the stakeholders for disaster response and reconstruction.

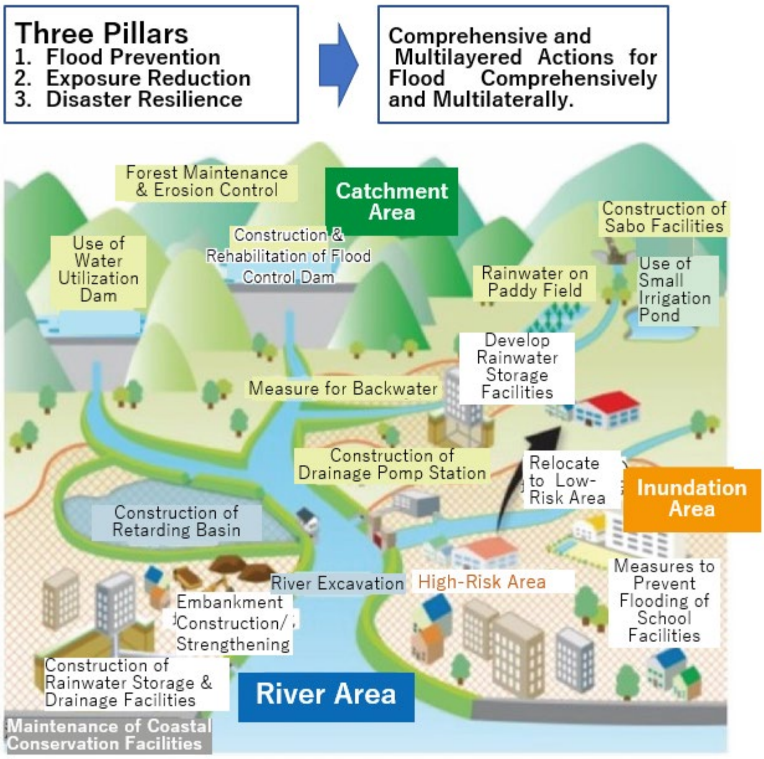
The risk-managed "stable water supply" is the key to thoroughly utilizing existing facilities and ensuring the functioning of the overall system through coordination of structural and non-structural measures. A stable water supply requires advanced technology, such as the latest observation technology and ICT, to forecast uncertain future climate change.

Table 2.2 Rate of Change in Rainfall, Flow Rate, and Flood Frequency due to Climate Change

Climate Change Scenario	Rainfall	Flow Rate	Flood Frequency
2°C increase	Approx. 1.1 times	Approx. 1.2 times	Approx. 2 times
4°C increase	Approx. 1.3 times	Approx. 1.4 times	Approx. 4 times

Note: The target rivers are those managed by MLIT, and the average values are shown. Discharge (flow rate) was calculated based on the runoff model used for each water system.

Source: Proposal for Flood Control Planning in Light of Climate Change, Revised Edition, MLIT, April 2021



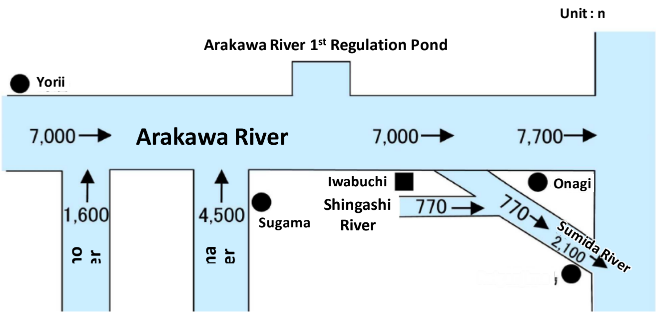
Source: MLIT Website

Figure 2.10 Schematic Diagram of River Basin Disaster Resilience and Sustainability by All

2.5 River Basin as a Unit of Water Resources Management

The governments formulate water resources management plans according to basin characteristics and regional customs. These include formulating a water resources management plan with consistency among the related sectors throughout the river basin and setting the improvement targets to optimize river facility development and water management from the perspective of the overall river basin. The hydrological data are essential for developing management plans. If the observation data are insufficient, satellite observations, past marks, and hearsay should be recorded.

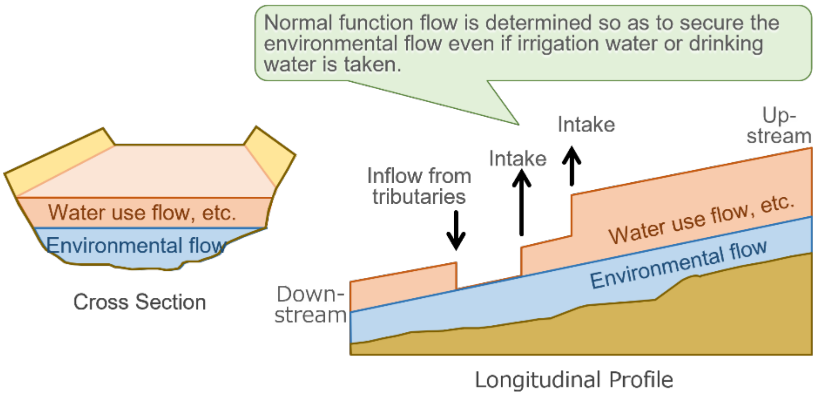
The safety level of flood protection should be set according to the importance of protected areas. The safety levels of the flood protection plan were expressed as the probability of the target flood level (probability year). Major rivers flowing through socioeconomically important areas require high safety levels. For example, the Tokyo Metropolitan Area and Osaka City have the highest target levels once every 200 years. Figure 2.11 shows the planned flood discharge of the Arakawa River, which runs in the Tokyo metropolitan area.



Note: Flood protection level 1/200
Source: Website of Arakawa Upstream Basin Office, MLIT

Figure 2.11 Planned Flood Discharge of the Arakawa River

The safety level (probable year of drought frequency)[10] **should be set as the target for the water management plan.** Governments formulate a plan to ensure the normal function of river flow, including the new demand for water use and environmental conservation of the river. In Japan, the safety level against drought is generally defined as a drought level of approximately once every ten years. If the natural flow in a river is insufficient, water storage facilities are constructed. The normal function flow includes not only water used for irrigation and domestic water supply but also a wide range of environmental flows (Figure 2.12) for (1) navigation, (2) fishery, (3) tourism, (4) maintenance of clean water flow, (5) prevention of salt damage, (6) prevention of blockage of estuaries, (7) protection of river management facilities, (8) maintenance of the groundwater level, (9) landscape, (10) habitat of animals and plants, and (11) securing rich interactions between people and rivers.



Source: Preparation of the Project Research Team based on the Hyogo Prefecture website

Figure 2.12 Image of Setting Normal Function Flow

A master plan and an action plan should be prepared to improve the river. The River Law revised in 1997 requires the preparation of a river development plan in two stages. "The Basic Policy for River Development" is a master plan for the comprehensive management of water resources, providing policies for (1) flood protection, (2) water use and maintenance of river flow functions, and (3) improvement and conservation of the river environment. It includes the target of flood protection, capacity of facilities for flood protection, planned river water level of the target flood, river discharge to maintain the normal function of the river flow (water use, function of river flow, and river environment), and environmental management. Basic policies cover the principles of managing the environmental issues of ecosystems, scenery, water quality, and recreation. "The River Improvement Plan", which is an action plan, specifies the concrete contents of improvement actions, including specific individual projects for 20 to 30 years. The RMOs formulate the River Improvement Plan upon consultation with a council, such as a river basin committee, and considering opinions from related residents, local governments, and academic experts.

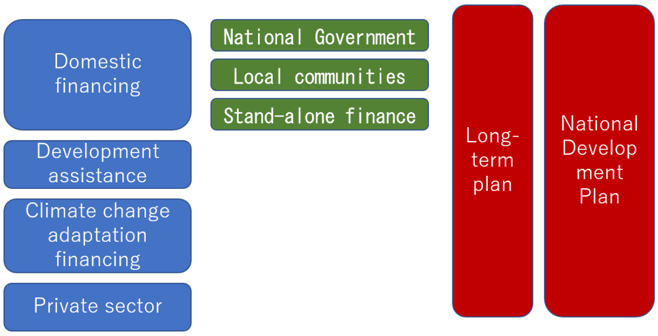
The RMOs understand the issues and needs of the field. The RMOs should understand the issues and needs of local communities in the field and prepare measures together with these communities. To collaborate with various stakeholders in water resources, disaster management, urban development,

[10] Indicators of water intake safety against droughts when using river water.

environmental conservation, and agriculture, the RMOs are required to build trust relationships with the relevant organizations and local communities in the field. The MLIT has an RMO for each river basin and branch office under the RMO to coordinate with stakeholders and establish mutual trust.

2.6 Cost Sharing according to Responsibility and Role

Governments should provide financing investments and involve the private sector in investing in water resources management (Figure 2.13). In Japan, public funds consist of general funds from national and local governments and special accounts. The local government has historically conducted flood protection projects and irrigation pond construction. At the end of the 19th century, the national government started directly implementing flood protection projects as modernization progressed. Local governments have implemented water supply and sewerage projects, while companies have implemented power generation projects. Projects of the national government require the local governments to bear the cost as project beneficiaries. Water supply and sewerage projects also require users to bear the costs. Table 2.3 and Figure 2.14 show the sharing of the project costs.



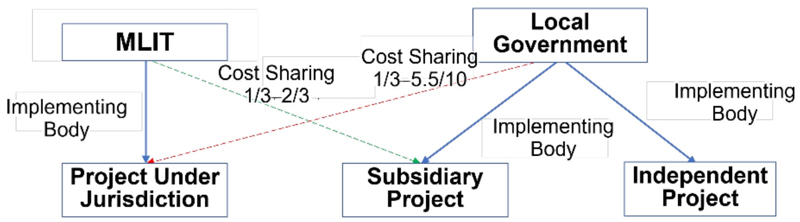
Source: Ishiwatari, M. and Akhilesh S. "Good enough today is not enough tomorrow: Challenges of increasing investments in disaster risk reduction and climate change adaptation." Progress in Disaster Science 1

Figure 2.13 Finance for Water Resources development and Management

Table 2.3 Sharing of Project Cost

Purpose	River Class	Share of Expenses
River improvement	Class A	National Government (MLIT) 2/3, Prefecture 1/3
	Class B	National Government (MLIT) 1/2, Prefecture 1/2
Irrigation		Beneficiary 1/10, for remaining portion: National (MAFF) 3/4, Prefecture 1/4
Water supply		Government subsidy (MHLW) 1/2～1/3
Sewerage		Public sewerage: Main pipeline 1/2, Wastewater treatment plant 1/2 or 5.5/10 Regional sewerage: Main pipeline 1/2, wastewater treatment plant 1/2 or 2/3
Industrial water supply		Government subsidy (METI) within 40%
Hydropower generation		Paid by the power company (Power companies collect and recover the costs from subscribers of electricity use.)

Source: Excerpts from the River Law, Specific Multi-Purpose Dam Act, and "Rivers in Japan," Ministry of Construction.



Source: Preparation of the Project Research Team

Figure 2.14 Cost Sharing in Projects under the Jurisdiction and Subsidiary Projects

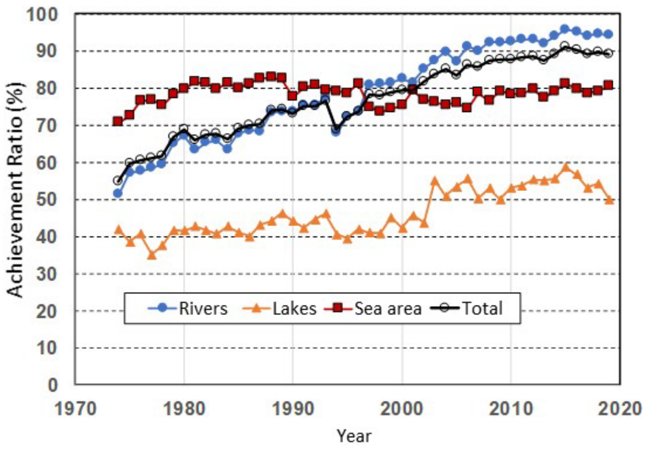
Investments are arranged by mobilizing various sources. In Japan, each organization shares the costs of the construction and maintenance of multipurpose facilities. The share of the cost is determined based on the benefit obtained for each purpose, that is, the construction cost of a single-purpose facility and the capability to pay for each organization. To reduce the financial burden on local governments, the Water Resources Development Public Corporation procures funds for the fiscal investment and loan programs (FILP) on behalf of local governments, and the local governments repay these loans after the facilities are completed.

The government should also consider public-private partnerships (PPPs) for managing facilities. PPP is widely used in water supply and sewerage projects and is classified into four types: (1) outsourcing, (2) design building (DB), or design building and operation (DBO), (3) private finance initiative (PFI) (traditional method), and (4) PFI (concession method). By adopting PPP, projects achieve efficient management by utilizing the know-how of the private sector. In Japan, the PPP method has been introduced to sustain services. The business environment of water and sewerage services is deteriorating as the population continues to decline and facilities are aging.

2.7 Effective Water Pollution Control and Environmental Conservation

It is necessary to establish a legal system to prevent environmental degradation. During high economic growth, water pollution caused by factory effluent and mine drainage led to the outbreak of diseases caused by pollution, such as Minamata and Itai-itai, which caused severe health damage to tens of thousands of people. Some patients are still suffering from them till date. The Water Quality Protection Act and the Industrial Water Act were enacted in 1958. But these acts had limited effects because regulated water areas were limited; there was no sanction for violation of effluent standards, and the number of restricted pollutant items was limited. In 1970, a "Pollution Diet" was held to discuss environmental pollution issues and measures, and several legislations against pollution passed the diet. The local governments set even stricter standards by ordinances than the national legislations. The local governments can conduct on-site inspections on factories and advice remedial measures to private companies.

Treatment facilities such as sewerage systems and on-site treatment systems, Jokaso, are developed according to population density and topographical conditions. The local governments installed sewerage systems in population-dense areas. Jokaso, an on-site treatment system, at the household level is used in rural areas. By 2019, the environmental standard (BOD) in rivers nationwide is achieved at 94.1%. (Figure 2.15)



Source: Water quality measurement results for public waters (2019) Ministry of Environment

Figure 2.15 Improvement of River Water Quality

The degradation of water quality in closed water bodies requires measures against non-point source loads, where pollution discharge sources cannot be specifically identified. These measures should be implemented in closed water bodies such as lakes, marshes, inland bays, and inland seas surrounded by land, improving water quality is a challenge. The non-point source load needs measures in (1) the source areas of loads such as urban areas, farmland, and forests; (2) the water channels and rivers, and (3) the closed water bodies where the load reaches. The measures in urban areas include sewerage systems, cleaning roads, underground infiltration facilities, and rainwater storage. Measures in agricultural areas include improvements in irrigation management and implementation of proper fertilization. The achievement ratios[11] of the water quality standards for lakes and marshes as of 2019 were 50.0% and 80.5%, respectively. These are far less than the 94.1% achievement ratio for rivers.

The national government has promoted "Nature-friendly river programs" since the 1990s to conserve and restore the natural environment in rivers. While ensuring safety against floods, the governments preserve the diverse natural environment to a considerable extent with minimized alterations of rivers to restore the good natural environment.

Utilizing the traditional technique. Traditional construction methods are nature-friendly because the materials include wood, bamboo, and stone, which are harmonized with the surrounding nature and topography. Traditional methods include (1) initiating flood control works such as “Seigyu,” (2) submerging fascine mattresses in water to protect riverbanks, (3) preserving riparian forests to mitigate flooding, and (4) putting up weirs with large stones. In Afghanistan, irrigation water intake weirs made of large stones were constructed by using the Yamada weir in Kyushu as a model and applying a similar design to their system (Figures 2.16 and 2.17).

[11] Water quality measurement results for public waters (2019), Ministry of Environment

Source: Website of Kouhu River and Road Office

Seigyu (Groin)

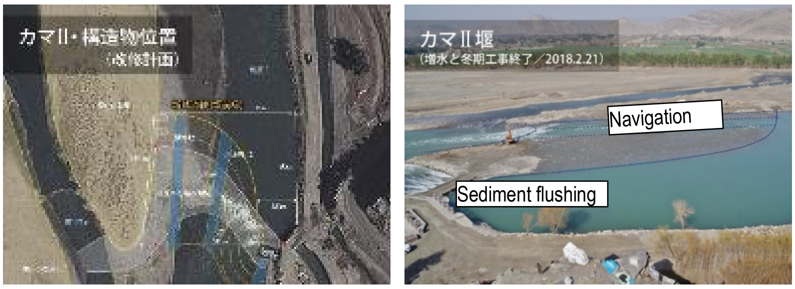
Source: Website of Shinanogawa Downstream Office

Fascine Mattress (Riverbed and Riverbank Protection)

Source: Website of Hokkaido Regional Development Bureau

Riparian Forest

Figure 2.16 Traditional Construction Method



Kama II Weir (Afghanistan)

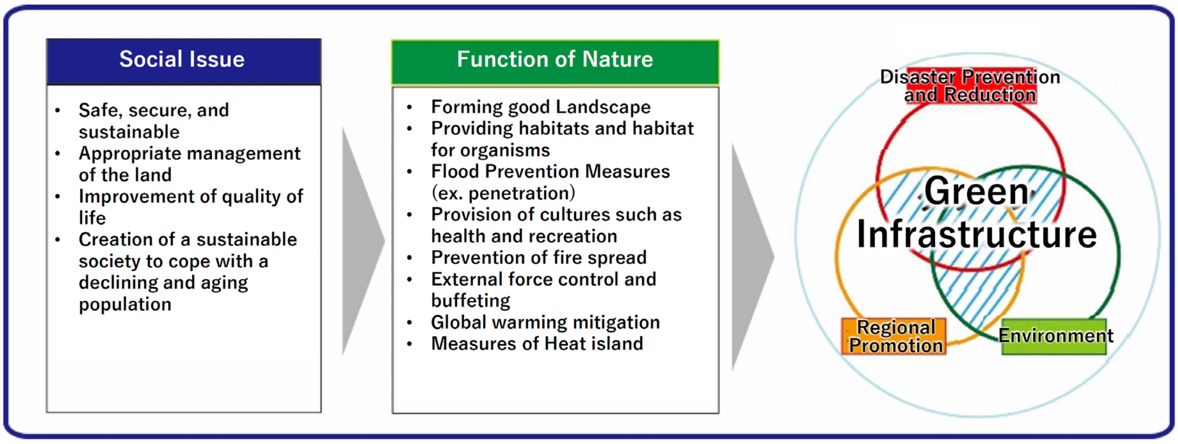
Yamada Weir (Japan)

Note: In Afghanistan, Kama II Weir has constructed an irrigation intake weir based on Yamada Weir, which has been in use in Japan since the Edo period.

Source: Kana II weir; Website of Peshawar-kai, Yamada weir; Proved by Asakura City

Figure 2. 17 Overseas Weirs using the Traditional Construction Method

Green infrastructure has diverse effects on disaster mitigation, the environment, and regional development, leading to the achievement of the SDGs. Green infrastructure is an initiative to create sustainable and attractive national land, cities, and regions by utilizing the functions of nature (Figure 2.18). In Japan, governments have developed many infrastructures and land uses involving nature-based solutions in their design and construction to address local issues.



Source: Green infrastructure portal site MLIT

Figure 2. 18 Scope of Green Infrastructure

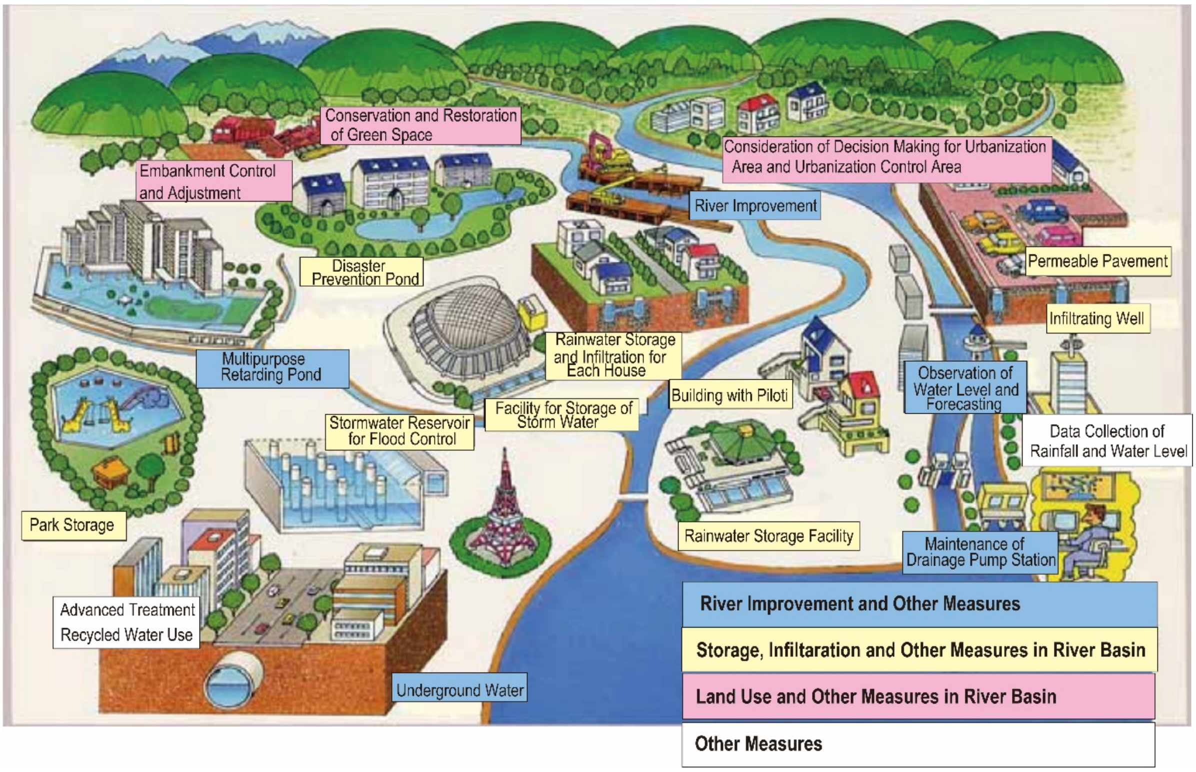
2.8 Improvement of the Urban Water Cycle

The water cycle should be restored to coexist with the environment to ensure water utilization, flood protection, and environmental conservation. The concentration of population in urban areas, expansion of urban areas, and increase in socioeconomic activities have deteriorated the water cycle and caused various impacts on water quality and quantity, the riparian environment, and groundwater. As a wide range of issues may have a cascading effect, collaboration among multiple fields and sectors is required to resolve these issues (Table 2.4 and Figure 2.19, respectively).

Table 2.4 Measures Related to Water Utilization, Flood Protection, and Environment in Urban Areas

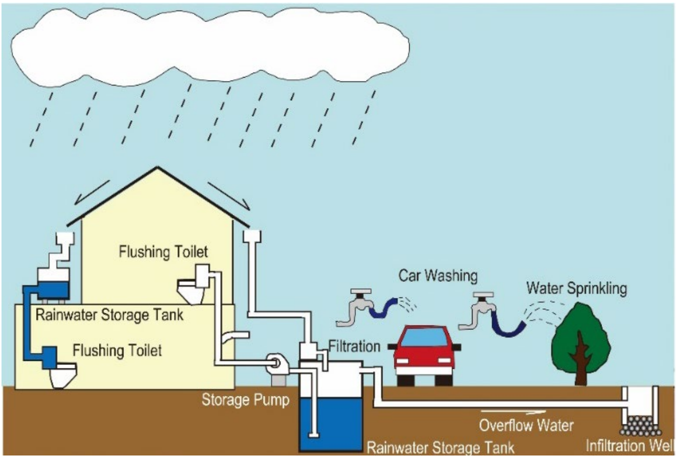
Measures	Water Utilization	Flood Protection	Environmental Conservation	Remarks
1. Water Utilization				
1.1 Water fee system	○			Setting a higher fee for high volume users
1.2 Water-saving tap	○			Control of water use by each household.
1.3 Reduction of non-revenue water rate	○			
1.4 Rainwater harvesting (water use)	◎	○		It also reduces runoff during floods.
1.5 Recycled water use	○			
1.6 Sewerage high-treatment water use	◎		○	High-treated water is reused for environmental purposes.
1.7 Use of recovered water for industrial use	○			
1.8 Seawater desalination	○		△	Desalination plants return water with a high salt concentration to the sea
2. Flood Protection				
2.1 River improvement (Construction of levee, dredging of riverbed)		◎	○	Example is the super levees being built in Tokyo.
2.2 Retarding basin, multiple retarding basin		◎	○	It is used as a facility for other purposes.
2.3 Permeable pavement and permeable groundwater infiltration	○	◎		Contribution to groundwater conservation
2.4 Underground storage		◎		Energy is required for drainage.
2.5 Underground River		◎		
3. Water environment				
3.1 Nature-friendly River program		○	◎	
3.2 Sewerage system maintenance		◎	◎	Decrease in water quality during floods due to discharge of sewage and rainwater by same pipe.
4. Public awareness campaign	○	○	○	Link with all initiatives.

Note: ◎Extremely effective as a countermeasure, ○Highly effective as a countermeasure; △Low effectiveness as a countermeasure
Source: Preparation by Project Research Team



Source: MLIT Website

Figure 2.19 Image of Measures for Urban River Basins

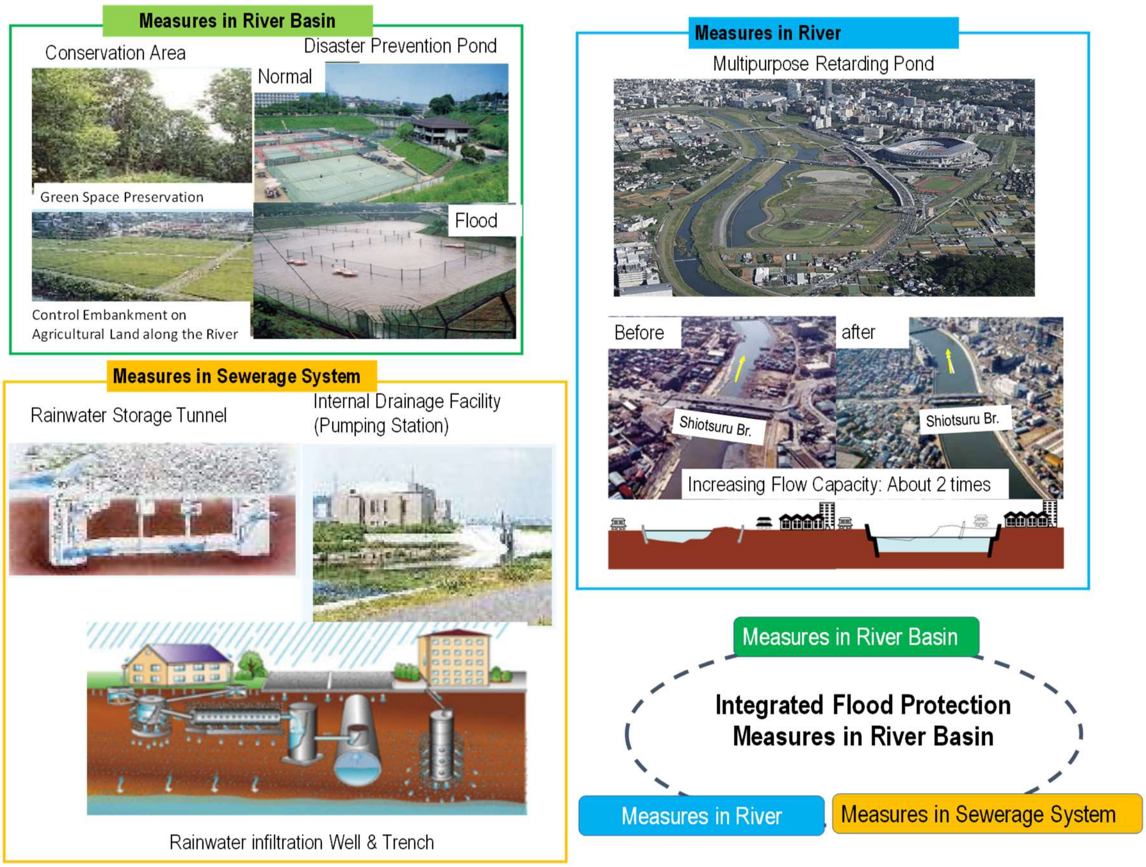


Source: Sumida-ward website

Figure 2.20 Rainwater Use

Demand management can save water and benefit multiple areas. Local governments adopt a progressive tariff system, in which the unit water fee increases as the amount of water usage increases. In addition, they encourage the use of water-saving taps in households and public awareness campaigns regarding water conservation. The average leakage ratio of the water distribution system was as small as 5%. Rainwater, recycled water in individual buildings and districts, and treated sewage water are used (Figure 2.20). Approximately 11.2 million m^3 of rainwater is used annually for toilet water, sprinkling, and other purposes, such as for firefighting and landscaping. The Ryogoku Kokugikan Sumo Stadium in Tokyo installed a 1,000 m^3 rainwater storage tank underground, which is used for toilets, air conditioning, and for sprinkling water. Industrial companies have reduced the amount of fresh water for industrial use. The amount of recycled water exceeded the revised water supply volume after 1970, and as of 2015, the recycling ratio was 77.9%.

Comprehensive measures are required to manage urban floods. It is difficult to mitigate flood damage through mere river improvement as the land necessary for the improvement works is difficult to acquire due to the high density of houses. The RMOs should collaborate with other related departments and agencies for the execution of hard and soft measures in urban areas, such as the construction of flood regulation ponds and infiltration facilities, and the development of warning and evacuation systems (Figure 2.21). The establishment of water governance is important in collaboration with a wide range of institutions and CSOs. Governments could effectively implement flood protection facilities in cooperation with the private sector. For example, the Myoshoji River in Tokyo introduced the construction of parks and pilot-type housing complexes above the flood regulation pond to effectively use expensive lands.



Source: Tsurumi River Multi-Purpose Recreation Area Brochure, Tsurumi River Management Office, MLIT, Photo: River channel training "Key points for river development in Tsurumi River", Tsurumi River Management Office MLIT

Figure 2.21 Integrated Flood Protection Measures in the Basin

Green infrastructure has a variety of functions in urban areas. River improvement projects using green infrastructure not only mitigate flood damage, but also enhance habitat, reduce costs, and provide recreational spaces. An adjacent elementary school conducts an environmental learning program with a group of citizens in the Kamisaigo River in Fukuoka Prefecture (Figure 2.22). Improving the work in urban rivers contributed to the regional economy and tourism in Osaka (Figure 2.23).

Source: Fukutsu City

Figure 2.22 Green infrastructure, Kamisaigo River, Fukuoka Prefecture

Source: Japan Riverfront Research Center

Figure 2.23 Urban Development Integrated with the River Space, Doutonbori River

2.9 Management of River Water and Land

The national government has established a legal system and organization to properly maintain and manage river water and land. In Japan, the RMOs define river areas and manage land, including privately owned land and water on the river. The RMOs located on the sites promote water management by permitting the occupation of land, collection of river materials, construction of structures, excavation of land, floating down bamboos, and navigation through locks. Penalties are imposed on illegal river-use activities.

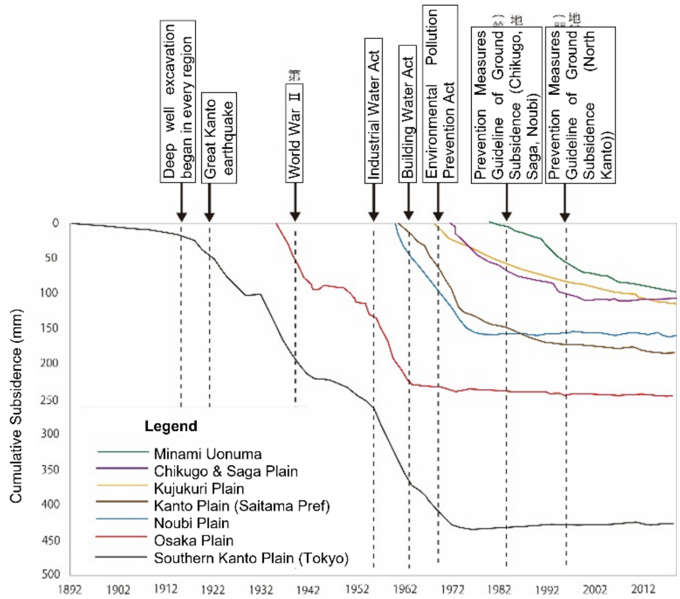
Collaboration with the local communities is essential for river management. The RMOs collaborate with CSOs in activities such as river cleaning campaigns, environmental and disaster management education on rivers, and surveys and research on river environments.

The national government has established a management system for rivers and river structures. During a flood event, the RMOs patrol rivers and facilities and operate dams and gates. The RMOs announce flood forecasts and notify relevant organizations of flood information. The RMOs also support the flood-fighting activities of local communities. The RMOs should regularly conduct patrols of the river facilities, weeding, removal of obstacles, visual inspection, and operation checks of gates at normal times.

2.10 Management of Groundwater

Excessive extraction of groundwater lowers the groundwater level, resulting in land subsidence, structural damage, flood damage, and saltwater contamination of the groundwater. Land subsidence is an irreversible phenomenon resulting from the consolidation of underground clay layers due to the drainage of water contained in the clay layers. In Japan, river water has been used for irrigation purposes for a long time. An increased demand for water for domestic and industrial purposes encourages the use of groundwater. Large volumes of groundwater were extracted for domestic and industrial uses owing to the increase in population and industrial production. The most severe land subsidence occurred in major cities such as Osaka and Tokyo, with some areas sinking more than 20 cm in a year, reaching a cumulative total of more than 5 m (Figure 2.24).

For sustainable management of groundwater, extraction should be regulated, and alternative water sources need to be developed. The national government established legislation to regulate groundwater use. Local governments formulated their ordinances. An industrial water supply system was established by developing alternative water sources for surface water shifting from groundwater.



Source: Overview of Land Subsidence in Japan in 2019, Ministry of the Environment, Water and Air Environment Bureau (2019 March)

Figure 2.24 Changes in Land Subsidence at Representative Sites

The conservation and management of groundwater are realized by considering regional characteristics. The sustainable management of groundwater requires the accumulation of observed data. Kumamoto City, with a population of over 700,000, relies on domestic groundwater. Local governments, companies, and residents work together to conserve groundwater based on observations and research.

Groundwater quality management prevents harmful substances from infiltrating into the ground. Groundwater contamination is quite difficult to remove. Therefore, underground water quality standards should be established. Regular monitoring based on standards is performed. If anomalous values are observed, people should be warned of groundwater use, and contamination in wells should be investigated.

2.11 Dam-Safety Management and Operation

Because dam failure would cause damage to the downstream areas, strict dam construction and safety management processes are essential. The national government has developed policies, established organizations for safety management, and carried out human resource development. The dam operator obtains approval for the project from the supervising authority and permission for construction from the MLIT. Approval is required at each stage, such as the planning, design, completion of construction, and formulation of operating rules.

Dam discharge during flooding should be determined by considering the safety of downstream areas. The maximum dam discharge should be set as no damage to the downstream area, which is called "harmless discharge". Dam discharges should not cause a sudden rise in the water level on the downstream reaches to allow people to evacuate from inside the river area. In Japan, the guide for the rising limit in the water level is set at 30 cm in 30 min due to dam discharge. Before releasing the dam discharge, the dam office notifies residents and recreational users of safety issues in the river area via speakers and patrols. The dam office records hydrological observation and operation data and reports them to the RMO.

The dam discharge should always be released within the flood inflow to the reservoir. If the reservoir is expected to be unable to store any further water, then the dam discharge should be equal to the flood inflow. Because an accurate estimate of the inflow flood is difficult, it is important to improve the rainfall and water level observations of the tributaries upstream of the dam reservoir.

Dams for water supply may also be used for flood protection by improving the operation rules. Because rainfall can be predicted more precisely owing to advanced technology, the dam office can release the water stored in the reservoir for irrigation, urban area use, or hydropower, to create the capacity for flood protection before flooding. The government should make agreements with water users to create a reservoir capacity for flood protection through pre-release. The government should compensate these water users if the reservoir capacity does not recover to the normal level after the pre-release owing to less rainfall than the forecast.

The national government should support to reinforce the aged irrigation ponds (Figure 2.25). Once the irrigation ponds collapsed, the downstream area experienced significant damage. Japan has approximately 210,000 irrigation ponds. Approximately 75% of these buildings were built more than 150 years ago. Due to the aging population in the farmland, the farmers' associations weakened. The national government enacted an act for a financial subsidy system for pond reinforcement.

Source: Causes of the Break of Fujinuma Dam, Emergency debriefing one month after the great east Japan Earthquake by Tohoku University

Figure 2.25 Failure of the Fujinuma Dam

Integrated operation of multiple dams within the same river basin may achieve efficient water resources management. The integrated operation coordinates the water supply, considering the dam location, reservoir capacity, and characteristics within the river basin. For example, the Tone River Dams Integrated Management Office conducts operations commanding nine dams in the Tone River System (basin area: 16,400 km^2) to supply water to the Tokyo Metropolitan Area. Water supply priority is given to dam reservoirs that have a larger basin area than the reservoir capacity. This means that these dams may recover reservoir water faster once they are emptied.

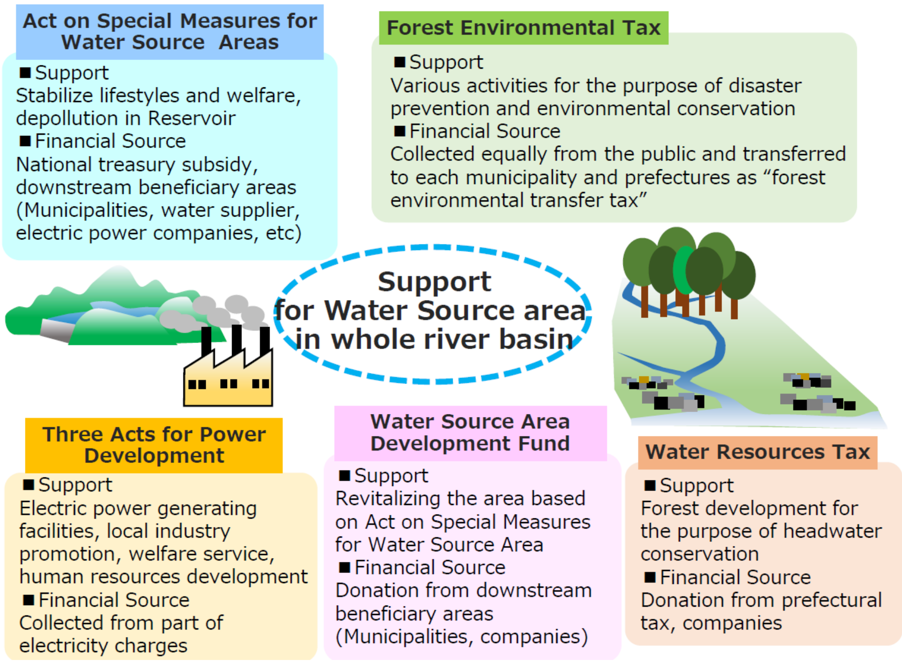
Advanced technologies can be effectively utilized in existing dam facilities. In Japan, dams are enhanced by increasing the reservoir capacity with dam crest raising (Figure 2.26), increasing the dam discharge capacity with additional facilities, installing hydropower equipment, and adding sediment discharge facilities.

Source: Sapporo Development and Construction Office, Hokkaido Regional Development Bureau

Figure 2. 26 Cross-section of the Body of the Shin-Katsurazawa Dam Photograph of Construction Works

2.12 Environmental and Social Considerations of Large-Scale Projects

The government should support the rebuilding of local communities submerged by large-scale projects to avoid fracturing or disappearing (Figure 2.27). The system, including financial resources, is established so that relocated residents and water source areas can become beneficiaries of the project. Essentially, water resources development projects improve people’s lives; however, they also have negative effects on some communities and ecosystems. Therefore, it is necessary to rebuild submerged communities and mitigate environmental damage. In Japan, legislation stipulates financial support for public projects, such as roads, water supply, sewerage systems, and housing development, as well as tax reductions for relocated residents. The Water Source Area Development Fund was created to support livelihood reconstruction and regional development that the public works budget could not cover. Contribution of the downstream local governments and of other entities that receive the benefits of dam financing is added to this fund. This fund is used to support the revitalization of water source areas and the development of human resources, tourism programs, and sales channels for local products. In the upstream and downstream exchange projects, residents of the downstream area visit the water source area and deepen their friendships through cleaning activities and sports exchanges (Figure 2.28). In 2001, the government introduced a water resources tax as a local tax to finance the conservation of forests and a stable supply of quality water in the water source area.



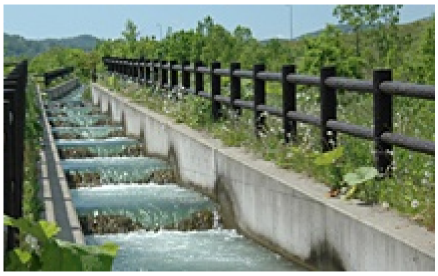
Source: Preparation by Project Research Team

Figure 2.27 Support for Water Source Areas in the River Basin

Source: The Tone River Dams Integrated Management Office website

Figure 2. 28 Activity of Environmental Conservation with Residents in the Water Source Area of the Tone River

Environmental impact assessments are conducted in large-scale projects and various environmental measures are implemented to avoid or mitigate adverse impacts. Water resources development facilities have a significant impact on the natural environment because they are artificially stored in naturally circulating water and block the circulation of materials. In Japan, the measures cover: (1) ecosystem conservation through biotopes and fish ladders (Figure 2.29), (2) reduction of the impact of water release against cold water and eutrophication, and (3) forestation in water source areas.



Note: By installing an overflow bulkhead with a notch in a staircase pattern at the part where the height difference is large, the fish can run upstream with stops along the way.

Source: Website of Hakodate Development and Construction Department, Hokkaido Regional Development Bureau, MLIT

Figure 2.29 Fish Ladder of the Pirika Dam

2.13 Human Resources Development and Technology Development

In the Meiji era, the Japanese government promoted technological learning by inviting foreign engineers. Engineers who returned to Japan after studying abroad took the initiative in public works and trained their successors during the Meiji era. Currently, the university-enrolling ratio is 49%, and universities supply civil engineering graduates to society. On-the-job training is the basis for human resource development. Off-the-job training includes training, participation in lectures and seminars, the acquisition of technical qualifications, and academic society activities.

The national government should develop and disseminate this technology. National research institutes and associated organizations conduct a wide range of research and publish research output. They are also used to prepare various guidelines and manuals.

Mechanisms should be established to utilize the technologies developed by private companies. Government agencies request private companies to submit technical proposals/bids for public works. These are comprehensive bid evaluations from the viewpoint of quality assurance. Each company conducts its research and development. The MLIT promotes technology development by companies through public invitations to perform research and development in the river as well as implementation of innovative management.

THEME 1 GOVERNANCE

THEME 1-1 LEGISLATION AND ORGANIZATION: ESTABLISHING MECHANISMS TO RESPOND TO CHANGING NEEDS

ABSTRACT

Water resources management is implemented across multiple organizations and requires coordination of conflicts of interest among water users, upstream and downstream areas, and flood protection areas, as well as environmental conservation. It is essential to develop a legal system and organizations to execute policies and master plans for water resources management.

Japan has traditionally practiced comprehensive water resources management in the use of river water for irrigation and the mitigation of damage from floods. The Japanese River Law, which regulates river water, river areas, and river management facilities, differs from water laws of other countries. Legal systems and organizations have been established to administer water use and flood protection in a consistent manner.

During the high economic growth period in the mid-1950s through the early 1970s, the demand for domestic and industrial water use rapidly increased. Water sources, especially in metropolitan areas, could not supply enough water to meet the demand. Therefore, new water resources were required to be developed based on a wide-area coordination involving a large number of water users. Legislation and organizations were established for this purposes. As the economy matured in the 1990s, water demand began to decline, values diversified, and the water needs of the people changed. The River Law was revised to focus on the natural environment of rivers and public involvement. Furthermore, the roles of the public corporation and development plans for water resources were also revised.

The Basic Act on the Water Cycle, enacted in 2014, contributes to sustainable development and the improvement of the lives of the residents by restoring a healthy water cycle. Urbanization and changes in the natural environment during periods of high economic growth have caused an increase in the outflow of rainwater, deterioration of water quality, and lowering of the groundwater level. Comprehensive water management, including that in relation to groundwater had to be established to respond to these changes.

CHAPTER 1 INTRODUCTION

Water resources management covers coordination of conflicts among various stakeholders and between water sources and beneficiaries, trade-offs between development and environmental conservation, and demarcation of roles and cost allocation among stakeholders. Therefore, the legal system and organizations should be established with consideration of these factors. For the past nearly 2000 years in Japan, water resources have been managed based on the legal system and other organizations.

Water resources management has faced various difficulties, such as conflicts among water users, between water sources and beneficiary areas, and between development and environmental conservation. Japan has established and improved its legal system and organizational structures to coordinate a wide range of issues into this management. It has become necessary to clarify the roles and cost allocations of stakeholders. The cost of projects related to water resources management should be borne by various stakeholders such as the national government, local governments responsible for domestic water services, companies involved in hydropower and industrial water supply projects, and agricultural parties.

River water in Japan has been utilized since ancient times. Rain mainly occurs during the flood season, and rainwater rapidly flows into the sea due to the steep terrain, so the discharge of the river decreases significantly in the non-flood season. In the course of its modernization in the late 19^{th} centry, Japan frequently experienced large-scale floods. This triggered the government to enact flood protection acts. During the high economic growth, facilities were developed to store river water during the flood season to prevent flood damage and utilize the stored water during the non-flood season to meet the rapidly increasing demand for domestic and industrial water. The legal system was developed with a focus on integrated flood protection and water utilization in a consistent manner throughout a river basin. During the transition from high economic growth to socioeconomic maturity, the values of the public also changed. The legal system was changed to conserve and improve water environment, and new laws were enacted amid these changes in society.

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

Relationships between Legislation and Organization and the SDGs:

(1) An appropriate establishment of the legal system and organizations is the basis of equitable and sustainable water resource development for each sector:

SDG6 "Clean Water and Sanitation"

(2) The legal system enables coordination among water users and facilitates hydropower generation:

SDG7 "Affordable and Clean Energy"

(3) A legal system centered on the River Law enables the integrated water management of flood protection, and ensures that water utilization and the river environment are consistent throughout a river basin:

SDG11 "Sustainable Cities and Communities"

(4) The legal system stipulates the roles and responsibilities for mitigation and adaptation measures in relation to climate change:

SDG13 "Climate Action" 13.1 "Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries"

(5) Establishment of the legal system in response to current demands would realize sustainable development while fulfilling the needs of society:

SDG17 "Partnerships for the Goals"

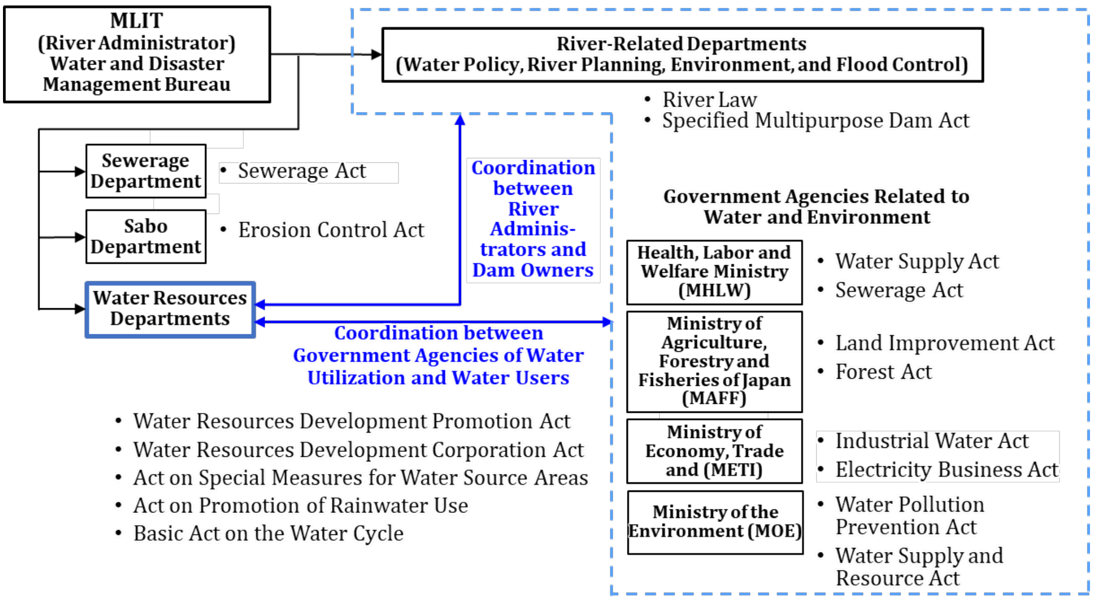
CHAPTER 2 COORDINATION AMONG PARTIES FOR WATER RESOURCES MANAGEMENT

2.1 Organization for Coordination of Water Resources Management

> To achieve proper water resources management, an organization must comprehensively coordinate with ministries and agencies, as well as formulate and promote fundamental plans. It is necessary to establish a legal system which stipulates the roles, authorities, and responsibilities of related ministries and departments.

(1) Government Organization for Water Resources Management

Flood protection and agricultural water utilization have traditionally been the main reasons for water resources management in Japan, which is located in the Asian monsoon region. During the period of modernization, as the demand for domestic and industrial water increased, the national government was required to manage water resources with a wider view of the entire basin. The Water Resources Department was established by the Economic Planning Agency of the national government in 1961. It was transferred to the National Land Agency in 1974 and to the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) in 2001. The Water Resources Department involves various entities and is responsible for coordinating relevant agencies and supervising organizations for water use and water users, including prefectural governments, as shown in Figure 2.1. The MLIT governs water resources management as the river administrator for Class A rivers, and the owner of multi-purpose dams. The MLIT centrally manages flood protection, river water utilization, and the river environment consistently throughout a river basin. It consists of regional development bureaus in each region of the country with a river management office in each basin. The river management office constantly communicates with communities to understand the local needs. (Note: Details of river administrators and the river management offices are described in Section 2.2 (3). The role of river administrators is explained in the present theme.)

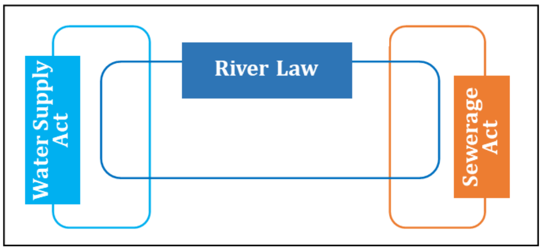


Source: Prepared by Project Research Team with reference to the MLIT website.

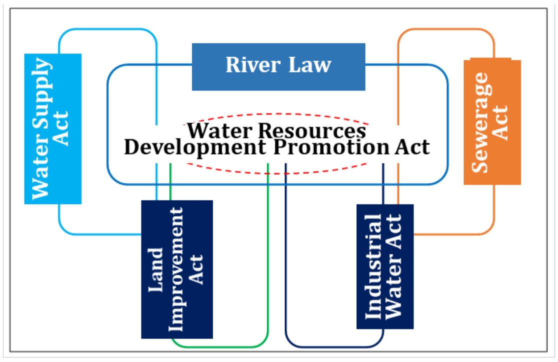
Figure 2.1 Entities Involved in Water Resources Development and Concerned Law and Acts

(2) Conceptual Changes in the Legal System

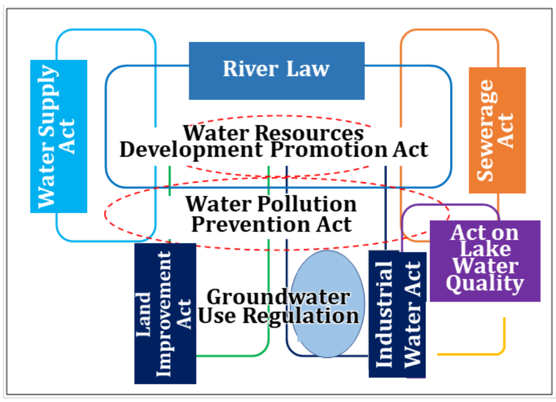
In Japan, various laws have been enacted in the legal system related to water resources in response to the changing needs of society (Figure 2.2 and Tables 2.1 and 2.2). A modernized nation was established at the end of 19th century, and during this period, the rivers were improved for river navigation.



Modernization: End of 19th Century-Mid 20th Century, Flood Prevention and Public health



High Economic Growth: Mid 20th Century to 1970, Water Resources Development



Sustainable Growth :1970-Present, Environment

Source: Modified figure of Team Water-Japan by Project Research Team

Figure 2.2 History of the Legal System Related to Water in Japan

The surface water of rivers is regulated as "public water[1]" by River Law. As river water is the main source of water use, a legal system related to water was enacted, centered on the River Law in 1896. During modernization, flood impacts became more serious, which induced the creation of flood protection projects. The development of water supplies and sewage systems to prevent infectious diseases has shown to improve public health in urban areas. The first regulation related to water use was the Ordinance for Domestic Water Supply in 1890, which was replaced by the Water Supply Act in 1957. The Sewerage Act was enacted in 1900.

After World War II (WWII) ended in 1945, the development of irrigation and hydropower was mainly executed for the reconstruction of the country to increase food production and secure power sources. Natural disasters with greater than 1,000 dead and missing occurred almost every year, causing Japan to intensively implement flood protection and forest conservation projects, such as watershed management, erosion control, and slope conservation. The Land Improvement Act was enacted in 1949 based on the Agricultural Land Improvement Act of 1899 and the Irrigation Association Act of 1908 to restore the devastated economy after WWII and increase food production.

During the high economic growth, water resource development for supplying domestic and industrial water accelerated in parallel with flood protection. The Specific Multi-Purpose Dams Act, Water Resources Development Promotion Act, and Water Resources Development Corporation Act were implemented for this purpose.

[1] "Public water" means water for public use. The River Law mentions river water is not to be a subject of private rights.

Economic growth presented challenges in terms of pollution-related diseases, water pollution, land subsidence due to excessive extraction of groundwater, and floods in urban areas. The values of the public, such as interest in the environment, had changed and diversified. The Industrial Water Act was enacted in 1956 to conserve groundwater, prevent land subsidence, and ensure a proper supply of industrial water. (Theme 5: Urban Water Management) The majority of the sewerage system was developed after the enactment of the Sewerage Act of 1958. The Water Pollution Prevention Act was implemented in 1970, and the Act on Special Measures Concerning Conservation of Lake Water Quality was enacted in 1984 to secure the health of the public and preserve the living environment. The Basic Environment Act was enacted in 1993 as a comprehensive framework for the basic principles of environmental conservation, including pollution control and natural environment conservation, and related measures based on these principles (Theme 4: Water Pollution and Environmental Management). The Act on Special Measures for Water Source Areas was implemented to support the reestablishment of the daily lives of people affected by the construction of large-scale facilities.

Table 2.1 Law and Acts that Contributed to Water Resources Management

Law and Act	Contribution to Water Resources Management
Old River Law (1986)	The Old River Law focused on flood protection as the main issue for the role of the government.
Specific Multi-Purpose Dams Act (1957)	This Act stipulates the budget allocation, ownership, and responsibility of operation and maintenance of multi-purpose dam projects. It was one of the main measures for water resource development to meet the rapid increase of water demand during high economic growth.
Water Resources Development Promotion Act (1961)	This Act stipulates the formulation of a comprehensive water resources management plan throughout a basin, realize systematic and efficient water use in wide areas, and build large-scale water resources facilities together with water convey facilities to meet the rapid increase of water demand during high economic growth. The Act aims at identifying river basins where such a comprehensive water resource development plan is required, establishing the process to formulate the Water Resources Development Basic Plan, and stipulating the advisory role of the Water Resources Development Council.
Water Resources Development Corporation Act (1961)	This Act authorizes the Water Resources Development Corporation to construct and operate the water resource facilities planned in the Water Resources Development Basic Plan.
River Law (renewed in 1964, (New River Law))	The New River Law stipulated not only flood protection but also water rights, conciliation regarding water use, and dam construction and operation, to meet the increase in hydropower development prior to WWII and the increase in water demand after WWII.
River Law (revised in 1997, (Revised River Law))	The Revised River Law incorporates a mechanism to communicate the opinions of local governments and residents on the river basin to river management as well as provisions relating to the river environment.
Basic Act on the Water Cycle (2014)	This Act aims for the sustainable development of the economy and society as well as the stabilization and improvement of the lives of the public by maintaining and restoring a healthy water cycle.

Source: Project Research Team

Table 2.2 Acts Regulating Water Resources Management with River Law

Category	Related Laws
Flood measures	Flood Control Act, Basic Act on Disaster Management, Flood Prevention Association Act, Act on Erosion and Flood Control Emergency Measures, Flood Control Special Accounting Act
Water resource utilization	Water Supply Act, Industrial Water Act, Land Improvement Act, Electricity Business Act
Water transportation	Act on Port Regulation, Port and Harbor Act
Regulations related to pollution, effluent, and environmental conservation	Basic Environment Act, Water Pollution Prevention Act, Act on Special Measures Concerning Conservation of Lake Water Quality, Sewage Act, Nature Conservation Act, Natural Parks Act, Waste Management and Public Cleansing Act, Mine Safety Act
Water cycle, underground water, and land subsidence	Basic Act on the Water Cycle, Industrial Water Act, Act on Regulation of Groundwater Extraction for Buildings, Act on Promotion of Rainwater Use
Land conservation regulations	Act on Special Measures for Water Source Area, Water Supply Act, Erosion Control Act, Building Standard Act, Forest Act, Landslide Prevention Act, Act on Prevention of Disasters Caused by Steep Slope Failure
Permissions for mining of riverbed material such as sand and gravel	Mining Act, Quarrying Act, Gravel Gathering Act

Source: Main Report on Water Right System in People’s Republic of China, 2006, JICA

2.2 History of the River Law and Role of River Administrators

Japan has historically focused on the utilization of surface water and flood protection in rivers as the main issues in water resources management. The River Law governs river water, river areas, and river management facilities, and differs from water laws of other countries. The law focuses on water use management, flood protection, and environmental conservation in a consistent manner throughout a river basin. River administrators play the leading roles for the planning, regulation, and coordination related to water resources management.

(1) History of Water Use in Japan Before the Modern Age

Japan is located in the Asian monsoon region. Flood protection and irrigation have historically been the main issues in water resources management. As rice dominated major agricultural production, people simultaneously developed agricultural land and irrigation systems. The first levee recorded in history is the “Manda no Tsutsumi” on the Yodo River that was built in the 4th century. It was constructed in conjunction with the development of irrigation water and paddy fields along that river. Local governments under the centralized nation formed in the 7th century administrated the rivers, when river water was considered public property. In the 8th century, the government promoted agricultural land reclamation to increase food production for the expanded population and allowed private ownership of agricultural land and water. At the same time, Gyoki, a prominent monk, developed many large-scale water resource facilities, such as the renovated Sayama pond.

In the Warring States period (15th to early 17th century), feudal lords endeavored to increase rice production using water diverted from small and medium-sized rivers. During the Edo period (17th to 19th century), the Edo shogunate implemented new paddy field development along large rivers, such as the Tone River located in the Kanto Region. Alluvial plains were rapidly converted into paddy fields. The shogunate constructed water supply systems, such as the Kanda water supply system in 1629 that was 63 km long and the Tamagawa water supply system in 1654 that was 85 km long to supply water to Edo, where the population had rapidly increased. The shogunate operated the systems by collecting water tariffs from residents according to the width of their houses.

(2) Implementation of River System Management

1) Old River Law

During the Edo period, feudal lords handled floods individually in their respective areas. At the end of this period, rivers and forests in the river basin were devastated by insufficient maintenance due to political and economic turmoil. Consequently, large-scale floods frequently occurred in the 1890s and 1990s during the Meiji period. The Old River Law was enacted in 1896 to deal with flood protection, together with the Forest Act and Erosion Control Act enacted in 1897. These are the three flood protection acts, which cover the river basins from the upstream mountainous areas to the downstream regions. Under the Old Law, while prefectural governors had the primary responsibility for flood protection based on the “section principle”, the national government implemented river works in large rivers and those that flowed through more than two prefectures, as well as river works in which the cost exceeded the financial capacity of the local government.

The Old River Law stipulated only that permission from the local government should be obtained for the occupancy of river water. The water rights of existing irrigation systems remained unchanged.

2) Enactment of the New River Law in 1964

From 1945 to 1960, flood disasters such as the Kathleen Typhoon and the Isewan Typhoon (Typhoon Vera) occurred. The national government promoted mid -to long-term flood protection projects by enacting the Act on Erosion and Flood Control Emergency Measures and the Flood Control Special Accounting Act in 1960.

The water resource development and supply system could not meet the rapid increase in water demand during high economic growth. Water users were dependent on groundwater utilization, and land subsidence caused by excessive extraction of groundwater became more intense. (Theme 7: Groundwater Management) Water resource development was required, but the Old River Law did not stipulate sufficient provisions regarding water development and distribution. Although the government had been interested in the development of multi-purpose dams since prior to WWII, this was hindered by the inadequate legal system, especially in terms of ownership and cost allocation. The Specific Multi-Purpose Dams Act was enacted in 1957 to promote the construction of multipurpose dams with the participation of multiple private sectors. The Water Resources Development Promotion Act promotes water resource development in designated river basins and systematic water use. The Water Resources Development Corporation Act was enacted in 1961 for the establishment of the corporation.

(3) Roles of River Administrators

The New River Law was enacted in 1964 to: 1) abolish the "section principle" managed by the prefectural governor and to introduce the "river management for river system" by the national government, 2) add provisions for river water use, and 3) add provisions for flood protection by utilizing dam reservoirs. The New Law aims to: 1) prevent flood disasters and high tides, 2) ensure proper river water use, and 3) maintain the normal functions of the river. Normal functions include water supply maintenance, environmental conservation, and other public interests. River management includes maintaining the floodplain of rivers, operating the river management facilities, providing permission to use rivers, restricting activities that affect river function, supervising the use of rivers, imposing costs, and providing public obligations for river management.

Rivers are divided into two classes. Class A rivers are designated by the Minister of Land, Infrastructure, Transport, and Tourism and are particularly important for national land conservation and the national economy. Class B rivers include other rivers, which have an important relationship with the public interest and are designated by the prefectural governor. Rivers are required under this law to be managed by river administrators, namely the Minister of Land, Infrastructure, Transport, and Tourism and the prefectural governors for the Class A and B rivers, respectively.

The roles of river administrators are to formulate plans (Theme 2-2: River Basin Planning), river water usage permissions, land occupation, structure construction and operation rules (Theme 6: River Management), and water rights coordination (Theme 1-2: Water Rights). The river management offices (RMOs) established by the MLIT for Class A rivers and by the prefectural governors for Class B rivers perform the roles of the river administrators on the ground.

(4) Characteristics of the River Law Compared to Water Laws of foreign Countries[2]

In many countries, water law forms the basis of a legal system for water management. The management of river water, river areas, and river management facilities is required for water resources management in Japan, and the related legal system consists of the River Law and various acts (Table 2.2). Throughout history, Japanese society has established a system for the utilization of river water and the prevention of water-related disasters to stabilize society. The River Law mainly covers flood protection, river water use, and the river environment. It has limited provisions regarding water quality, purification, wastewater, replenishment, groundwater, rainwater, and navigation, which are present in water laws of other countries. For example, the Italian Water Law stipulates that both surface and groundwater should be treated as public water. The Israeli Water Law covers not only surface water and groundwater but also natural water, artificial water, and wastewater as public water and a part of water resources. In Germany and France, wastewater is returned to rivers in principle; in other words, the wastewater is treated in the same way as water extracted from the river. European societies traditionally had riparian rights from the ancient Roman laws, whereby only those who own land along the river could use the river water. This

[2] This section refers to "Management and Utilization of Country's Land" (Kenji Sanbongi), "Philosophy and Status of Water Law Systems in Other Countries" (the River, November 1980), "Contribution on Modern Legal System of River of 100 years" (the River, February 1997), "Half Century of Domestic and Foreign Water related Legal System surrounding the River Law" (the River, December 2014), "Main Report on Water Right System in People's Republic of China" (2006, JICA).

caused challenges for the government to develop an administrative system such as permissions for water use or the imposition of fees .

The riparian areas of rivers were floodplains, and river water was extracted for public use or transferred for irrigation in Japan. Therefore, Japan shifted private water rights to the public, and the government established an administrative system for water rights. River water was legally separated from the right related to the riparian land, and the water became public goods. Comprehensive basin-based water management was realized early in Japan. The Water Resources Development Promotion Act of 1961 establishes the water resources management for each river basin.

Strong opposition to administrative intervention for river management had remained in countries with traditions of riparian rights. France adopted the basin foundation system relatively early, in 1964. Italy and Spain revised the law in 1980. Germany has a traditional union system for tributaries, except for the mainstream of the Rhine. This system handles flood protection, river water use, and drainage in an integrated and autonomous manner.

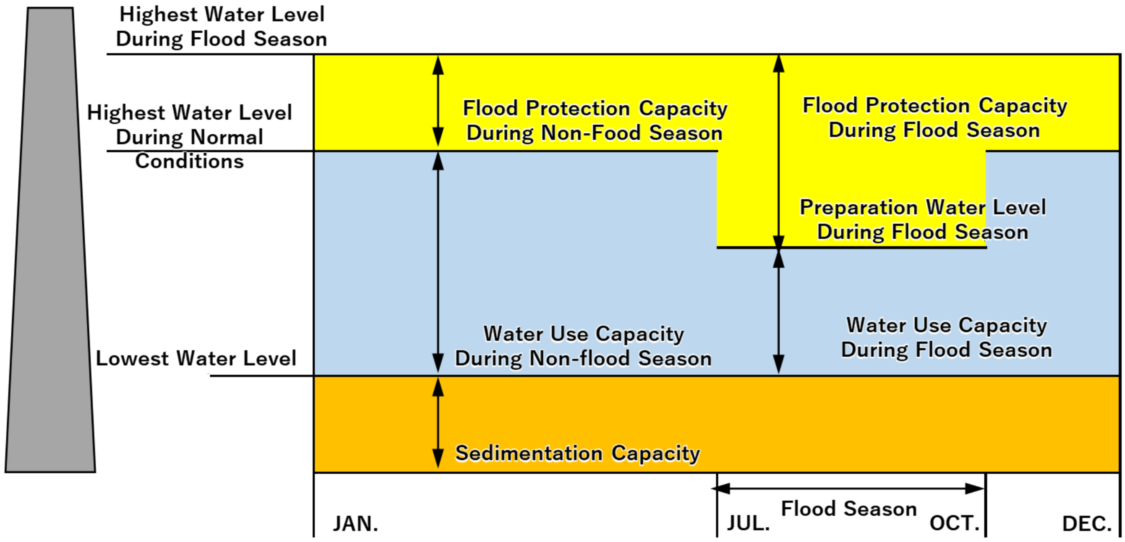
Japan has no international rivers. The national government manages large rivers that cross multiple prefectures and coordinates stakeholders for each basin. This coordination that transcends administrative boundaries can be used as a reference for international river management.

2.3 Water Resources Management using Multi-Purpose Dams

A multi-purpose dam is an effective measure for water resources management. A legal system should be established to stipulate ownership of facilities, cost allocations for construction and maintenance, and demarcation for operation and maintenance of facilities.

(1) History of Multi-purpose Dams in Japan

Most rainfall in Japan is concentrated during the rainy and typhoon seasons. Rainwater flows down steep rivers in a short time and frequently causes floods, while a decrease in river flow during non-flood seasons can cause droughts. The government has attempted to promote a comprehensive river development project since the 1930s to manage flood protection and river water use in an integrated manner. The project aimed to store river water during the flood season and utilize the stored water during the non-flood season (Figure 2.3). The multi-purpose dam has the multiple functions of flood protection, hydropower, irrigation, and water supply. Four multipurpose dam projects, including the Ikari Dam, were initiated in 1949 by the national government.



Source: Web site of Disaster Information for River, MLIT

Figure 2.3 Operation of a Multipurpose Dam which Stores River Water in the Flood Season and Utilizes Stored Water in the Non-Flood Season

(2) The Specific Multi-Purpose Dams Act

Several multipurpose dams were constructed using a facility-sharing system in which water users jointly owned the dam. This system proved inconvenient and ineffective because: 1) the rights for stored water and facilities were not clear, 2) the responsibility and demarcation of facility operation and maintenance were not clear, and 3) the Minister of Land, Infrastructure, Transport and Tourism, as the river administrator, could not take the leading role in managing the facilities. Considerable time and effort had to be spent on obtaining consent from users for facility operation and cost allocation.

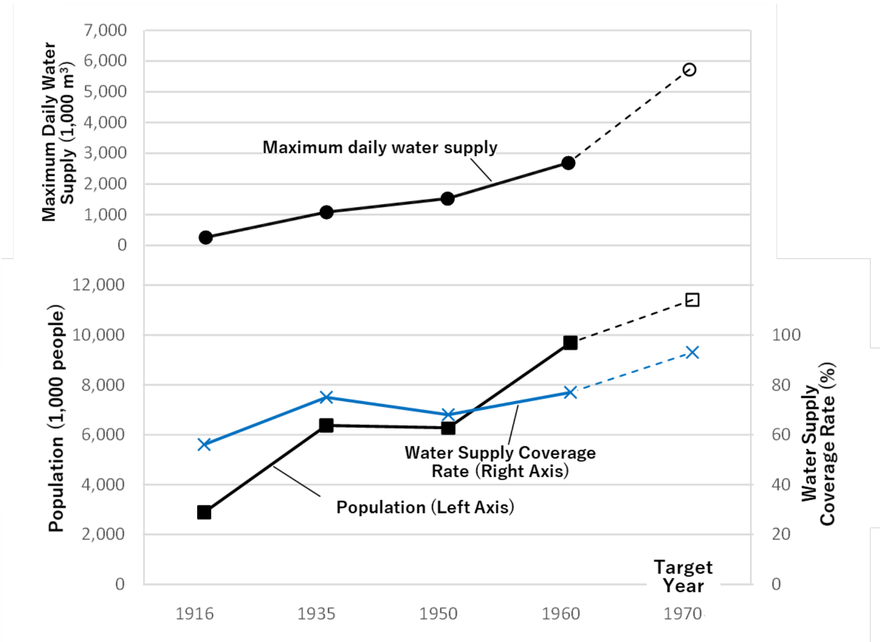
The Specific Multi-Purpose Dams Act was enacted in 1957 to facilitate the construction of multi-purpose dams by stipulating a method of cost allocation, responsibility for facility management, ownership of facilities, and rights to use the dam. The responsibilities of the construction project and the management of dams were allocated to the Minister of Land, Infrastructure, Transport, and Tourism. The Act stipulated the right to store water in the reservoir and distribute the stored water to the project participants, such as power generation companies and water supply companies, who shared in the construction costs. Ownership of the dam belonged to the Minister of Land, Infrastructure, Transport, and Tourism. The cost allocation method followed the substituting dam-justifiable cost method. (Theme 3: Finance)

2.4 Water Resource Development during High Economic Growth

> For wide-area water resource development, inter-regional and inter-organizational coordination is essential. The establishment of a necessary legal system and implementation of counter measures for confrontation are required.

(1) Coping with Water Shortages in Tokyo during a Period of High Economic Growth

With the high economic growth in Japan in the 1960s, the domestic water demand rapidly increased due to the population concentration and industry in urban areas, changes in the living environment such as the proliferation of flush toilets, washing machines, and sewage systems, and the development of heavy and chemical industries. The water resource development portion of the National Income Doubling Plan established by the Cabinet in 1960 intended to increase industrial water use by 3.3 times and raise the domestic water supply coverage rate from 49% to over 80% in Japan. The Tokyo Metropolitan Government planned to develop water supply facilities with a target coverage rate of 93% by 1970 (Figure 2.4).

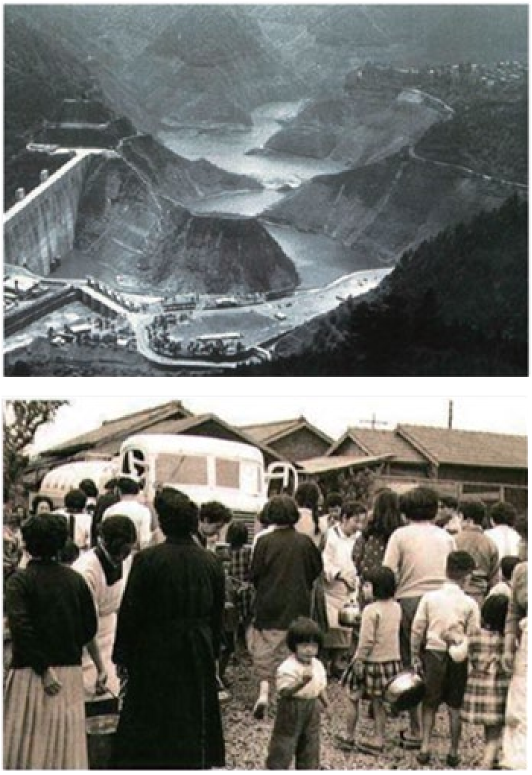


Source: A Historical Study of Modern River Projects Leading to the Comprehensive Revision of the River Law, Saburo Yamamoto

Figure 2.4 Amount of Water Supply in Tokyo

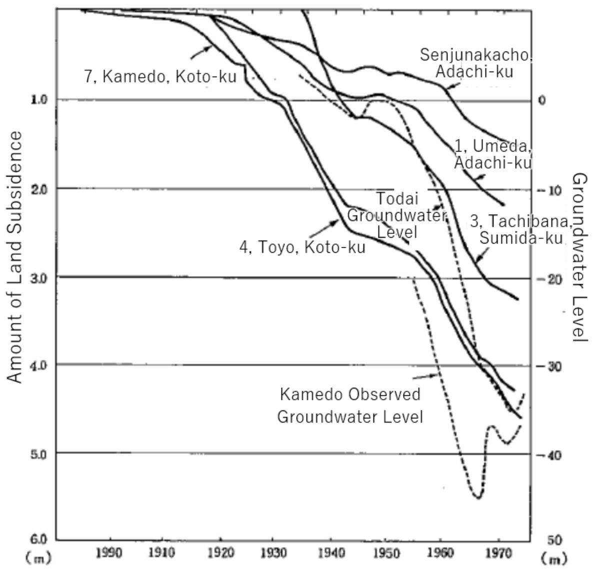
When Tokyo was preparing to host the Olympic Games in 1964, it suffered a serious water shortage known as the "Tokyo Desert". In the 1950s, the Tokyo Metropolitan Government expanded its water supply systems from neighboring rivers, such as the Tama, Sagami, Edogawa, and Nakagawa, but it could not secure sufficient water sources. Water supply restrictions were imposed for approximately 42 months, from October 1961 to March 1965. The water storage rate of the Ogouchi Dam on the Tama River dropped to 2%, and the lives of the citizens were disrupted by the cutoff of the water supply (Figure 2.5). Land subsidence due to the excess extraction of groundwater became more serious, and regulations on extraction became tighter (Figure 2.6). (Theme 7: Groundwater Management)

One solution was the implementation of a wide-area water supply project from the Tone River, which has the largest drainage area in the country and flows through the northern part of the Tokyo metropolitan area (Figure 2.7). The Tokyo Metropolitan Government could not cover the considerable costs of the project, and coordination among users regarding cost-sharing was complicated. A large number of water resource stakeholders, such as related prefectures and water user groups, were involved in the project.



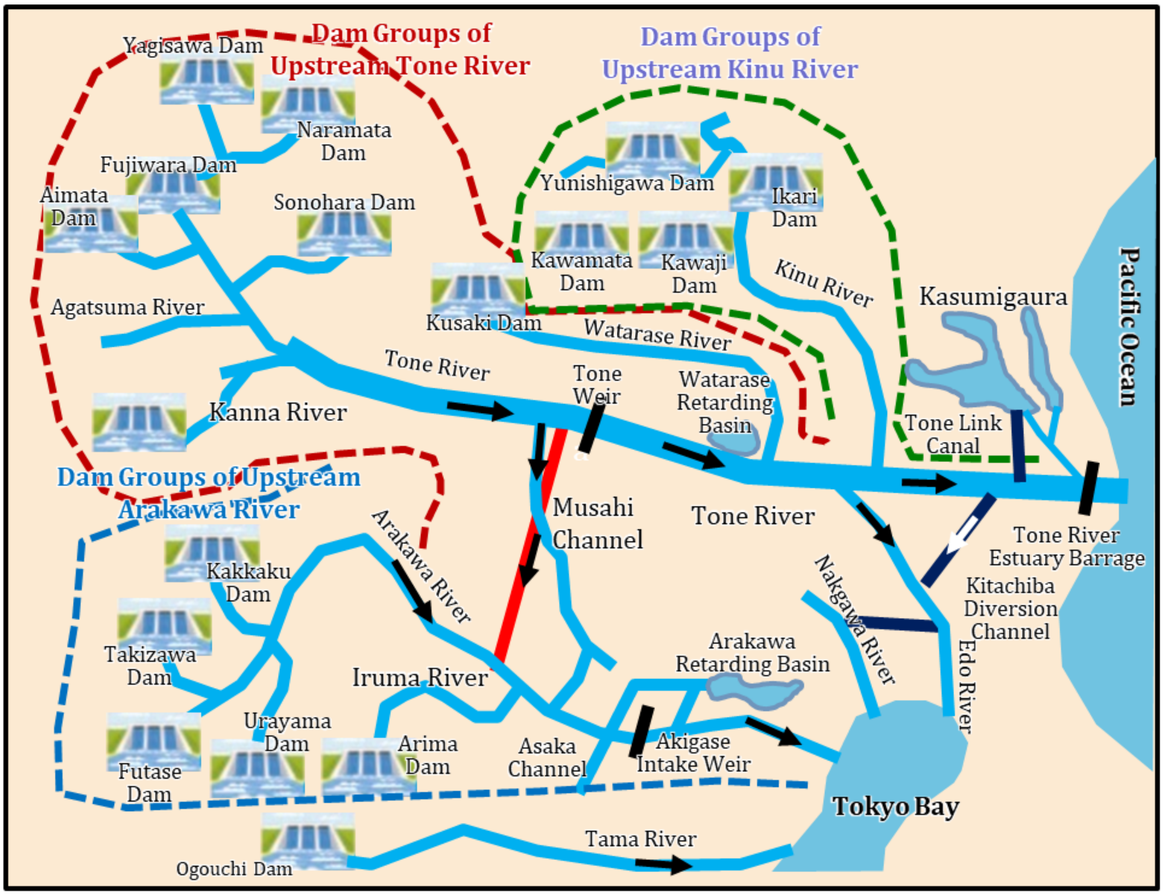
Source: Water Cycle Policy 2017, Cabinet Secretariat

Figure 2.5 Ogouchi Dam Reservoir During the Drought (upper) and Emergency Water Supply (lower) in 1964



Source: A Historical Study of Modern River Projects Leading to the Comprehensive Revision of the River Law, Saburo Yamamoto

Figure 2.6 Land Subsidence and Groundwater Levels in Tokyo



Source: Project Research Team based on summary of the drought in 2009, MLIT

Figure 2.7 Major Dams and Water Networks in the Tokyo Metropolitan Area Centering on the Tone and Arakawa Rivers

(2) The Water Resources Development Promotion Act

The Water Resources Development Promotion Act and Water Resources Development Corporation Act were implemented in 1961. These acts enabled the promotion of projects according to evidence-based plans by determining specific goals and necessary projects.

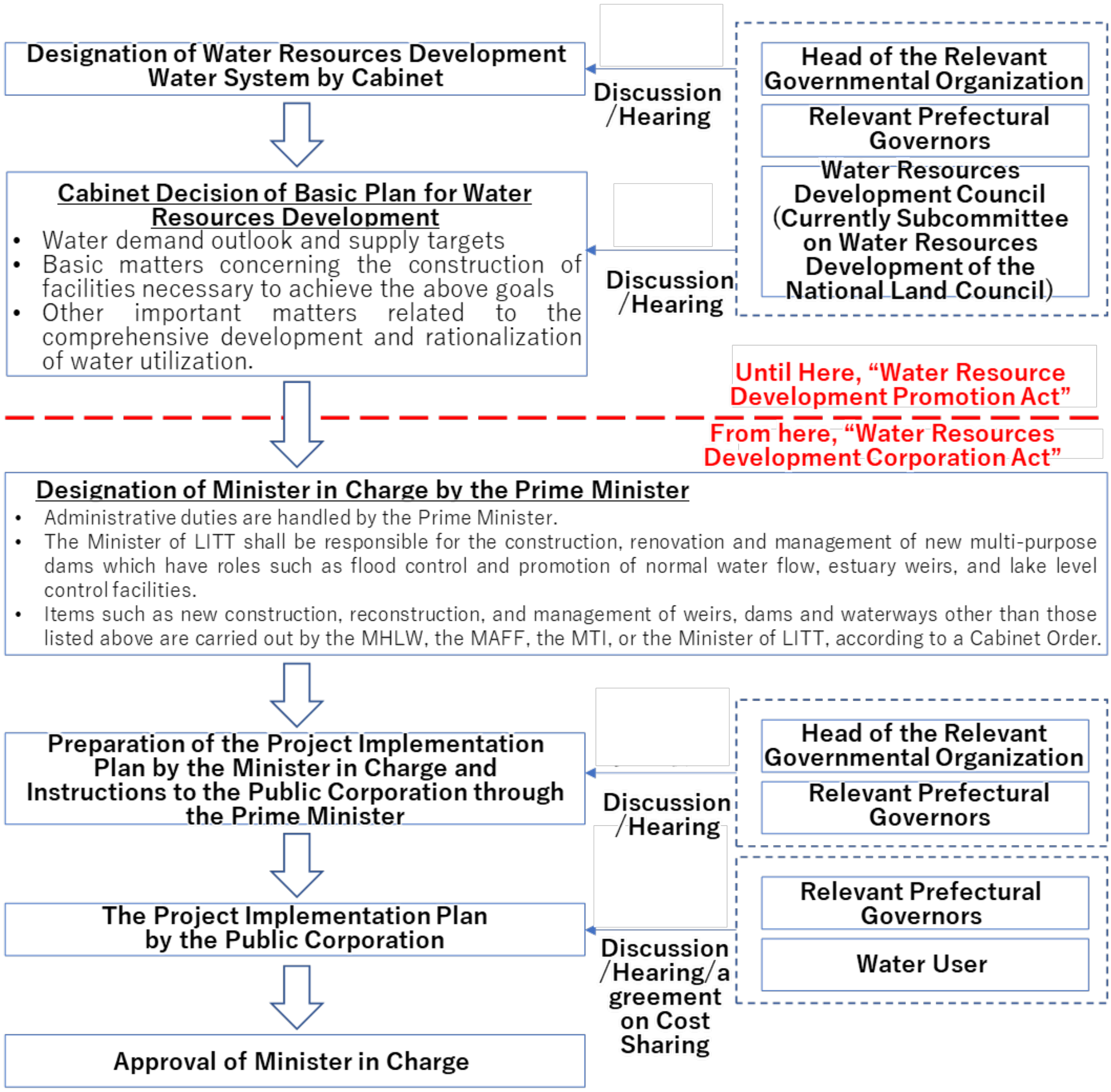
The Cabinet determines the Water Resources Development Plans, which are ranked higher than the plans of the Ministry. The plan is prepared after consulting with the heads of the relevant government agencies and receiving the opinions of the prefectural governors and the Water Resources Development Council (currently the National Land Council) (Figure 2.8). Through the fiscal investment and loan program of the government, financing for construction can be secured. (Theme 3: Finance)

The Economic Planning Agency was responsible for the two acts. The administration of water resources was transferred to the National Land Agency in 1974 and was further integrated into the MLIT in 2001. Currently, the Water Resources Department of the MLIT has jurisdiction over these two acts.

(3) The Water Resources Development Corporation Act

The Water Resources Development Corporation was established in 1962. The Corporation has implemented projects for dams, river mouth barrages, lake water level control facilities, and water channels. It is involved with projects that cannot be handled by a single local government, such as wide-area multipurpose main canals. To meet the rapid increase in water demand during high economic growth, it was necessary to make prior investments in water resource development. The Corporation introduced a system to execute prior investments with loans. (Theme 3: Finance, Chapter 3)

The Act stipulates the organization, operation, and government supervision of the Corporation. The procedures for the determination of the Basic Plan for Water Resources Development and implementation of projects in designated river systems, together with the Water Resources Development Corporation Act, are shown in Figure 2.8.



Source: Project Research Team based on the Water Resource Development Promotion Act and Water Resources Development Corporation Act

Figure 2.8 Flow of Procedures for Determination of the Basic Plan for Water Resource Development and Implementation of Projects in Designated River Systems

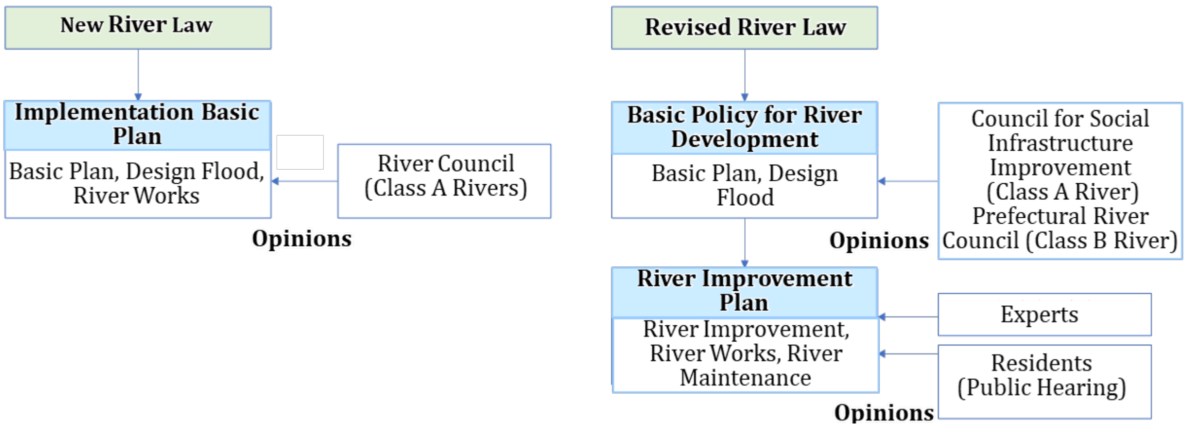
2.5 Response to Changing Needs

> The legislation and institutional systems are required to meet changing needs as the economy matures.

(1) Revision of the River Law for Conservation of the River Environment

After high economic growth, the required functions of the rivers change. Rivers are considered not only for flood protection and water use but also for providing waterside spaces and habitats for the growth of diverse organisms. (Theme 4: Water Pollution and Environmental Management, Chapter 5) Therefore, the Revised Law in 1997 introduced: 1) improvement and conservation of the river environment, and 2) a planning system and river improvement that reflected the opinions of local communities. The details are explained in the Theme 2-2: River Basin Planning.

Under the New River Law, a Basic Plan of Implementation of Construction Works was prepared for each river, incorporating the opinions of the River Council established by the Minister of Land, Infrastructure, Transport, and Tourism (Figure 2.9). The Revised River Law stipulates that a basic policy for river development and a river improvement plan should be formulated for each water system and should reflect the opinions of local residents and experts. This participatory approach requires accountability to the public, transparency of projects, and flexibility in the review of projects in response to changes in society. (Theme 1-3: Public Participation and Decision-Making Process)

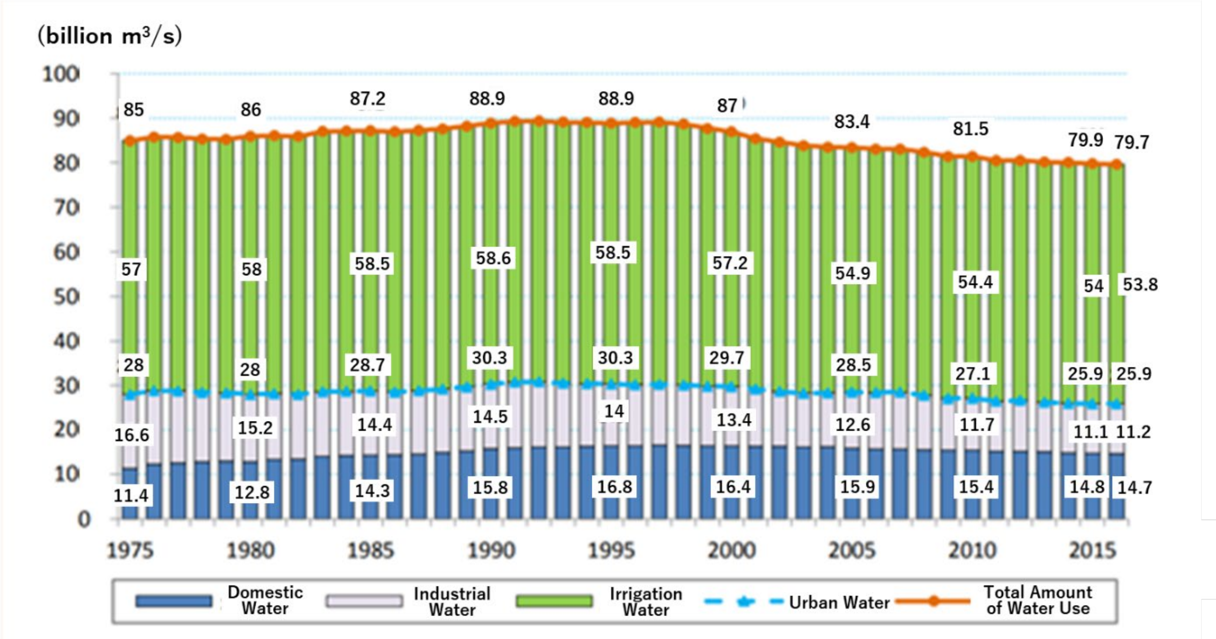


Source: Project Research Team

Figure 2.9 Differences in River Planning Under the New River Law and Revised River Law

(2) Transition from the Water Resources Development Corporation to the Japan Water Agency

The increase in water demand slowed down, and domestic water demand flattened and slightly declined in the 1990s (Figure 2.10). The necessity for water resource development decreased, and the role of water resources management shifted from new development to the effective use of existing facilities. The Water Resources Development Organization Act was abolished; the Japan Water Agency Act was enacted in 2003, at which time the Japan Water Agency was established. The Agency does not implement new water resource development projects, but continues the ongoing projects of the Water Resources Development Corporation. The focus of the Agency is on securing a stable water supply and environmental preservation through the rehabilitation and management of existing facilities.



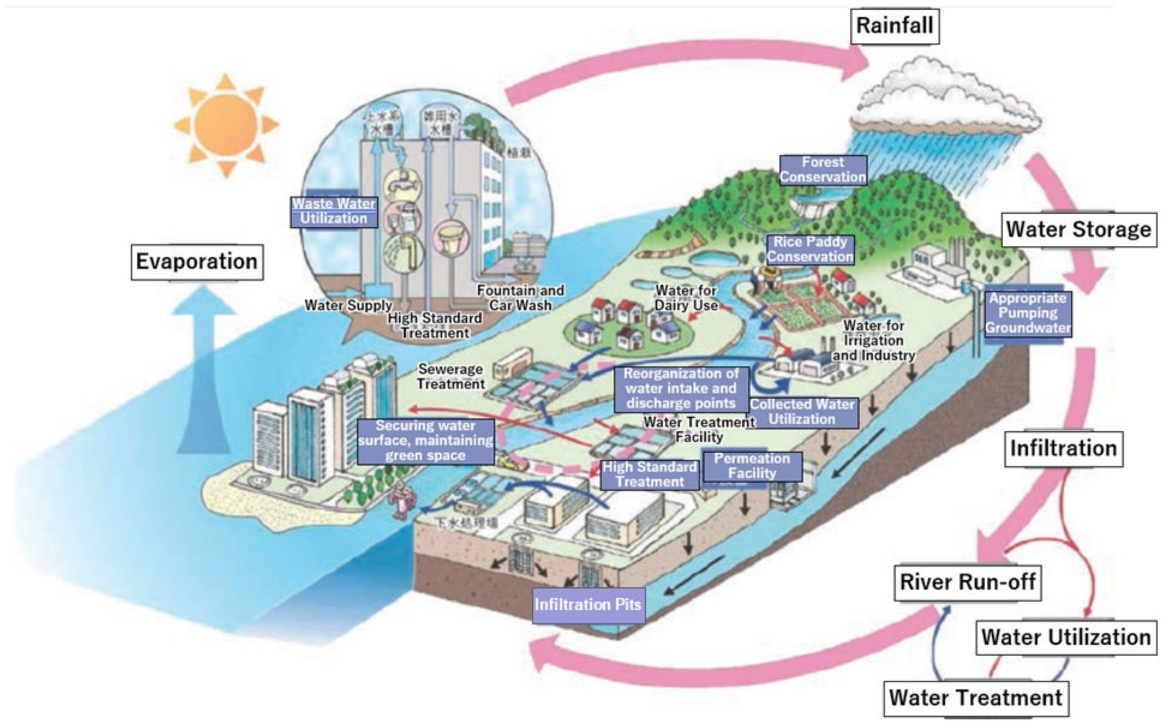
Source: Current Water Resource in Japan 2019, MLIT

Figure 2.10 Water Use Trend in Japan

2.6 Initiatives for a Healthy Water Cycle

The comprehensive management of river systems including groundwater is required to cope with the adverse effects of increasing rainwater runoff, deteriorating water quality, decreasing groundwater level and land subsidence caused by urbanization and alteration of nature. Cross-sectional efforts are required not only among the administrative divisions of forests, rivers, land use, and agriculture, but also across regions. The Basic Act on the Water Cycle was enacted in 2014 in Japan, and the Headquarters for Water Cycle Policy headed by the Prime Minister has been organized to work toward a healthy water cycle.

The "water cycle" is defined as the circulation of surface and ground water around a river basin in the course of its arrival at a sea area and its evaporation, falling, flow, or infiltration (Figure 2.11). It is necessary to maintain or restore a healthy water cycle by promoting measures in a comprehensive and integrated manner.



Source: Water Cycle White Paper 2018, Cabinet Secretariat

Figure 2.11 Concept of the Water Cycle

(1) Necessity for the Comprehensive Management of River Systems

The rapid increase in population through high economic growth and industrialization, centered on the heavy and chemical industries, has caused rapid changes in land and nature. Accelerated urbanization and alteration of land use of forests, paddy fields, and reservoirs has increased the risk of floods and other disasters and worsened water quality due to the inflow of pollutants that exceeded the natural purification capacity of rivers. Many adverse effects became apparent, such as reduced groundwater recharge capacity due to the expansion of impermeable areas in the basin, reduced river flow due to short-circuiting of the water cycle system, decline of the diverse inland aquatic ecosystems and natural environment inherent in rivers, and land subsidence due to excessive extraction of groundwater.

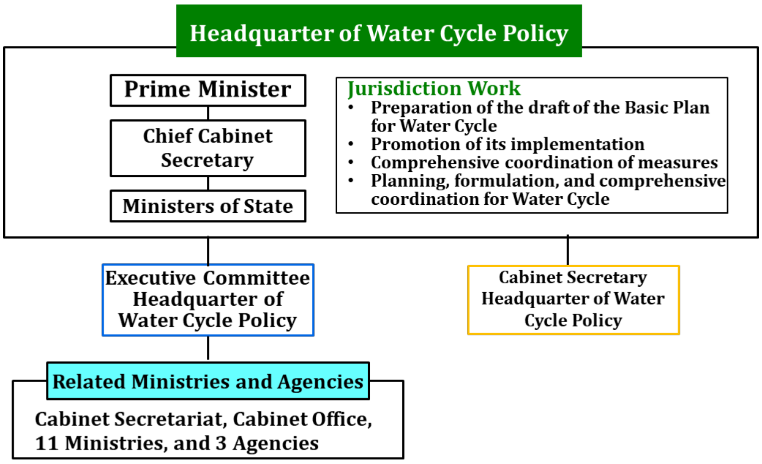
The 3rd National Comprehensive Development Plan (NCDP), approved by the Cabinet in 1977, pointed out the necessity for comprehensive management of river systems. The 5th NCDP planned to investigate and clarify the water cycle mechanism in river basins and the comprehensive management of the water cycle system including river water and groundwater. It is necessary to organize councils for cross-sectional coordination and cooperation on multi-layered issues that are beyond the administrative divisions for water quality, erosion and flood control, sediment management, forests, farmlands, and land use. It is also necessary for the Minister of Land, Infrastructure, Transport, and Tourism and the prefectural governors to create a different framework from the existing management system in accordance with the revised River Law to overcome the issues caused by the vertically divided administration system. More details are provided in Theme 7: Groundwater Management.

(2) The Basic Act on the Water Cycle

The Basic Act on the Water Cycle, enacted in 2014, aims to maintain or restore a healthy water cycle and contribute to the beneficial development of the economy and society of Japan, as well as an improvement of the lives of the users. The "Healthy Water Cycle" is defined as a state in which water functions for human activities and environmental conservation are properly maintained. The basic measures include the development of facilities for water storage, recharge of water sources and underground infiltration, and rationalization or regulation of water use.

The Headquarters for Water Cycle Policy is established in the Cabinet with the Prime Minister as the head, the Chief Cabinet Secretary and the Minister in charge of the Water Cycle Policy as deputy heads, and all other ministers as members. The government establishes the Basic Plan for the Water Cycle, including measures that are reviewed and approved by Cabinet every five years. This system has enabled related ministries and agencies to coordinate (Figure 2.12).

The Cabinet Secretariat prepared the Guide for Developing Basin Water Cycle Plans in 2015. As of 2020, 44 basin water-cycle plans have been prepared. To expand and improve the quality of the plans, various initiatives have been implemented, such as an advisory system based on good practices, the development of case studies and manuals, and the incorporation of initiatives to deal with disasters caused by climate change. These initiatives involve strengthening the national land with integrated hard and soft measures, risk management-type water supply, preparation of a drought response timeline consisting of scenarios and action plans, extending the life of water-related facilities, storing flood water using green infrastructure, and strengthening the recharge function. Examples of water cycle initiatives are described in Theme: 2-2 River Basin Planning.



Source: Project Research Team based on Headquarters for Water Cycle Policy, Cabinet Secretariat

Figure 2.12 Relationship Between the Water Recycling Policy Headquarters and Ministries and Agencies

(3) Basic Plan for the Water Cycle

The government establishes the Basic Plan for the Water Cycle and reviews it approximately every five years. The first basic plan was formulated in 2015 and a new basic plan was prepared in 2020. The three main points of the new basic plan are as follows:

1) Aiming for Water Cycle Innovation by Basin Management[3]: Support the development of basin water cycle plans and visualize healthy water cycles and the effectiveness of basin management.

2) Realizing of Safe Society: Intensify the measures for disaster risks increased due to climate change. Promote measures to adapt to critical droughts caused by climate change. Strategically maintain and upgrade the water infrastructure. Maintain and improve the storage and recharge functions to ensure sustainable groundwater conservation and use.

3) Inheriting Prosperous Society Through a Healthy Water Cycle for Future Generations: Promote awareness of the water cycle through public awareness, public relations, and education. Contribute to solving global water problems and achieving the SDGs through leadership by Japan.

[3] To maintain or improve human activities and water quantity and quality, and maintain the natural water environment in a basin in a proper condition, related public organizations such as national and local governments, business owners, groups, and residents work together through various initiatives.

CHAPTER 3 COUNTERMEASURES AGAINST CLIMATE CHANGE

> The countermeasures for climate change are implemented by stipulating the roles of national and local governments, and private sectors and citizens, and monitoring their activities through the development of a legal system in Japan.

Climate change affects various sectors and results in crop failures, weather disasters caused by heavy rains and storms, heat stroke, deterioration of water quality in lakes, and changes in fish habitats. Many sectors, including water resources, need to adapt to climate change. Mitigation efforts toward climate change by the public and private sectors and individuals are crucial.

The Act on the Promotion of Global Warming Countermeasures was enacted in 1998. It has established a framework for national and local governments, the private sector, and citizens to work together to fight global warming. National and local governments formulate action plans to curb greenhouse gas emissions and announce the status of implementation. The private sector is requested to prepare plans and publicize their implementation status for: 1) reducing greenhouse gas emissions and 2) improving products and international cooperation. The Act revised in 2013 requires that the government formulate a global warming countermeasure plan that includes targets for the control and absorption of greenhouse gas emissions, specific measures to be taken by the private sector and citizens, and measures to be taken by the national and local governments. “The realization of carbon neutrality by 2050” is positioned as the basic principle, with measures for decarbonization with local renewable energy, a mechanism for promoting digitization, and open data of private sector emissions information to achieve this goal.

The sixteenth Conference of the Parties to the United Nations Framework Convention on Climate Change (COP16) of 2010 established the “Cancun Adaptation Framework”, which includes the creation of an Adaptation Committee to strengthen adaptation measures by all ratifying countries. The Paris Agreement also includes the expansion of adaptive capacity and the strengthening of resilience as its objectives, including promoting action on adaptation and the preparation of appropriate plans. The Climate Change Adaptation Act was enacted in Japan in 2018 (Table 3.1).

The Ministry of the Environment (MOE) published the Climate Change Impact Assessment Report in 2020. The impacts of climate change are listed in Table 3.2. The specific concepts and measures to be adapted for water resources are described in Theme 2-1: Management Planning, Chapter 5, Theme 5: Urban Water Management, and Theme 8: Dam Management.

Table 3.1 Outline of Climate Change Adaptation Act

Items	Contents
1) Promotion of Comprehensive Adaptation	・ Clarify the roles of the national and local governments, private sectors, and citizens for promoting adaptation to climate change. ・ The national government formulates a climate change adaptation plan. ・ The MOE assess the impact of climate change every five years, after hearing the opinions of the Central Environment Council.
2) Development of Information Platform	・ The National Institute for Environmental Studies collects and provides information on climate change impacts and adaptation, and provides technical assistance to local governments and regional climate change adaptation centers.
3) Intensifying Regional Adaptation	・ Prefectures and municipalities formulate regional climate change adaptation plans, taking into account climate change adaptation plans formulated by the national government. ・ Prefectures and municipalities collect information on climate change impacts and adaptation and secure a center for providing information (the regional climate change adaptation center). ・ Local environmental offices of the national government, prefectures, and municipalities may organize a Regional Council for Climate Change Adaptation through wide-area cooperation.
4) International expansion of adaptation	・ Promotion of international cooperation on climate change adaptation, and project activities by private sectors

Source: Cabinet Decision on the Climate Change Adaptation Draft Bill, MOE

Table 3.2 Impacts of Climate Change on the Water Resources and Disaster Departments in Japan

Department	Evaluation	Impacts
Water Resources	Current Evaluation	▪ Drought due to no rainfall or low rainfall ▪ Shortage of irrigation water in early spring due to increased snowmelt during the winter, and increased demand for agricultural and domestic water ▪ Saltwater intrusion into coastal aquifers and shrinking freshwater lenses in small islands
	Future Prediction	▪ Worsening of drought due to increase in days with no precipitation. ▪ Snowfall decreases, while rainfall increases due to global warming. This results in an increase in river flow in winter and a decrease of snowmelt flow in spring. Consequently, this impacts the quantity and timing of river water utilization ▪ Shortage of agricultural water due to declining groundwater levels ▪ Saltwater intrusion to more upstream areas of the river due to rising sea levels and its impact on river water use ▪ Increasing polarization of drought and flood risks ▪ Increase in slope failure due to increased groundwater supply from rain and snowmelt
Disaster	Current Evaluation	▪ Upward trend in sea level and extreme high tide levels caused by expanded and strengthened typhoons ▪ Large-scale complex disasters such as the occurrence of numerous deep-seated collapses, simultaneous surface collapses, and sediment and flood inundation ▪ Changes in typhoon intensity and path ▪ Increase in insurance payments to natural disasters
	Future Prediction	▪ Increase in extraordinary rainfall and flood, inundation, and damage ▪ Increase in the number of people affected by inundation and damages due to inland floods ▪ Rising sea level and its impact on river intake facilities, coastal disaster prevention facilities, and port and fishing port facilities ▪ Increased storm surge anomalies and increased risk of storm surges due to changes in the size and path of typhoons, and loss of beaches due to rising sea levels ▪ Impacts from an increase in the number of strong winds and strong typhoons and the frequency of strong tornadoes

Source: Climate Change Impact Assessment Report 2020, MOE

CHAPTER 4 LESSONS LEARNED

(1) **Stakeholders should be coordinated by establishing a legal system.** Various stakeholders are involved in water resources management. These are the users of agricultural, domestic, and industrial water, as well as hydropower companies. It is necessary to resolve inter-sectoral conflicts regarding water use and environmental conservation, and between water sources and beneficiary areas. The River Law and related Acts aim to integrate river basin and water use management in Japan.

(2) **Various acts should be implemented to cope with the increased water demand.** The establishment of a legal system facilitated coordination among stakeholders and enabled water resource development to cope with the rapidly increasing demand in Japan. The Specific Multi-Purpose Dams Act stipulates the roles and authorities of dam owners and users and promotes the construction of multi-purpose dams. The Water Resources Development Promotion Act and the Water Resources Corporation Act coordinate the relevant ministries, departments, and parties involved in water use, prepare of the basic plan for water resource development, and promote a comprehensive and systematic development of water resources over a wide area, including major cities.

(3) **The legal system should be revised as needs change.** Various acts and regulations have been revised in accordance with changing needs and values in Japan. When the country stated modernization, related acts aimed at mainly flood protection and water supply. To reconstruct national lands devastated by WWII and supply urban water during the high growth, legislation was developed to generate hydroelectricity and to supply irrigation and urban water. When the economy matured, the growth in water demand ceased, and the demands for and values of rivers and water resources became more diverse. The River Law was revised in 1997 to address the needs of the river environment and include public participation. The Basic Act on the Water Cycle of 2014 promoted comprehensive measures to maintain and restore a healthy water cycle.

(4) **The roles and measures should be clarified to respond to climate change.** The roles of national and local governments, the private sector, and citizens in climate change mitigation and adaptation measures were clarified through legislation. Japan is implementing countermeasures in collaboration with its stakeholders.

THEME 1-2 WATER RIGHTS: ESTABLISHING THE ORDER OF WATER USE BASED ON REGIONAL PRACTICES AND CHARACTERISTICS

ABSTRACT

Where water is a limited natural resource, it needs to be used effectively and appropriately. Disorderly water usage by individual users may cause water shortages, conflicts among users, and adversely affect ecosystems.

In the past 2,000 years, Japan has developed paddy fields in alluvial plains and established agricultural irrigation systems in each river basin. Earlier, water conflicts among farmers were settled by swords. Thereafter, the conflicts were gradually settled by the lord in the area, and subsequently autonomous village water associations resolved these issues.

In Japan, water management has been carried out through the water rights system, which was established by the River Law in 1896. Water rights are licensed; the amount of water intake is determined, and penalties are imposed for intake violations. Irrigation users who took water prior to the introduction of the modern water rights system were allowed customary water rights. Water rights holders pay a fee, which serves as a source of general finance for local governments. During a drought event, a drought coordinating committee is set up to set rules for adjusting water intake in the spirit of mutual concession based on the history and circumstances of river basins.

Granting a new water right is possible, provided that it does not impair the normal functioning of rivers to conserve the environment, and maintain the supply of other water users. If the amount of water to be taken up by the new water right applicant exceeds the sum of the environmental flow and water use flow, a new storage facility is required.

In Japan, a farmers' association manages the distribution of irrigation water and maintains irrigation facilities. The association collects levies from the farmers and implements agricultural projects with financial support from the national and local governments.

CHAPTER 1 INTRODUCTION

> Each country, region, and river basin has different water issues, distinctive and individual circumstances, and practices and history of water use. Thus, they should build a water rights system to establish an order for water use based on this background.

Water resources are used for various purposes, such as irrigation, hydroelectric power generation, domestic water supply, and industrial water supply. Furthermore, rivers and lakes provide habitats for a variety of plants and animals and are also used for navigation, dilution of wastewater, and recreation. Disorderly water usage by individual users may cause water shortages and conflicts among water users and adversely affect the environment and ecosystem. Where water resources are limited, effective and appropriate use mechanisms are needed.

In Japan, rice cultivation started more than 2,000 years ago, and water conflicts have occurred for a long time due to the use of agricultural water. Orderly water use has been gradually established by settling conflicts. This theme explains Japan's practice of establishing mechanisms for water rights systems based on their practices and histories.

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

Relationships between Water Rights System and the SDGs:

(1) Stable water intake is possible by building a water use order based on the water rights system and the coordination of water use during drought:

SDG1 "No Poverty," SDG2 "Zero Hunger," SDG6 "Clean Water and Sanitation for All," SDG11 "Sustainable Cities and Communities," SDG12 "Responsible Consumption and Production," SDG15 "Life on Land," SDG16 "Peace, Justice and Strong Institutions"

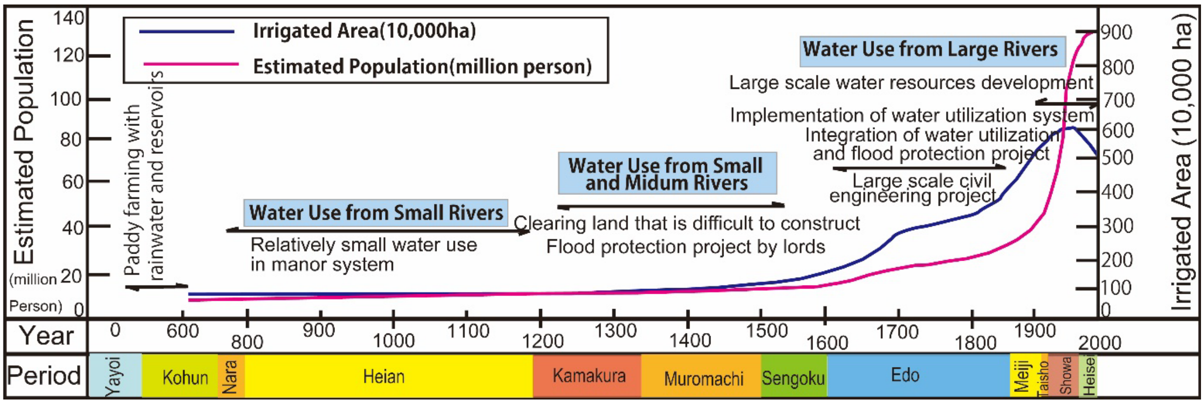
(2) Granting water rights for hydroelectric power generation, which is a renewable energy source:

SDG7 "Affordable and Clean Energy"

CHAPTER 2 THE CHANGE OF WATER USE

In Japan, systems to coordinate water users have been established based on past experiences of water use and conflicts. While respecting customary rights, the government has granted new water rights necessary for economic growth and built a system to manage the water use.

Water use must change according to socioeconomic development. In Japan, agricultural irrigation systems have been developed to supply water to paddy fields expanding in alluvial plains. Farmers and agriculture-based communities have managed irrigation water for a long time. As seen in Figure 2.1, over 2,000 years, the area of cultivated land has increased, along with the population, with the development of water resources. Japan had escaped the Malthusian trap, that is, the phase in which the population could not increase due to food shortages. In the process of modernization and economic growth since the 19th century, new water use was permitted to meet the increasing water demands in cities, industries, and power generation while respecting customary water rights.



Source: A partial excerpt and revision of the "Farm Land and Water in Japan, Ministry of Agriculture, Forestry and Fisheries"

Figure 2.1 Changes in the Population and Cultivated Area

[4th century BC to 19th century AD]

Rice cultivation commenced in Japan in the 4th century BC. It began through rainwater and ponds, and gradually cultivated land was developed. As the development and redevelopment of paddy fields have been promoted since the latter half of the 11th century, water rights have become complicated and conflicts on water intake have occurred more frequently. After the 17th century, conflicts were settled by the federal lord through an authorized judgement instead of violence. Thereafter, water management shifted from the lord's ruling to autonomous village irrigation associations; this was recognized and maintained as a custom in water usage.[1]

[1] "*Hyakusho tachi no Mizushigen Senso: Edo Jidai no Mizuarasoi wo Ou* (Water Resources War of Peasant Farmers: History of Water Conflicts in Edo Period)" Watanabe Takasi, Soshisha Publishing (2009) (in Japanese)

[1896 to 1964]

Under the old River Law enforced in 1896, the local government permitted the use of river water. Water taken from the river for irrigation purposes before the enactment of the law was licensed as customary water rights. During industrialization at the end of the Meiji Period,[2] new water users (such as hydroelectric power companies) appeared, and conflicts between new and existing water users occurred. The old River Law had limited provisions for water use and could not adequately deal with new demands. Hence, it was not resolved, and there was no major change until the legislation of the Specific Multi-Purpose Dams Act[3] in 1957.

Government-appointed prefectural governors carried out river management under the old River Law. Thereafter, prefectural governors were elected publicly according to the Local Autonomy Act of 1947. Each prefecture managed only one section of the river within its jurisdiction, so consistent river management was difficult for the entire basin.

The Specific Multi-Purpose Dams Act, legislated in 1957, designated that the Minister of Construction (currently the Minister of Land, Infrastructure, Transport, and Tourism) granted water rights solely for dams. However, the issue of water intake from rivers remains unresolved because the management system for each section of the river by each governor has not changed.

[1964 to present]

The new River Law was enacted in 1964. It stipulates a principle of river management in which the river should be managed consistently in the entire water system and provides regulations for water use. The national government, which is the administrator of major rivers, is responsible for managing water use, such as granting water rights and monitoring river flow. (Theme 1-1: Legislation and Organization, Chapter 2)

[2] Meiji Period: 1868 to 1912
[3] The Act for multipurpose dams aims to facilitate an immediate and sufficient impact by executing its planning, construction, and management in an integrated way and setting a new right for dam use instead of the existing right for shared ownership of the business owners. (Theme 1: Legislation and Organization for details)

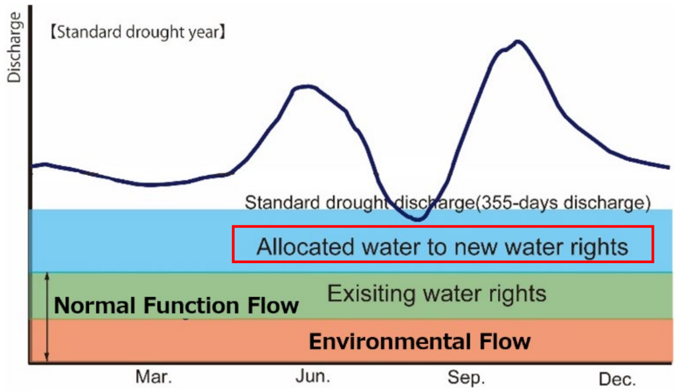
CHAPTER 3 BUILDING A WATER USE ORDER THROUGH THE WATER RIGHTS SYSTEM

3.1 Water Rights Licensing System

Each country should establish a water rights system in order to maintain orderly water use.

Water rights are the right to use water for a specific purpose, and require permission from the licensor. The purpose is to serve domestic water, industrial water, irrigation water, hydroelectric power generation, and other uses. The monitoring of river flow is a prerequisite for water rights management (Theme 2-2: River Basin Planning, Section 2.1).

In Japan, River Management Offices (RMOs)[4] grant water rights. The national government established RMOs on-site to manage major rivers (Theme 2-2: River Basin Planning, Section 2.6). The RMOs examine the application of new water use by examining river flows of existing water rights and river environmental flow based on the drought condition of once every ten years. If a newly applied water intake discharge is available, the RMOs grant new water rights.



Source: Project Research Team

Figure 3.1 Flow Discharge to be Allocated for New Licensed Water Rights

(Newly applied intake water) < (Drought discharge[5] in a standard drought year) – (Normal function flow[6])

The normal function flow is the sum of the river environmental flow and the amount of water rights of the existing water users (Theme 2-2: River Basin Planning, Chapter 2). Figure 3.1 shows the relationship between the flow discharge capable of being allocated for new licensed water rights and normal function flow.

(1) Classification of Water Rights Based on the Stability of Rights

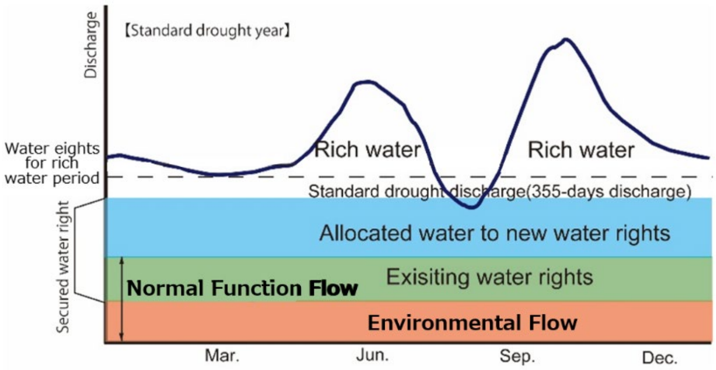
1) Stable Water Rights

Stable water rights ensure a stable and continuous water intake. Water rights obtained from newly constructed facilities are also stable water rights (Figure 3.2).

[4] Rivers are for public use and river administrators are the authorities that have power and are obliged to manage the rivers. River administrators are explained in detail in "Theme: 6 River Management."
[5] Drought discharge at planned water intake points in a drought year about once every 10 years (flow discharge not less than this for 355 days a year)
[6] Normal function flow discharge = intake water discharge based on existing water rights + river environmental flow

2) Water Rights during Rich Water Period

Water rights during the rich water period were licensed only when the river flow exceeded the rich water flow[7] (Figure 3.2). Users cannot take water continuously throughout the year. The issues are as follows.



Note: Water can be taken only during the period marked as rich water
Source: Project Research Team

Figure 3.2 Stable Water Rights and Water Rights during Rich Water Period

(a) Because water intake is allowed only during the rich water period, the purpose of water use may not be fully achieved.

(b) If water is taken in violation of a license during a drought event, it may affect existing water users and the environment.

(c) There is a difference in cost sharing between stable water rights holders who take water continuously from the constructed facilities and water rights holders who take water only during the rich water period.

(d) The construction of new facilities regulates river flow conditions so that the amount of water available for water rights holders during the rich water period may be reduced.

Additionally, water rights during the rich water period were limited. For example, water users, such as run-of-river-type hydroelectric power producers, use water only for a certain number of days in a year.

3) Provisional Water Rights during Rich Water Period

Provisional water rights during a rich water period are provided to users who have urgent requirement until a dam is completed. After completion of the dam, provisional water rights are replaced by stable water rights.

(2) Required Documents and Actions by the Applicant to Obtain Water Rights

The criteria for granting water rights are 1) promotion of public welfare, 2) certainty of water use, 3) relationship between discharge of river flow and water intake, and 4) no interference to the public interest. Licensed water rights are managed by recording them in the water rights management book and keeping the register at the RMO.

If water and fishery rights holders are expected to be affected by water rights applicants, they can present their opinions. The applicant is required to obtain the consent of other water users by taking necessary measures (for example, construction of dams) to prevent such impacts.

[7] "Rich water": discharge exceeding the standard drought discharge.

The documents necessary for the application are: 1) outline of the implementation program; 2) evidence for water demands; 3) evidence for the amount of water used from the river; 4) records of river water level and runoff discharge for the past 10 years; and 5) explanation of the predicted impacts on other users and necessary countermeasures.

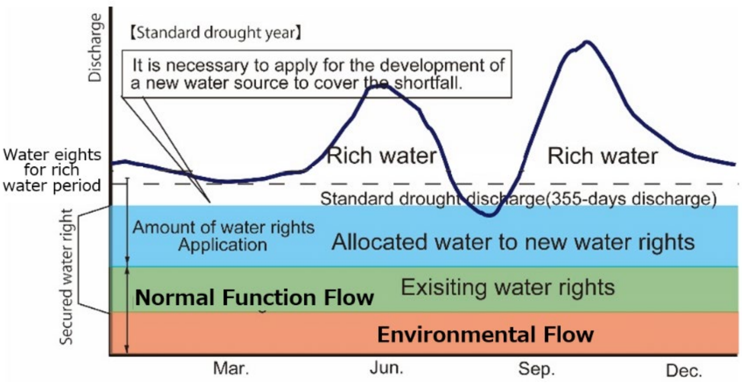
If there was no record of the actual discharge measurement for the last ten years, it was estimated using the following methods:[8]

(a) The discharge was estimated using data from other river basins where topography, geology, and rainfall characteristics are most similar to those of the intake basin. It is necessary to measure the river discharge at the water intake point for a certain period and examine the correlation between the measured discharge and the estimated discharge.

(b) If the discharge data are available in the river basin, where the rainfall conditions are very similar to the intake basin, simultaneous discharge observation at the existing observation point and the planned water intake point is carried out throughout the year. Based on the correlation, the discharge at the intake point is estimated.

(c) If there are no discharge data, the discharge is estimated by applying a simulation model by using rainfall data.

If the water requirement for the new water rights exceeds the discharge capable of being allocated for new water rights (Figure 3.3), a storage facility is required. Documents on the construction of this facility are also required for water rights applications.



Source: Project Research Team

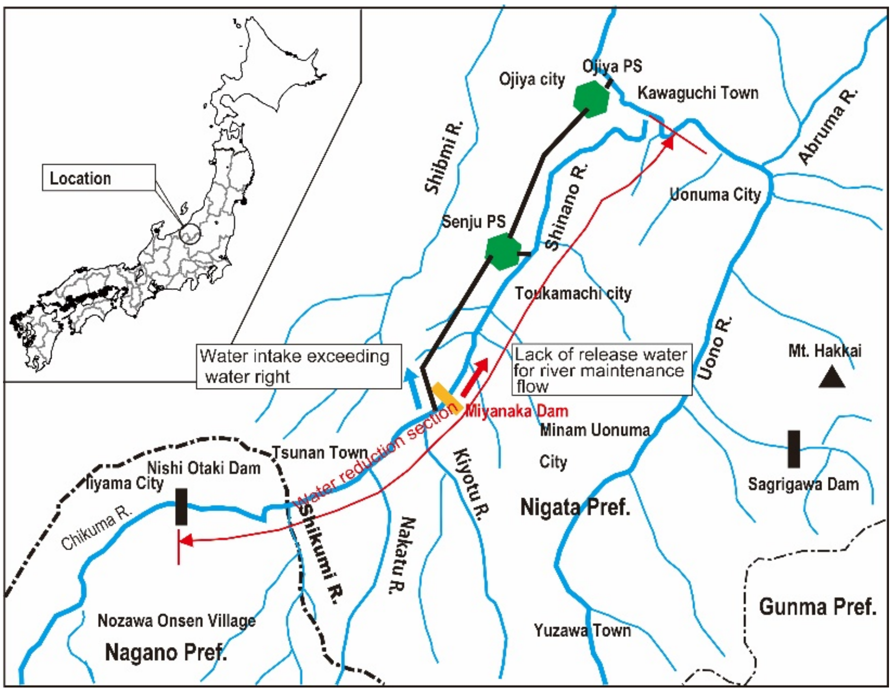
Figure 3.3 Relationship between Flow Discharges to be Allocated to New Water Rights and Discharge Amount of Water Rights Applied

(3) Valid Period of Permission

As a general rule, the valid period of permission for the use of irrigation water, domestic water, and industrial water is usually ten years. For hydropower generation, considering the large investment cost, it is twenty years.

[8] Compiled by the Water Conservation Coordination Office, Water Administration Division, River Bureau, Ministry of Construction <Vol. 2> Q&A of water rights practice, Taisei Publishing Co., Ltd.

(4) Penalties for Illegal Water Intake



Note: Shinano power station consists of Senju power station and Ojiya power station
Source: Project Research Team

Figure 3.4 Location Map of Shinano River Hydroelectric Power Station

Illegal water intake can result in punishment. Various punishments, including revocation of permission, change of permission content, and other penalties, are given depending on the illegal activities. For example, at the Shinano River Hydroelectric Power Station (Figure 3.4) owned by the East Japan Railway Company (JR East), there were violations of 1) water intake exceeding the water rights, and 2) insufficient environmental flow discharge from the dam. The water rights of the JR East were revoked as punishment.

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Hokuriku Regional Development Bureau (Hokuriku RDB) requested the JR East to report the records of water intake. JR East reported that there was no inappropriate measure for two years, but in the third year, a limiter was discovered to be set in the recording program for water intake and release of environmental flow. MLIT issued a notice to start the procedure for "supervisory order on water use" and punished JR East by "revoking water rights."

JR East discussed the amount of water rights and river environmental flow with the local community for the reacquisition of water rights, and donated 3 billion Japanese Yen to Tokamachi City, 2 billion Japanese Yen for Ojiya City, and 700 million Japanese Yen to Kawaguchi Town (a total of 5.7 billion Japanese Yen). JR East reacquired water rights with the consent of the locals.

(5) Review of Water Rights for Hydroelectric Power Station Considering Environmental Issue

Due to the water intake for hydroelectric power generation, sufficient water may not flow to conserve the environment in rivers. To remedy this, MLIT formulated the guideline for securing the river environmental flow (approximately 0.1 to 0.3 m^3/sec per 100 km^2 of catchment area) in 1988, and enforced it at the time of renewal of the water right. There was no compensation for the power reduction caused by this measure.

In the middle reach of the Shinano River, approximately 63.5 km long between the Nishi-Otaki Dam and the confluence with the Uono River, there was a period of almost no water flow in a year due to hydropower generation (Figure 3.4). To improve the river environment, it was decided to release 20 m^3/sec from the Nishi-Otaki Dam and 40 m^3/sec from the Miyanaka Dam (these discharges were decided after the above-mentioned punishment). Consequently, the river environment improved, as evidenced by the recovery of salmon swimming upstream. The required discharge of the normal function flow was determined considering eight aspects: (1) river morphology, (2) water temperature, (3) periphyton, (4) benthic animals, (5) fish inhabiting and swimming upstream and downstream, (6) landscape, (7) water quality, and (8) groundwater level.

3.2 Prioritized Customary Water Rights

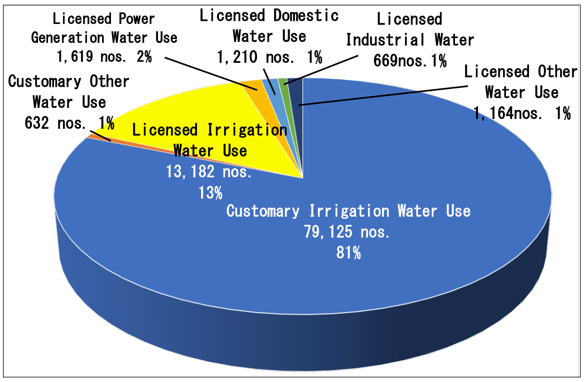
> Japan has given the customary water rights to traditional water uses made before establishing the water rights system, and the rights remain valid.

Customary water rights remain valid to the present day. As shown in Figure 3.5, the total irrigation water intake accounts for approximately 88% of the total water use in Class A rivers.[9] In terms of irrigation water intake, licensed water use accounted for 59%, whereas customary water use is about 29%. The total water intake discharge was 10,142 m^3/sec, while the customary water use was 2,987 m^3/sec and licensed water use was 5,965 m^3/sec. As for the number of irrigation water rights, the customary water rights are the largest, accounting for 81% of the total. There are 92,307 irrigation water rights, consisting of 79,125 customary and 13,182 licensed water rights.

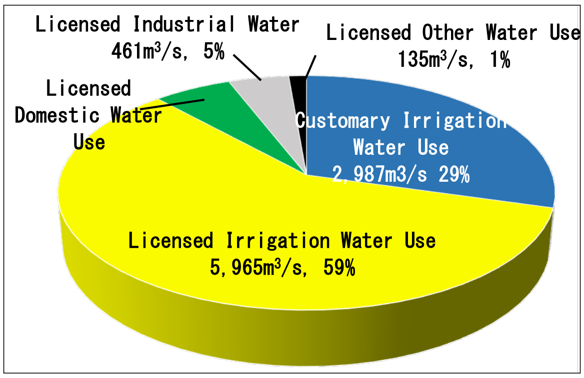
Water users with customary water rights do not have the duty to record and report the amount of water intake. This makes it difficult to accurately determine actual water intake. Also, there is no opportunity to review the rights.

The RMOs have requested to change the customary water rights to licensed ones on occasions such as the renovation of water intake facilities. Approximately 100 customary water rights are changed to licensed ones annually. Most rights holders are individuals and small organizations. To change the right to the licensed one, the holder must prepare application documents and observe the discharges. Because this requirement is a substantial burden, RMOs assist in this process.

[9] Important rivers managed by the national government. They are explained in detail in "Theme 2-2: River Basin Planning."



Total Number of Water Rights



Maximum Intake Water Discharge

Note: FY 2014 data
Source: Fourth study group on the sophistication of river use as a resource, Document No. 2 Customary Water Rights MLIT

Figure 3.5 Customary and Licensed Water Rights

3.3 Water Right Fee

Water right holders should pay water right fees according to the amount of water intake. Public interests and local customs should be considered when setting water right fees.

Water rights holders are obliged to pay fees to the local governments. Public power generation, irrigation, and public water supply are exempt due to high public interest. Therefore, fees are collected from power generation and industrial water users. Even in the case of Class A rivers managed by the MLIT, the prefecture collected water rights fee. Under the Old River Law, prefectural governors managed the rivers. This fee collection system was taken over by the new River Law because of the insistence of the prefectures.

The fees collected from hydroelectric power generation are approximately 32.8 billion Japanese Yen annually. Since the annual revenue of local governments is 47.4 trillion Japanese Yen, it is approximately 0.07% of the revenue. The MLIT has established a calculation formula for the water rights fee for hydroelectric power generation.

The water rights fee for industrial water is set by local governments and varies depending on the local government. Table 3.1 shows examples of these fees.

Table 3.1 Examples of Water Right Fee for Industrial Water

Local Government	Tokyo Metropolitan Government	Nagano Prefecture	Saga Prefecture	Fukui Prefecture	Tochigi Prefecture
Unit Price (Japanese Yen per litter/s)	6,288	3,900	1,550	2,970	3,800

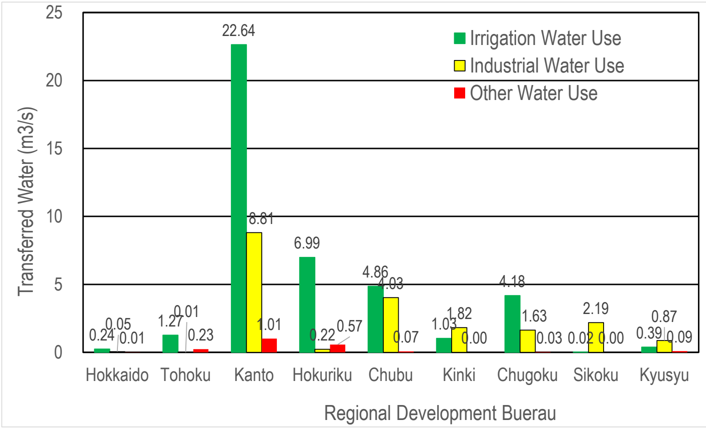
Source: The River Law Enforcement Ordinance at each prefecture

3.4 Transfer and Trade of Water Rights

> Establishing the appropriate system of water right transfer aids an effective utilization of water resources. In Japan, water rights for irrigation use, whose water demand is declining, is being transferred to urban use with increasing water demands.

(1) Transfer of Water Rights

In Japan, trading water rights with financial compensation between water rights holders is not permitted. The water rights for excess water are returned to public water and the returned water is allocated for new water rights. With an agreement between water users, the existing water rights holder returns all or part of the water rights, and a new user applies to obtain permission for new rights from the RMOs. Seventy-eight cases, or approximately 46 m^3/s in Class A rivers, were transferred from FY1965 to FY2017 (Figure 3.6).



Note: As of FY 2017
Source: 2018 Edition: Current status of water resources in Japan Reference data MLIT

Figure 3.6 Status of Transfer of Water Across Applications (Class A Rivers)

The Ministry of Agriculture, Forestry and Fisheries (MAFF) has implemented rationalization of the water distribution system by improving facilities such as pipelines for waterways and disclosing excess water for irrigation due to a reduction in irrigation area. In recent years, water for urban use has not been tight. Instead, water rights transfer to environmental conservation in some cases.

In the case of the transfer of water rights relating to dams, it is necessary to perform “back allocation.” Changes in the ratios of cost allocation decided at the time of dam construction are required, and the transferred user must pay the cost in accordance with the new ratio. In some cases, the transferred user is required to bear a part of the construction cost.

> **Irrigation Water Rationalization Projects in Saitama Prefecture[10]**
>
> In Saitama Prefecture in the Tokyo Metropolitan Area, where urbanization is progressing, rationalization projects of improving irrigation canals produced water for urban use. Urban uses in Saitama Prefecture and Tokyo Metropolitan Government bore most of the cost of the Four projects besides national subsid (Table 3.2). The second rationalization project in Nakagawa river system (Figure 3.7) is explained below.

[10] “Reallocation of Water Resources between Water Uses and Cost Sharing (I), (II)-Case Study on Agricultural Water Rationalization Project in Saitama Prefecture” Takeda Mari, Water Science, (I) Vol. 49 No. 1 pp. 57-84, 2005, (II) Vol. 49 No. 2 pp. 90-120, 2005

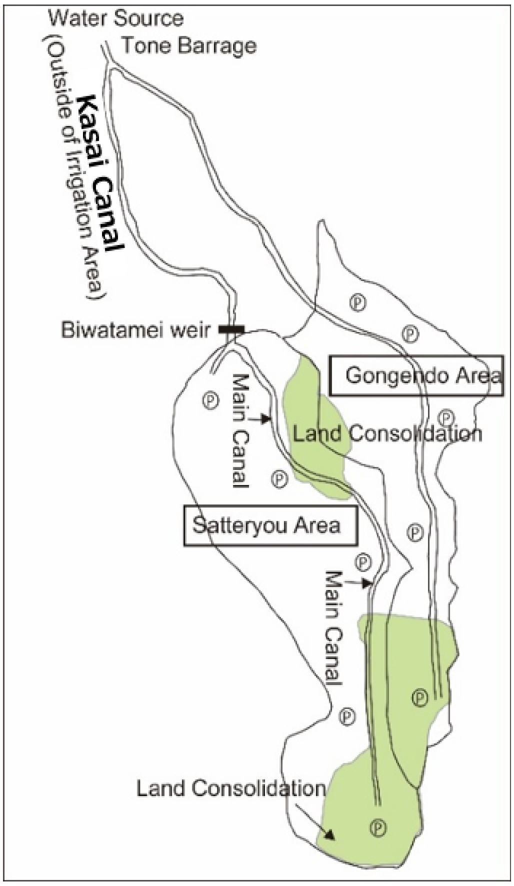
Table 3.2 Irrigation Water Rationalization Projects in Saitama Prefecture

Project Name	Target Area	Transfer of Water Rights
First Rationalization Project in Nakagawa River System (1968 to 1972)	Kasai Canal	Reduced: Water Resources Development Public Corporation (WRDPC) 3.166 m^3/s New: Saitama Prefecture Enterprises Bureau 2.666 m^3/s
Second Rationalization Project in Nakagawa River System (1972 to 1987)	Gongendo Area and Satteryou Area	Reduced: WRDPC 2.829 m^3/s New: Saitama Prefecture Enterprises Bureau 1.581 m^3/s
Saitama Intake Integration Project, Phase 2 (1978 to 1994)	Minumadai Canal and Arakawa Water Supply Canal	Reduced: WRDPC 7.124 m^3/s New: Saitama Prefecture Enterprises Bureau 3.704 m^3/s New: Tokyo Metropolitan Government 0.559 m^3/s
Tone Central Project (1992 to 2003)	Kasai Canal	Reduced: Kasai Canal agricultural irrigation area improvement and management association 5.441 m^3/s New : Saitama Prefecture Enterprises Bureau and Tokyo Metropolitan Government 3.811 m^3/s

Source: "Study on Beneficial Use of Water" Suzuki Satoshi, Water Science, No. 347, 2016

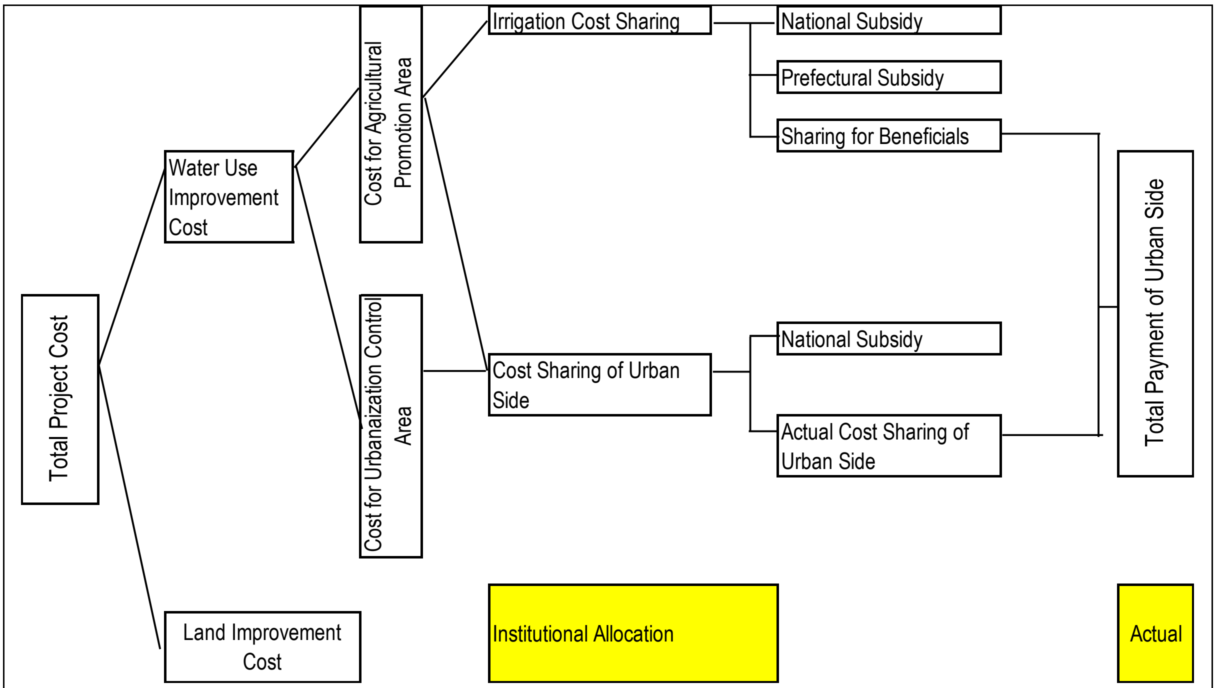
In order to generate excess water by renovating the irrigation facilities in the Gongendo-Satteryou area, the project installed a pumping station and pipelined the irrigation canal. MAFF subsidized this irrigation rationalization project. Part of the generated excess water can be transferred because the return flow is used in downstream and not transferrable. Transferred water discharge was about a half of the excess water. Agricultural lands were developed at the same time. Although it was not originally planned, the project contributed to restructuring farmers' association by eliminating overlapped associations.

The project cost was shared by the agricultural side and the domestic water supply side (Figure 3.8). The urban water users covered the local portion in the agricultural side's share. Farmers did not cover project costs.



Source: "Reallocation of water resources between water uses and cost sharing (I) -Case study on agricultural water rationalization project in Saitama Prefecture" Takeda Mari, Water Science,

Figure 3.7 Location Map of Second Rationalization Project



Source: "Reallocation of water resources between water uses and cost sharing (I) -Case study on agricultural water rationalization project in Saitama Prefecture" Takeda Mari, Water Science

Figure 3.8 Allocation of Costs in Irrigation Water Rationalization Project and Actual Share after Negotiations

History of Nikaryou Canal for 400 years: Valuable Assets of Local Community that Continue to Meet the Changing Needs for Urbanization and Modernization

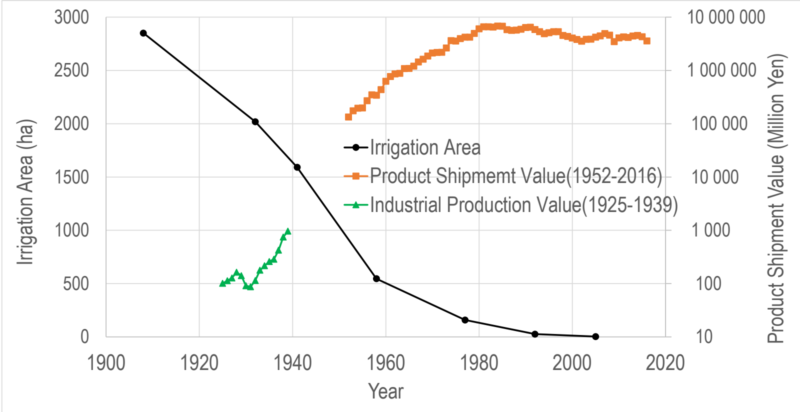
1) Developed as an Irrigation Canal

In the early 17th century, at the order of Tokugawa Ieyasu (the first Shogun of Edo Shogunate), the Bakufu of the military government developed irrigation water called Yonkaryou Canal in the lower reaches of the Tama River, which flows through the southern part of Tokyo. Tokugawa Ieyasu promoted water resources development, such as domestic water supply, irrigation, and navigation, in the Kanto region when the Edo Shogunate was established. A total of 60 km of water canals were constructed in present-day Ota-ward and Setagaya-ward, Tokyo, on the left bank of the lower reaches of the Tama River as Rokugo Canal, and in Kawasaki City on the right bank as Nikaryou Canal. The two irrigation canals were collectively called Yonkaryou Canal, and used for domestic water and irrigation in the paddy field of about 3,500 ha.

2) Used for Urban Use to Support Industrial Development

In 1873, Yokohama City, which was developed as an international port, started to receive water from Nikaryou Canal. Yokohama City shared 2/3 of the maintenance cost for the facilities in exchange for the water supply.

In the 20th century, agricultural lands were redeveloped for factories and houses in line with modernization and urbanization. Reallocation of water resources was required from irrigation to urban use, especially industrial water use. Kawasaki City, located on the right bank of the Tama River, was developed as an industrial area, so that securing a water resource was a major issue to supply industrial water. The development of groundwater reached its limit with the dropped water level, and river water was fully developed for irrigation water. Management of irrigation water and maintenance of facilities conducted by the farmers' association became difficult due to reduction of the agricultural land area by urbanization. The number of their members and revenue decreased.



Source: For irrigation area; "Historical consideration of Nikaryou water intakes, Akasawa Hiroshi 2004", "History of Nikaryou Canal from agricultural water to environmental water from the viewpoint of water quality survey Takagi Masahiro, Komazawa Geography No. 47" For shipment value of manufactured products, etc.: 1925-1939 "Kawasaki City Handbook 1941", 1952-2016" Industrial statistics survey results, long-term time series data (Industry)" prepared.

Figure 3.9 Changes in the Irrigation Area by Nikaryou Canal and the Product Shipment Value of Kawasaki City

In the 1930s, heavy industries were developed in the coastal area of Kawasaki City. The Nikaryou Canal supplied industrial water together with domestic water. This supply also benefited the farmers' association suffering from financial shortages. Figure 3.9 shows the changes in the irrigation area of Nikaryou Canal and the product shipment value of Kawasaki City.

Kawasaki City established a public industrial water supply in 1936 to smoothly transfer water rights, because it is difficult for private companies to negotiate with the farmers' association. As the industrial water supply in Kawasaki City was the first case in Japan, this Kawasaki's method was adopted in various locations of Japan. Kawasaki City bore most of the costs for the maintenance and repair of the Canal. Furthermore, Kawasaki City repeatedly merged with cities, towns and villages to manage the Canal efficiently, and finally the entire area of the Canal became the city area of Kawasaki. This is the reason why Kawasaki City has an elongated shape along the Tama River. In the 1940s, the responsibility of the farmers' association was transferred to the city.

3) Nikaryou Canal Provides a Valuable Environment for the Community

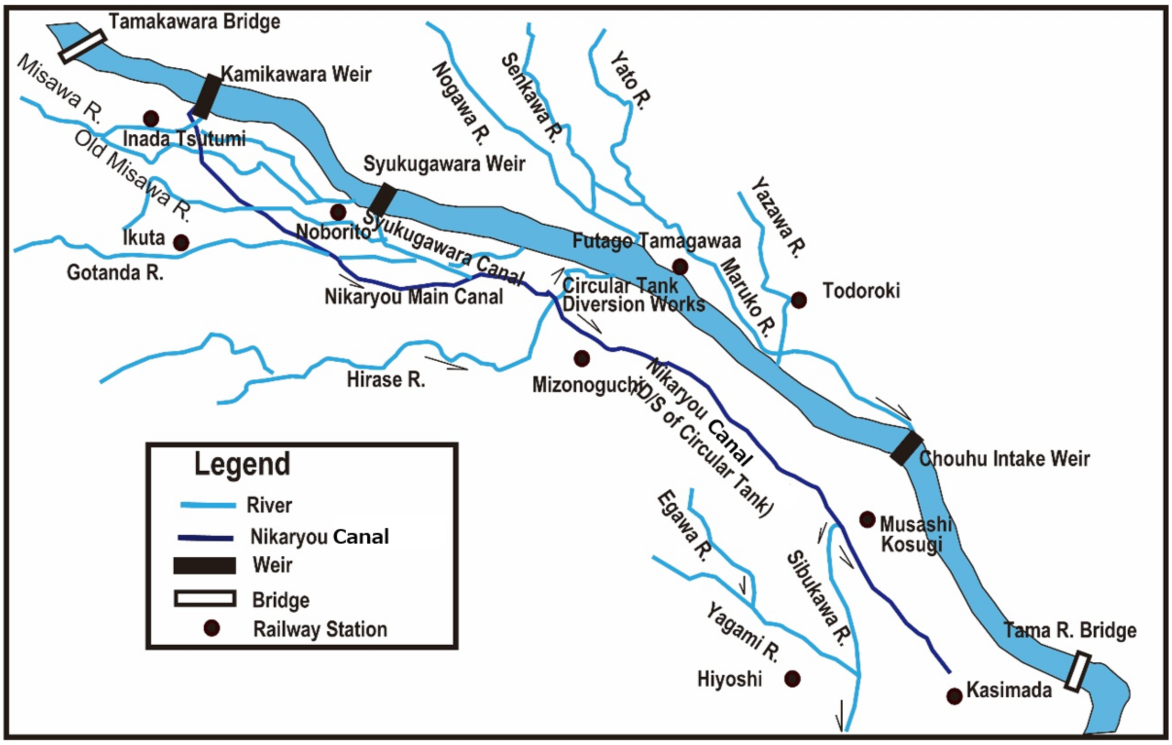
After 1945, the water supply for irrigation from the Nikaryou Canal decreased. Kawasaki City was developed as an industrial city that drove national economic growth and as a residential area in the metropolis. In the period of high economic growth after the 1960s, urbanization progressed, and paddy fields almost disappeared. The water rights for irrigation were reduced from 9 m^3/sec to 1 m^3/sec, and the right of 2.3 m^3/sec was transferred to industrial water. The Canal became an urban drainage for houses and factories. The water quality deteriorated to 20 ppm in BOD with dark color and bad odor.

Source: Wikimedia commons, KCyamazaki - Works by the poster himself, CC-BY-SA-4.0, https://commons.wikimedia.org/wiki/File:Cherry blossom along Nikaryou Canal .JPG?uselang=ja

Figure 3.10 Cherry Blossom along the Nikaryou Canal

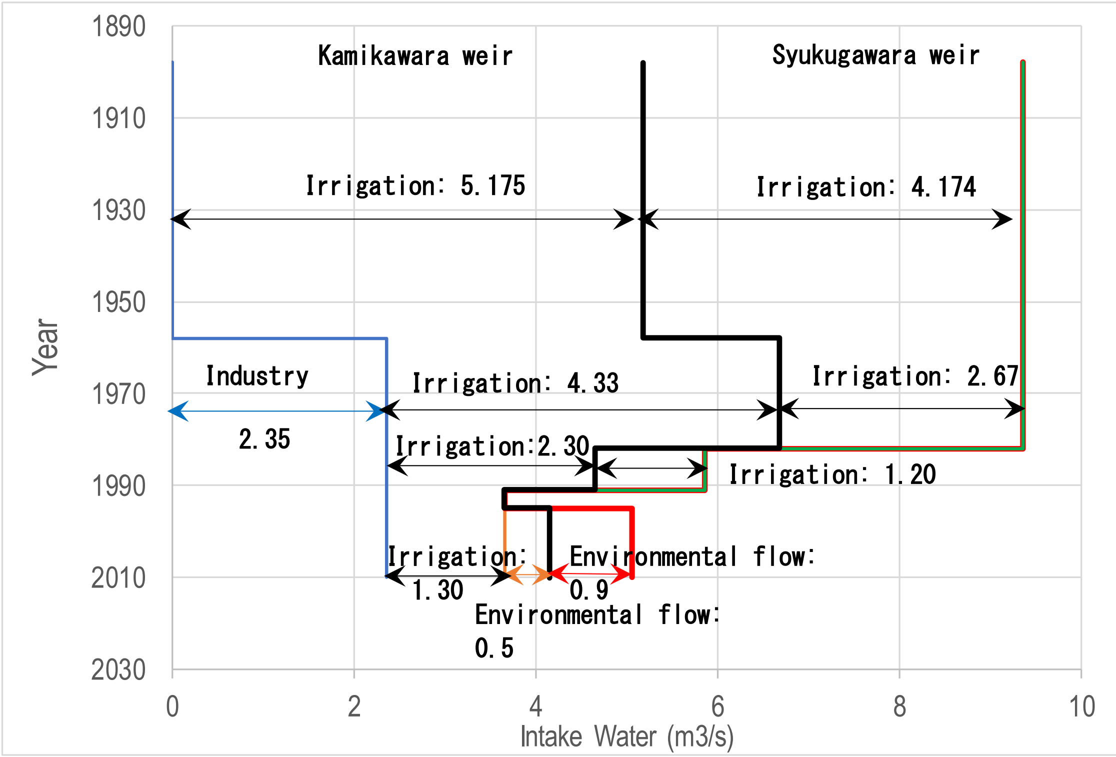
In the 1970s, the water quality in the Canal was improved by water purification projects and sewerage projects. The Canal became a place to provide a valuable water environment in the city. Citizens' activities for water environment conservation become active, and the Canal is now a place for environmental learning and citizens' relaxation. Cherry blossom trees have been maintained (Figure 3.10), and the area is crowded during the cherry blossom season.

In contrast, Rokugo Canal on the left bank of the Tama River was abandoned except for a certain portion. As urbanization progressed in the 1930s, the Canal was used for a drainage channel, and floods occurred frequently. The management for the Canal was transferred to the local government, and the farmers' association of Rokugo Canal was dissolved in the 1940s. After 1945, the Canal was reclaimed and used for roads and sewerages. Only a part of the Canal shows a sign of the past Canal at present. The present location of Nikaryou Canal is shown in Figure 3.11, and transfer of water rights is shown in Figure 3.12.



Source: Corrected location map of History of Nikaryou Canal from agricultural water to environmental water from the viewpoint of water quality survey Takagi Masahiro, Komazawa Geography No. 47"

Figure 3.11 Location Map of Nikaryou Canal



Source: Corrected data from the History of Nikaryou Canal from Agricultural Water to Environmental Water from the Viewpoint of Water Quality Survey Takagi Masahiro, Komazawa Geography No. 47"

Figure 3.12 Chronology of Water Right for Nikaryou Canal

4) Lessons Learned

- Water resources development facilities are valuable community assets that can contribute to communities by changing their roles such as irrigation, industry, urban, and environment in the midst of social changes such as urbanization and modernization.
- The transfer of water rights for irrigation required coordination among related stakeholders. Government agencies could enhance reliability of water use order, improve industrial water supply, and support financial sources.
- Short-term measures such as the use of irrigation canals for roads and sewers do not always lead to long-term benefits.
- Community participation is essential for improving and protecting the water environment.

(2) Trade of Water Rights

Some countries also engage in water trading. Table 3.3 shows a comparison of the water markets in each country.

Table 3.3 Comparison of Water Markets in Each Country

Water Market	Australia (New South Wales/ Murray-Darling)	America Colorado/ Colorado River Basin	Mexico	Chili	China
Transferability of rights	Although there are some restrictions, transfer of water rights is possible.	Basically transferable. However, transfer of water rights for the irrigation zone to outside the zone is restricted.	Transfer of water rights is possible. However, permission from CAN (National Water Commission) is required.	There are almost no restrictions and transfers are free.	The amount of water saved is transferable.
Transfer restrictions	Regulations divide permits into water intake permits and water usage rights. This is to regulate the transfer of water used for the ecological environment or the public interest to other purposes.	The regulation controls the transfer from a specific use to another purpose by placing a legal obligation.	Regulations have transfer restrictions in order to protect the ecological environment and third parties.	Transfers are reviewed by registration and improper transfers are regulated.	Although the system has not been established yet, it has a basic policy to regulate the transfer from the viewpoint of ecological environment, impact on third parties, and total amount of regulation.
Purpose of water market development	Market principle (competition policy), Environmental policy	Flexibility to changing irrigation and urban water demand	Market principle, Increased water demand due to urbanization, industrialization, and cash crops	Neo-liberal policy, Flexibility to changing irrigation water demand / urban water demand	Socialist economy, Consideration for urban water demand and protection of ecological environment
Pricing	The water price is decided by consultation between seller and buyer.				The system has not been established yet
	Service charge is regulated.			Urban water is somewhat restricted	
Market	Private				None
Mediation	Intermediary market	There is an intermediary market depending on the location.	-	Broker system Intermediary market	Government agencies intervene as intermediaries.
Compensation	There is compensation only if the adjustment is planned supply, but generally, it is not.	Designated area is covered by compensation	Yes	Designated area is covered by compensation	Consider compensation in the price

Source : Australian Productivity Commission (APC) 2003 Water Rights Arrangements in Australian and Overseas
International Seminar on Water Rights System Development in China, Beijing December 6-7, 2005, China-Japan Cooperation on Water Rights System Development in China

CHAPTER 4 WATER DISTRIBUTION DURING DROUGHT ACCORDING TO HISTORICAL PRACTICES IN EACH BASIN

During droughts, adjustment of water distribution to users is required by establishing rules to prioritize and reduce water intake. In Japan, such adjustment has been carried out by coordinating water users with the spirit of mutual concession created with historical practices and characteristics of the river basin.

In Japan, water has been used to reflect the history and circumstances of the area. The rules for adjustment of water intake during drought events have been established based on the traditional spirit of mutual concession that "water users use river water based on the rules decided by them." History shows that water conflicts became more intense as droughts became more severe in each basin; hence, adjustment rules were established.

4.1 Drought Coordinating Committee

Water users establish and participate in drought coordination committees for each river basin in Japan. Water users take the initiative to determine rules for drought adjustment. The River Management Office (RMO) provides information necessary for discussion, such as the current situation and outlook for drought conditions and forecasted water storage in the dam reservoir. The RMO may present an adjustment proposal that includes the saving rate of water intake to facilitate discussion. If coordination is not successful among water users, the RMO mediates water users. The offices sometimes host the committee[11] or participates as an observer.

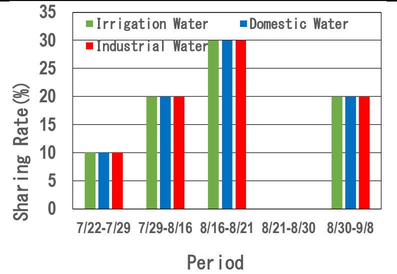
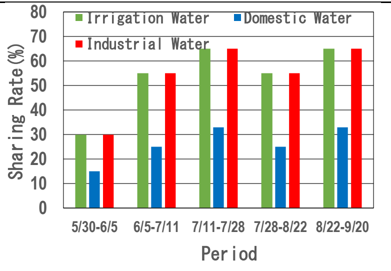
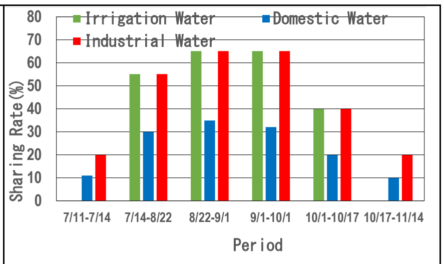
4.2 Examples of Drought Adjustment

(1) Drought Adjustment in 1994[12]

Seventy-five drought-coordinating committees were established nationwide in 1994, of which 55 committees decided to save distributed water. The following are the three water-saving rate patterns (Figure 4.1).

(a) All water users reduce intake water discharge at a constant rate
(b) There is a difference in the water-saving rate among water users, and the different rates remain almost constant as the drought becomes more severe.
(c) There is a difference in the water saving rate among users, and the different rates change depending on the drought stage.

[11] It is common for river administrators to call the committee for basins with water storage facilities, such as dams.
[12] Source: "Agricultural Water Management during Abnormal Drought, especially the Actual Condition of Water Distribution-Case of Drought in Western Japan in 1994" Nakagiri Takao, Ando Taichi, Hirayama Syusaku, Ishikawa Sigeo, Mauyama Syoich, Journal of Japan Society of Hydrology and Water Resources Vol. 12, No. 3(1999) pp . 242-249

		
Constant rate of water saving	Fixing priority of water supply 1. Domestic water, 2. Irrigation and Industrial water with the same water saving rate	Changing priority of water supply First step: Priority to irrigation water Next step: Prioritizing 1. domestic water, 2. irrigation and industrial water with the same water saving rate
Dams in Tone River System	Yahagi Dam	Akigawa Dam

Source: Agricultural Water Management during Abnormal Drought, especially the Actual Condition of Water Distribution Case of Drought in Western Japan in 1994" Nakagiri Takao, Ando Taichi, Hirayama Syusaku, Ishikawa Sigeo, Mauyama Syoich, Journal of Japan Society of Hydrology and Water Resources Vol. 12, No. 3(1999)

Figure 4.1 Examples of Water Saving Rate for Each Pattern

In general, longer water use, such as by users with customary water rights, is a priority. However, under severe drought conditions, irrigation water, which covers a major part of the licensed total water use, must be saved to secure domestic water. According to the results of a survey of 127 agricultural dams and ponds in 67 river systems in 1994, the water-saving rate for irrigation was overwhelmingly higher than that for domestic water. The savings started when reservoirs had a rate of less than 70% in the water storage. Severe water saving was then carried out at a storage rate of approximately 40% for irrigation and industrial water, and less than approximately 20% for domestic water. Table 4.1 shows the degree of drought in the irrigation water and the corresponding countermeasures.

Table 4.1 Degree of Drought (Drought Index) and Countermeasures against Drought

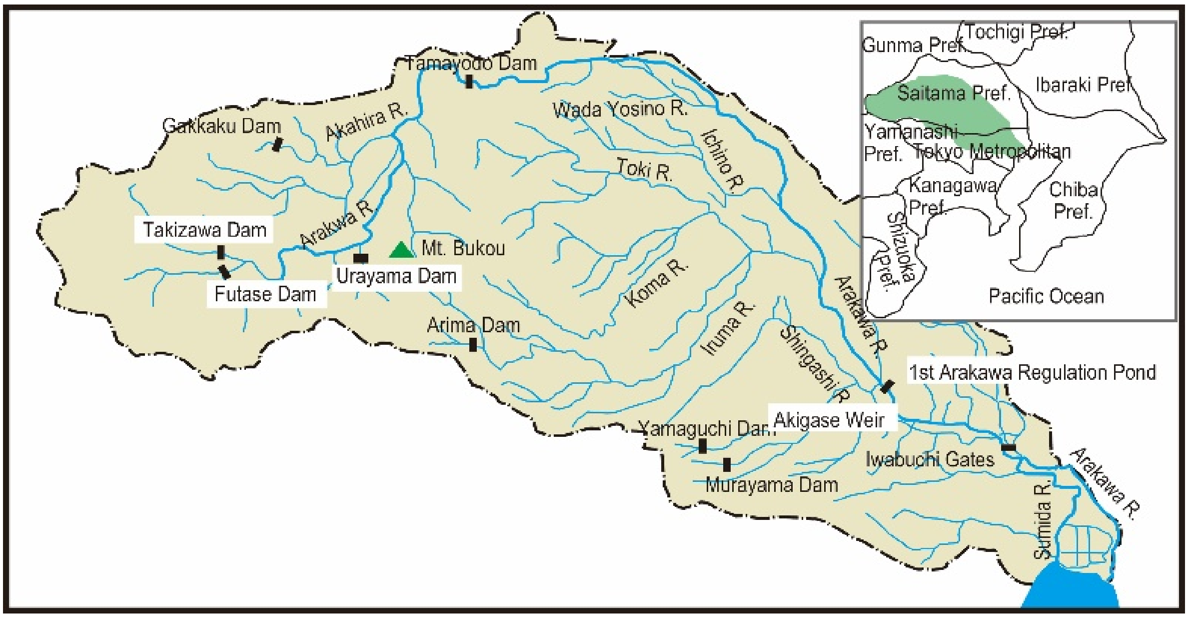
Drought Index	Content/ Degree of Drought	Countermeasures against Drought	Drought Damage	Affected District
1 (Minor)	・Normal water management	・Public relations of water saving	・None	・Isikari River system
2 (Impact: small)	・Adjustment of water supply and distribution throughout irrigation area.	・Adjustment of water supply and distribution throughout the irrigation area	・None	
3 (Impact: middle)	・Increased water management effort ・Impact on agricultural activities	・Increased water management effort ・Fine adjustment of water distribution ・Strengthening adjustment of total drainage	・Drying of paddy fields ・Impossible to spray chemicals	・Tone River system ・Kinokawa River system
4 (Impact: large)	・Start of rotational water supply and repeated use of water in the district ・Large impact to paddy rice	・Increased water distribution operation cost ・Execution of rotational water supply(block level) and drip irrigation ・Repeated water use in paddy field and irrigation canal (using drain water)	・Increased farming labor force for paddy field water management ・Inability to plant and poor growth of paddy rice	・Chikugo River system
5 (Impact: very large)	・Strengthening of rotational water supply ・Securing a provisional water source from rivers ・Irrigation facility failure ・Confusion in the irrigation area	・Rotating irrigation (field level) ・Water supply by pump from rivers and terminal drainage canals ・Purchase of emergency pumps and rental to shortage areas ・Drilling emergency well	・Occurrence of splitting of paddy rice ・Occurrence of water conflict	・Whole Kagawa Prefecture ・Kiso River system (Water use by dam)

Source: "Agricultural Water Management during Abnormal Drought" Nakagiri Takao, *et. al.*, Journal of Japan Society of Hydrology and Water Resources Vol. 12, No. 3(1999) pp. 242-249

(2) Response to Drought in the Metropolitan Area[13] in 2017

In 2017, water intake from 14 rivers in 12 river systems was restricted owing to drought in Japan. The responses to drought in the Arakawa River system (Figure 4.2) in the metropolitan areas of the Tokyo and Saitama Prefectures are as follows:

[13] 2017 Drought Summary, MLIT – Summary of the drought situations in basins for rivers managed by MLIT in Kanto Region

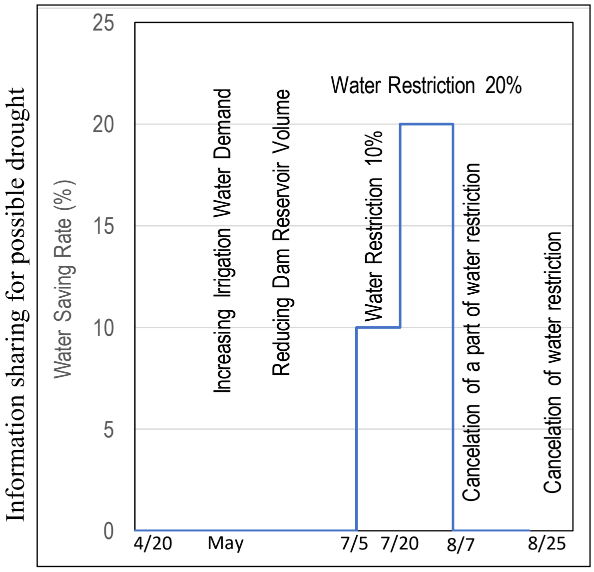


Source: Prepared from"Outline of Arakawa River Basin and Rivers," MLIT

Figure 4.2 Arakawa River Basin Map

1) Drought Adjustment

Precipitation in the upper reaches of the Akigase Weir from January to June 2017 was as light as 60% of the normal year. The amount of stored water in dams at the end of March reached 70% of the normal year. Drought information-sharing began on April 20, 2017. On July 26, the amount of water stored in the four dams (Takizawa, Futase, Urayama, and Arakawa No. 1 Reservoir) fell to a record low. Water intake was restricted from July 5 to August 6. The amount of stored water gradually recovered from the end of July because of rainfall. Part of the water intake restriction was lifted on August 7 because the river flow increased owing to rainfall. On August 25, the water intake restriction was completely lifted, because the water storage capacity of the dam was restored (Figure 4.3).

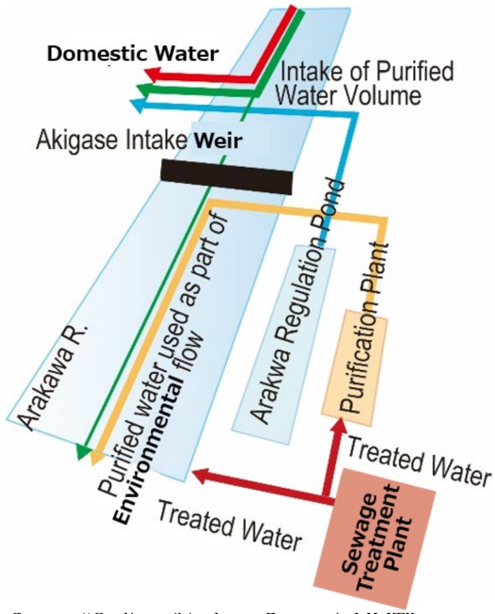


Source: Prepared based on "2017 Drought Summary: MLIT"

Figure 4.3 Status of Drought Adjustment

2) Countermeasure for Drought

Water for urban use in the Tokyo Metropolitan Area and irrigation water in the Kanto Plain can be accommodated by neighboring water systems by developing a wide-area network. The wide area network covers dams in the Tone and Arakawa River Systems, Musashi Channel,[14] and the Kita Chiba Headrace (Theme 1-1: Legislation and Organization, Figure 2.7). Because of dam development since the 1997 drought, the amount of water stored in the upstream dams increased by approximately 4.7 times. Even during the drought of 2017, 500 million m^3 of water was conveyed from the Tone River to the Arakawa River basin via the Musashi Channel from January to August.



Source: "Outline of Arakawa Reservoir MLIT"

Figure 4.4 Operation of Purification Facility

When there is a water shortage in the Arakawa River, a portion of the treated water from the sewage treatment plant adjacent to the Arakawa regulation pond is treated at a higher level by a purification facility[15] and discharged into the River (summer: 3 m^3/sec, winter: 2 m^3/sec) (Figure 4.4). Instead, river water is used for domestic water as a transfer of purified water to make effective use of river water. In the 2017 drought, the discharge from the purification facility of approximately 7 million m^3 from April 1 contributed to saving the water stored at the upstream dams.

3) Extensive Public Relations to Promote Water Saving

Government organizations carried out extensive public relations regarding water saving, such as using road information display boards, advertisements at railway stations and transportation terminals, calls using the media, and through various media in each local government (Figure 4.5).

[14] The channel that conveys river water in the Tone River taken at the Great Weir of Tone River to the Arakawa River to distribute water to Tokyo and Saitama Prefectures
[15] This purification facility purifies the treated water of the adjacent sewage treatment plant by higher-order treatment.

 Distribution of Dam Card[16](Drought Version)	 Wakaba Station, Tobu Tojyo Line (Saitama Prefecture) (Arakawa River Basin) PR by poster of "Water is in a pinch! Please cooperate in saving water"
PR of Saving Water with Posters (Dam Card)	**PR to Saving Water in Cooperation with Transportation**
 "Please cooperate in saving water" is displayed on the Arakawabashi Dam discharge warning display board.	 River patrol vehicle Attach a magnet sheet such as "Please cooperate in saving water"
Water-saving PR by Information Bulletin Board	**Water-saving PR by Public Car**
 (Tokorozawa City) Banner of "Please cooperate in saving water"	 NHK "Ohayo Nippon" (Arakawa Futase Dam)
Water-saving PR for Local Government Building Visitors and Passers-by	**Explanation / Call When Appearing on TV**

Source: Preparation based on "Summary of Drought in 2017 MLIT," "Summer 2017, Summary of drought information in rivers under the direct control of the Kanto region MLIT Kanto Regional Development Bureau and Japan Water Agency. "

Figure 4.5 Various Public Relation Methods during Drought

[16]This is a dam managed by the MLIT and the Japan Water Agency. It is a card created in 2007 and distributed to visitors to the dam in order to familiarize them with the dam.

CHAPTER 5 OPERATION AND MAINTENANCE OF IRRIGATION FACILITY

Participation of farmers is indispensable for distributing irrigation water and maintaining irrigation facilities. The government agencies and farmers' associations share their roles of water management for the irrigation facilities

5.1 History of Irrigation Water Management

During the Edo Period (1603–1868), an irrigation association was formed by a coalition of villages for each intake weir. It managed water distribution and maintained canals and other facilities. In 1908, the legislated Irrigation Association Act established a legally recognized irrigation association that was engaged in projects for irrigation and flood protection.

Agrarian reforms[17] since 1945 have promoted various agricultural systems based on the landowning farmers system, and the agricultural irrigation area improvement and management association (farmers' association) was established based on the Land Improvement Act enacted in 1949. The farmers' association is responsible for distributing irrigation water and maintaining the irrigation canals. Numerous farmer associations have been established nationwide, making them powerful organizations in rural communities. With stable rice production and increased revenue, they have played a major role in agricultural development. The number of farmers' associations reached 5,040 nationwide in 2010 but decreased due to mergers in order to rationalize organizational management.

5.2 Operation and Maintenance of Irrigation Facilities and Water Distribution by the Farmers' Association

The farmers' association manage the irrigation water. The role of the farmers' association is: a) to manage irrigation facilities to control irrigation water (headworks, water and drainage canals, pumping stations, and drainage pump stations); b) to perform facility maintenance and renovation; and c) drainage management, water distribution management, farm road management, and harmony with the local environment. The members of the associations are farmers in the irrigation area, and it is compulsory for them to join as long as they draw water from the irrigation canal. The budget is collected from the members as a levy. In addition, when the farmers' association conducts the project, the farmers' contributions are collected as a beneficiary share. This association is highly public, and therefore, is tax exempted. (Theme 3: Finance, Chapter 2)

5.3 Distribution of Irrigation Water in Full Plan River System[18]

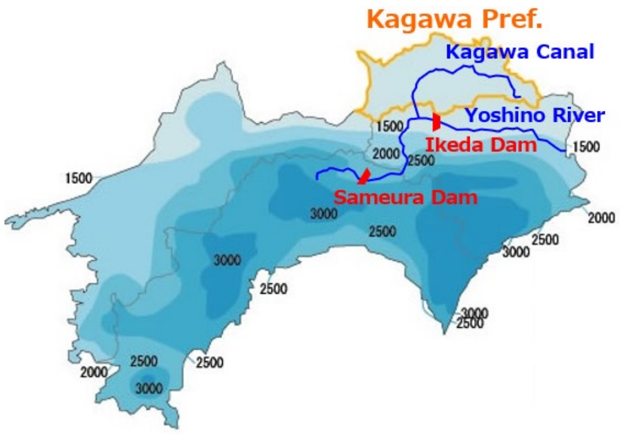
At irrigation facilities managed by the Japan Water Agency (JWA), farmers make water distribution rules and monitor operations, while the JWA operates facilities. Farmers are more satisfied if they

[17] Before World War II, Japanese agriculture was owned by landowners, but due to agrarian reform after the war, the government bought land cheaply from landowners and sold it to farmers who were actually cultivating it. This resulted in having many landowning farmers.
[18] Under the Water Resources Development Promotion Act, a water system for which the MLIT needs to implement wide-area water supply measures in line with the development of industry and the increase in urban population. Currently, 7 water systems are designated. Details are described in Theme 2-1: Management Planning.

themselves make the rules, instead of the JWA. Farmers can dispel their distrust of irrigation water distribution because the neutral JWA operates based on water distribution rules.

Activity of the Agricultural Irrigation Area Improvement and Management Association of Kagawa Water Canal

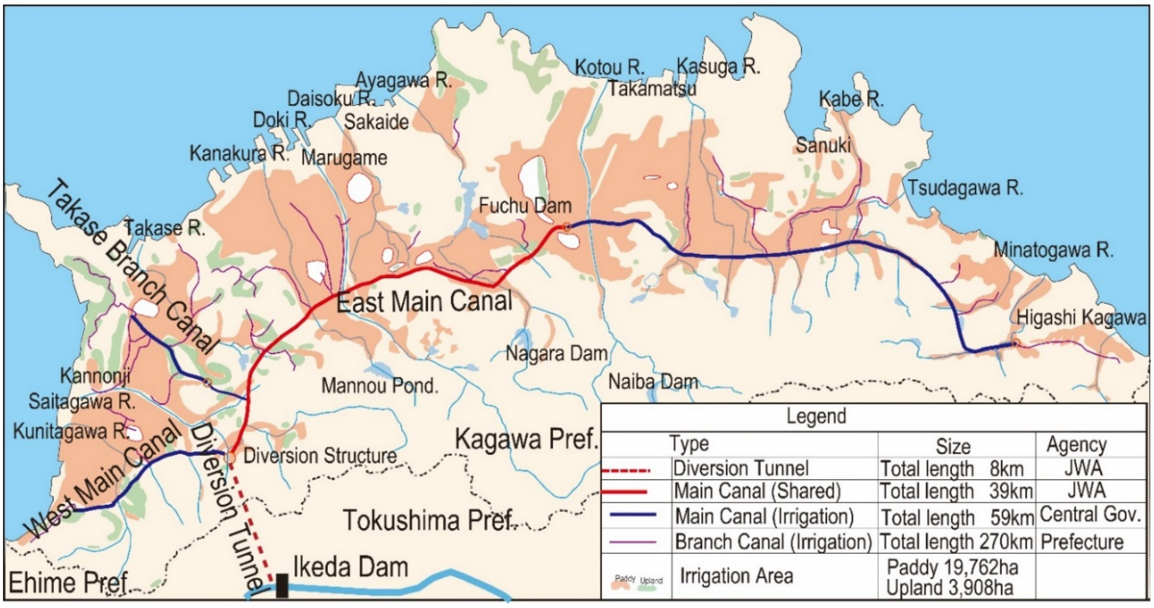
Kagawa Prefecture with little rainfall and no large rivers suffered from drought historically (Figure 5.1). Farmers tried to secure water from ponds, but could not solve the water shortage. As proposed in the Yoshino River Comprehensive Development Plan, the Sameura Dam (Kochi Prefecture), the Ikeda Dam (Tokushima Prefecture) and the Kagawa Canal supplying water to Kagawa Prefecture were constructed (Figure 5.2, Theme 1-3: Public Participation and Decision-Making Process, Section 2.5).



Source: MAFF, Chugoku-Shikoku Agricultural Administration Bureau

Figure 5.1 Isohyetograph in Shikoku

The farmers' association of Kagawa Canal is commissioned by the MAFF to manage land improvement facilities, and is involved in the distribution of 105 million tons of irrigation water annually. The farmers' association (1) maintains the levy system, (2) collects levy, (3) distributes water, (4) manages facility, (5) implements projects of contracted national, prefectural, JWA, and (6) coordinates state-owned land improvement projects.



Source: Project Research Team prepared based on "Yoshino River Comprehensive Development, Location Map of Kagawa Canal, Kagawa Prefecture"

Figure 5.2 Location Map of Beneficiary Area and Water Conveyance Canal for the Farmers' Association of Kagawa Canal

The farmers' association manages the canal of around 60 km. The association does not have enough members to patrol such a long management section. A patrol system was introduced in 2007 so that local residents would participate in part of the patrol activity by monitoring water leaks, damage to facilities, and illegal dumping of garbage. As of June 2020, 164 local residents and a total of 17 groups including 12 engineer associations and 5 fire-fighting organizations, have registered as patrols.

CHAPTER 6 LESSONS LEARNED

(1) **To ensure an orderly water use based on the history and practices of water resource management, each country should establish a water rights system.** Water distribution could induce an increase in tension and conflict between areas and users. In the past, Japan had experienced violent disputes over the distribution of irrigation water. At the time of the establishment of the modern legal system, the government recognized irrigation water as a customary water right and permitted it continue as before. A new licensed water right was granted according to the potential of the water resources. If new water is not available, development of a storage facility is required to acquire new water rights.

(2) **Institutions should be developed to manage the water rights.** It is ideal for one organization to manage the water for the entire river basin. Management organizations must formulate procedures, criteria, and guidelines for permitting water rights. The organization also needs to monitor licensed water intake. The Minister of Land, Infrastructure, Transport and Tourism and prefectural governors are responsible for managing water rights in Japan.

(3) **Governments should manage the water rights for water use that change over time.** Water use changes by increasing domestic and industrial water due to urbanization and industrialization and by decreasing irrigation water. In addition, people’s concerns have changed from development to environmental conservation. Governments must revise policies to respond to these changes.

(4) **Water resources can be used effectively by establishing a system for the transfer of water rights.** The demand for irrigation water is decreasing, and urban water use is increasing as the economy develops. Water rights can be transferred from irrigation users to urban users, expecting the efficient use of water resources. Water rights trading with financial compensation is not practiced in Japan because river water is treated as a public good.

(5) **To adjust water intake during drought, coordinating mechanisms are required.** In Japan, a coordinating committee composed of water users was established for each river basin. This committee determines the rules of intake reduction rates for every user based on the consensus formed among water users with the spirit of mutual concession. The rules vary by river basin, depending on the history and practices of water management. River management offices can provide the necessary information on meteorological and hydrological data and storage facilities, as well as facilitate discussions among water users.

(6) **Farmers' associations are indispensable to distribute irrigation water and maintain irrigation facilities.** Members of farmers' associations decide the rules for water distribution in the irrigation area and carry out maintenance and management activities independently in Japan. Farmers' associations also spend their money on maintaining and developing facilities, in addition to subsidies from the national and local governments.

REFERENCES

Classification of Water Rights Holders According to the Scale of Water Intake

In Japan, water use is classified into (1) specific water use, (2) semi-specific water use, and (3) other water uses (see the table below). In Class A rivers, permission for specific water use is granted by the Minister of Land, Infrastructure, Transport, and Tourism even if the water intake point for specific water use is located in a prefectural management section. This is based on the idea that Class A rivers were originally managed by the national government, but the management of some sections was commissioned by local governments.

Classification by Water Intake Scale

i) Specific Water Use	ii) Semi-specific Water Use	iii) Other Water Use
a) Hydropower: Maximum power output ≥1,000 kW b) Domestic Water: Maximum water intake ≥ 2,500 m^3/day or water supplied population≥ 10,000 persons c) Mining and Industrial Water: Maximum water intake ≥ 2,500 m^3/day d) Irrigation: water intake ≥ 1 m^3/s or irrigation area ≥ 3,000 ha e) Those related to the occupancy of river water, which are stored for the use of water listed in a) to d), or for power generation using the taken river water.	a) Hydropower: Maximum power output ≥ 200 kW b) Domestic Water: Water intake ≥ 1,200 m^3/day or water supplied population≥ 5,000 persons c) Irrigation: Maximum water intake ≥ 0.3 m^3/s or irrigation area ≥ 100 ha d) Water use with a maximum water intake of 1,200 m^3/day or more for purposes other than power generation, domestic water, or irrigation.	Water use other than i) and ii)

Source: Excerpt from the River Law Enforcement Ordinance

THEME 1-3 PUBLIC PARTICIPATION AND DECISION-MAKING PROCESS: MEETING DIVERSE NEEDS BY BUILDING WATER GOVERNANCE

ABSTRACT

It is essential to develop water governance with the consent of stakeholders to manage water resources based on basin-wide consensus. This cannot be achieved by government agencies using a top-down approach. Local communities, civil society, and stakeholders should be involved in decision-making processes from the planning stage.

In Japan, interest in the environment within civil society has grown since the 1980s and citizen movements questioning the need for public works and their environmental impacts are becoming an increasingly significant presence in society. The focus in water resources management has also shifted from a top-down governmental approach to stronger water governance involving all relevant stakeholders. As part of this process, Japan established laws and systems for information disclosure and project evaluation.

The River Law, revised in 1997, mandated that the opinions of concerned residents be reflected in the preparation of river improvement plans. However, bringing public participation into the planning process sometimes precluded finding common ground given the range of different opinions, and led to lengthy decision-making.

During activities to protect the environment and manage disasters, it is crucial for the public and private sectors to collaborate and fulfill their respective roles. Local communities have long formed flood fighting teams and created systems to protect themselves for the last several centuries. NPOs and other organizations are promoting activities that protect the water environment.

CHAPTER 1 INTRODUCTION

When implementing water resources management projects, it is necessary for water governance to reflect the actual situation in respective river basins. If projects are formulated and decided by the government and promoted unilaterally, they would be unable to meet the diverse needs of an increasingly complex society. In Japan, the River Law was revised to set out a mechanism for public participation. Various governance schemes have tried to tackle the Sustainable Development Goals (SDGs) through the collaboration of the public and private sectors and local communities.

Managing water resources requires establishing water governance to build a consensus among stakeholders. Such governance cannot be accomplished using a top-down approach by government agencies. The concept of water governance is defined to include not only water management for flood protection and water use, but also the basic values and visions of organizations and communities, such as the idea of respecting the will and human rights of the people, legality, reliability, and transparency.

Water has a vital impact on various interests and values, not only on people's lives and property, but also on economic activities, environmental resources, history, and culture. Since it spans many fields and involves various stakeholders, a joint working system should be established to implement projects. Civil society and residents occupy various positions: sometimes as beneficiaries, and sometimes as disadvantaged parties, taxpayers, or project collaborators[1]. All the stakeholders should be involved to develop water governance. There is a need for residents to participate in the decision-making process. With properly established water governance, projects would be implemented as planned, the needs of local communities would be met, and the country would achieve growth. To facilitate such participation, the government should disclose information on projects to secure accountability. It may also contribute to the mitigation of potential conflicts between communities or regions.

This theme explains the issues experienced in Japan and the legislative changes, policies, and institutions to address these issues. After the high economic growth, along with income growth and the improvement of living standards, civil society focused increasingly on environmental and social issues. From around the 1980s onwards, a series of strong opposition movements emerged from environmental groups and residents against water resources projects. While demanding administrative transparency and accountability, they began to demand participation in decision-making.

Japanese processes regarding how public works became transparent are reviewed in detail below. It was a change in approach from a top-down approach by the government, to one incorporating the views of the public.

[1] In addition to "residents," similar terms such as "citizens" and "nationals" are frequently used in this theme. In this section, these are used according to the following definitions:

Residents: People who live in a particular region or basin, or who act in relation to local interests. In addition to the use of the single word "residents," the following terms are often used: resident participation, resident opinions, concerned residents, relocated residents, local residents, site residents, and watershed residents.

Citizens: An ordinary person who has neither privileges nor specific status, or a person who acts beyond a particular region. The single term "citizen" is often used. It is also used as civic participation, civic activities, civic movements, civil society, and civic organizations. The term "**Citizens**" also refers to the people of a country as a whole. It is used to refer to people's awareness and values.

The above definitions are not based on legal definitions but are the ideas of the working group members involved in preparing this document and define how they are used within this document.

The roles of residents at the utilization and maintenance stages of water resources, and disaster response are also explained. In Japan, the government and citizens collaborate to promote various initiatives such as water environment conservation and disaster prevention.

Water resources management is closely related to the Sustainable Development Goals (SDGs), and the relationships between participation and the decision-making process and the SDGs are shown in the following box.

Relationships between Participation and the Decision-making Process and SDGs:

(1) Integrated Water Resources Management:

SDG Target 6 “Clean participation and the decision-making process he water and sanitation for all”

(2) In the scope of the preservation forests under the Forest Act, there is a preservation forest category called “Fishable Preservation Forest” that aims to conserve the aquatic environment and provide nutrition and feed for river and marine life:

SDG Target 14 “Sustain rich life in the sea”

(3) Various organizations, including the government, private sector, NGOs, and citizens are working together on forest conservation and forestation activities:

SDG Target 15 “Sustain rich life on land”

SDG Target 17 “Achieve the goals through partnerships”

CHAPTER 2 TRANSPARENCY IN THE PUBLIC WORKS PROCESS

2.1 Public Works as an Opportunity for Water Governance Reform

Opposition by citizens has increasingly intensified questioning over the need for public works and environmental impacts. Opposition pressure over dam projects sparked the enactment of a new law that supports the affected people to restore their lives. Japan reviewed the systems of disclosing information and environmental protection. The review results were reflected in the relevant systems.

Since the 1950s in Japan, public works such as construction projects of dams and barrages have become social issues, with citizens questioning the need for projects and their environmental impacts. The backgrounds to such issues are the diversification of people's values, growing interests in the environment, and the use of taxes.

Three main projects sparked turning points in water governance (Figure 2.1). The first was the movement against constructing the Matsubara and Shimouke Dams, which became an opportunity to strengthen the supporting rehabilitation of the daily lives of affected people. The second is the Nagaragawa River Mouth Barrage, which impacted information disclosure and relations with civil society organizations. The third is the long-term movement opposing Yanba Dam, prompting scientific arguments and re-evaluations involving experts.

Source: Project Research Team

Figure 2.1 Three Public Works Projects that Affected Water Governance

(1) Matsubara and Shimouke Dams

Matsubara and Shimouke dams were completed in 1973 amid 13 years of protests by residents. These protests significantly impacted the implementation of public works. The problem occurred in 1956 when the Ministry of Construction (presently the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT)) tried to remove trees for the topographic survey. The residents became distrustful of the government, which led to the largest opposition movement in the history of dam construction in Japan. Ever since, in addition to the beneficiary areas downstream of the dam, the need to protect livelihoods and promote the local economy in areas affected by dam construction have become increasingly important. In 1973 when the dam was completed, the Act on Special Measures for Water Source Area was enacted to stabilize the lives and boost the welfare of people living in water source areas. This system has been applied to the construction of dams and helped to revitalize water source areas, such as forming tourist attractions at dams.

(2) Nagaragawa River Mouth Barrage

The Nagaragawa River Mouth Barrage construction project was opposed twice. The first was the opposition by local fishermen in the Nagara River and Ise Bay who feared the environmental impacts of constructing the barrage in the 1960s and 1970s. They formed a wide network of opposition movements. However, the opposition movement declined after the flood disaster occurred in the Nagara River in 1976.

The second opposition was a nationwide movement that arose in the late 1980s to 1990s. When barrage construction began in 1988, the movement focused on ecological protection in the basin, the appropriateness of the project for flood protection, and the need of abstracting river water. The movement spanned multiple river basins rather than only the Nagara River and brought together actors, journalists, lawyers, photographers, and other outdoor groups. All joined the concerned parties, making it one of the most outstanding public works issues in Japan.

Right before the barrage operation in 1995, eight round table meetings were held to discuss issues among government and civil society organizations. They were unable to reach an agreement and the project was finally put into operation. Through the meetings, engineers in charge at the Ministry of Construction received direct feedback from residents opposed to the barrage and reaffirmed the need for consensus building among stakeholders at the planning stage. This feedback influenced the structure of the Yodo River Basin Committee and other committees. The details are described in 3.1.

This movement increased criticism of large-scale public works such as dams and barrages. In 1995, the Ministry of Construction established the Dam Review Committee to review 14 projects. The purpose of the Committee was to gather feedback from residents, review the projects, and ensure increased transparency and accountability public projects.

In 1997, the River Law was revised to include the development and conservation of the river environment as the purpose of the Law. The system for planning river management was divided into two stages: the first stage of the Basic Policy of River Development, and the second stage of the River Improvement Plan replacing the previous Basic Plan of Implementation of Construction. The River Improvement Plan is formulated by reflecting the opinions of experts and concerned residents in river basins (Theme 1-1: Legislation and Organization, Section 2.6).

(3) Yanba Dam Project

The Yanba Dam was completed in the Tone River in 2020 after nearly half a century of opposition. Most of the residents living in the submerged areas joined the opposition movements against the dam in the 1960s and 1970s, primarily in the Kawarayu hot spring resort area. They accepted the dam plan in 1985 after Gunma Prefecture presented a livelihood reconstruction plan to promote regional development.

The government announced the cancelation of the dam project in 2009 after a political party opposing the dam construction policy came to power. The Act on Special Measures for Water Source Area enacted in 1973 promotes regional development projects in the dam areas, but does not include any support mechanism for local municipalities in the dam areas where public finances are expected to become even tighter resulting from dam cancelation.

The MLIT scientifically re-examined the need for dams. In 2011, the Science Council of Japan formed an examination committee at the request of the MLIT to assess the design flood volume of the Tone River. Opposition groups pointed out the excessive plans of the Yanba Dam for flood protection, over-assessed benefits for flood protection, as well as the over projection of water demand. The committee concluded that the project plan was scientifically sound. The MLIT compiled the Study Report on the Verification of the Yanba Dam Construction Project in 2013 based on the feedback from concerned residents and academic experts. The Report concluded that as a comprehensive evaluation, the most advantageous plan for flood protection and water development is the current plan (the Yanba Dam).

Reconstruction of Livelihoods under the Yanba Dam Project

The Yanba Dam is a concrete gravity-type dam and is located in the middle of the Agatsuma River in Gunma Prefecture (Figure 2.2). The residents were strongly opposed to the dam project for a long period of time, saying, "Our homes would be submerged for the benefit of a Metropolitan Area." The purpose of the dam is flood protection, water supply, and hydropower generation. In the submerged areas, there are scenic sights such as Agatsuma isthmus and Kawarayu hot spring, and national highways and railways connecting the Metropolitan Area, as well as famous sightseeing spots in the Kusatsu and Manza areas.

Source: Tone River Integrated Dam Group Operation Office

Figure 2.2 Panoramic View of Yanba Dam

Gunma Prefecture developed the resettlement area and executed various supporting projects to revitalize the area, restore residents' livelihoods, and mitigate the impacts of prolonged construction. The prefecture has worked with the Kawarayu Onsen Association to promote tourism, subsidize lodging at Onsen facilities, and provide consultation services to relocated people. These activities have been conducted since 2008 as part of the livelihood-reconstruction project.

The Kanto Water and Land Management Bureau of the MLIT established the Yanba Dam Water Source Area Vision in 2020, targeting independent and sustainable development through cooperation between the upstream and downstream areas. The vision includes initiatives for the maximum use of the rich natural environment, tourism resources, and industries around the dam.

After half a century, the Yanba Dam was completed in 2020. The area around the dam is now a busy place and prospering with the construction of regional development facilities (roadside stations Michi-no-Eki, hot spring facilities, souvenir corners, and museums), and infrastructure tourism initiatives (bicycle trolleys and amphibious buses) aiming to promote the area and attract visitors (Figure 2.3).

Source: Gugutto Gunma Tourism Promotion Conference

Figure 2.3 Amphibious Bus

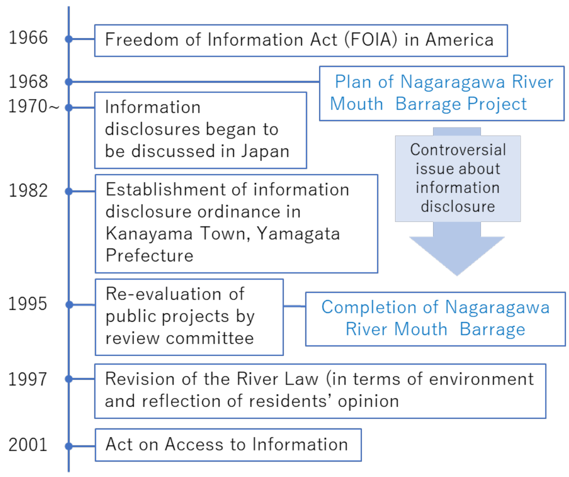
2.2 Information Disclosure

> While there is no uniform method of consensus building, information disclosure is crucial for the establishment of water governance.

Governments need to be accountable for their projects by disclosing adequate information. Without information disclosure, it would not be possible to gain the understanding of civil society on a project, leading to mistrust toward the government. Toyoho Tanaka, who has worked on issues relating to the Nagaragawa River Mouth Barrage for many years, stated the following regarding information disclosure[2]: "There was almost no information available on the Nagaragawa River Mouth Barrage except for a pamphlet published by the Water Resources Development Corporation. At that time, there was not much discussion about information disclosure. We had no way of knowing what kind of planning the Ministry of Construction[3] executed on the Barrage." The MLIT disclosed all information such as water quality, hydrological data, environmental studies, and technologies to the public. Details are shown in the box article titled, "Innovations in Information Disclosure during Controversy on the Nagaragawa River Mouth Barrage" below.

(1) Ordinances and Acts of Information Disclosure

In Japan, the need for information disclosure was first discussed in the 1970s (Figure 2.4). Local governments led in establishing procedures for information disclosure, with Kanayama Town in Yamagata Prefecture[4] establishing an ordinance in 1982, followed by Kanagawa and Saitama Prefectures in the following year. At present, all prefectures have enacted ordinances[5].



Source: Project Research Team

Figure 2.4 Background of the Act on Access to Information held by Administrative Organs

The Act on Access to Information Held by Administrative Organs (called the Information Disclosure Act) was enacted in 2001. It stipulates that any person is entitled to request the disclosure of all administrative documents held by administrative organs. The MLIT and local governments have established contact points for information disclosure and ensure that such information is properly and smoothly disclosed. Disclosure requests can generally be filed online. The MLIT formulated the Guidelines for Public Participation Procedures at the Conceptual Stage of Public Projects in 2003. Those who formulate plans have promoted public participation by actively disclosing and supplying information, and facilitated plan improvement in cooperation with the public and other related parties. The Guidelines for the Planning Process at the Conceptual Stage of Public Works were

[2] "Personal Reflection on Construction Issues of the Nagaragawa River Mouth Barrage", Toyoho Tanaka, Limnology in Tokai Region of Japan 64, 2014.
[3] Currently the MLIT.
[4] Shunji Taoka is a journalist who reported extensively on the issue of construction bid rigging, and provided advice to Koichi Kishi, the then the mayor of Kanayama Town in Yamagata Prefecture. This led to the creation of the first information disclosure system.
[5] Survey on the Enactment of Information Disclosure Ordinances by the Ministry of Internal Affairs and Communications

formulated in 2009, with the aim of increased transparency and fairer planning processes. The Guidelines show how information is to be provided according to the purpose and target party (Table 2.1).

Along with increasing internet extension, details of individual public works and their budgets for each fiscal year are generally disclosed and available on the respective websites. An accessible information disclosure system should be built by combining various methods as appropriate in accordance with the characteristics of the residents in the river basin.

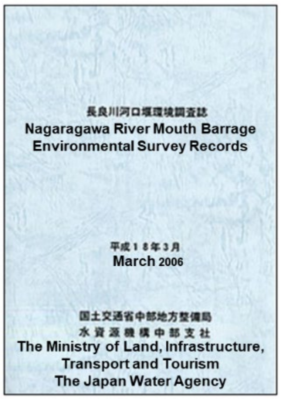
Table 2.1 Examples of Communication Methods by Objective and Target Party

Objective	Communication Method*	Main Target Party
Provision of Information	Publicity materials (newsletters)	Residents of the distribution area
	Newspapers, magazines	Ordinary citizens
	Mass media (TV, radio)	Ordinary citizens
	Websites	Ordinary citizens
	Mailing lists	Ordinary citizens
	Information centers	Visitors to the Information Center
Collection of Opinions	Hearings to representatives of relevant regions and organizations	Residents of relevant areas and organizations
	Surveys (postcards, websites)	Residents of relevant areas and ordinary citizens
	FAX, toll-free phone, and e-mail	Ordinary citizens
	Public comment/consultation	Ordinary citizens
Examination of Opinions and Disclosure of Responses	Briefings and public hearings in relevant areas	Residents of relevant areas, concerned parties, and ordinary citizens
	Consultative meetings or round-table discussions with representatives of residents and concerned parties in the relevant areas	Landowners and residents
	Workshops with concerned and interested parties or their representatives	Related parties and ordinary citizens
	Open house-type explanations held in the concerned areas	Residents of relevant areas
	Participation in events held in relevant areas	Ordinary citizens
	Forums and symposia	Ordinary citizens

Note: * Prepared based on past cases (roads, rivers, ports) at the conceptual stage
Source: Guidelines for the Planning Process at the Conception Stage of Public Works, 2009, MLIT

Innovations in Information Disclosure during Controversy over the Nagaragawa River Mouth Barrage

Around the time of the groundbreaking ceremony of the Nagaragawa River Mouth Barrage project in 1988, opposition to the project spread nationwide. Media interviews with the Water Resources Development Corporation (WARDEC, presently the Japan Water Agency) became heated. Previously, the WARDEC had focused on explaining the project to interested parties but had not taken sufficient steps to provide ordinary citizens with easy-to-understand explanations, responding only to the points raised by opposition parties on an individual basis. Since the project was facing court cases, the WARDEC often refrained from responding to the opposition. The WARDEC failed to respond adequately to the mass media and the opacity of the project information prompted a constant stream of critical reports.



Source: Japan Water Agency

Figure 2.5 Environmental Survey Records of the Project

In response, the WARDEC turned to a systematic explanation with materials and evidence, rather than individual clarification. It explained the need for the flood protection and water utilization project. It also released pamphlets for public explanation, details of environmental studies, reports on additional environmental studies, technical reports, and evaluation reports by the Japan Society of Civil Engineers (Figure 2.5). From 1991, it held detailed explanatory meetings to explain the project to the mass media, opinion leaders, and ordinary citizens.

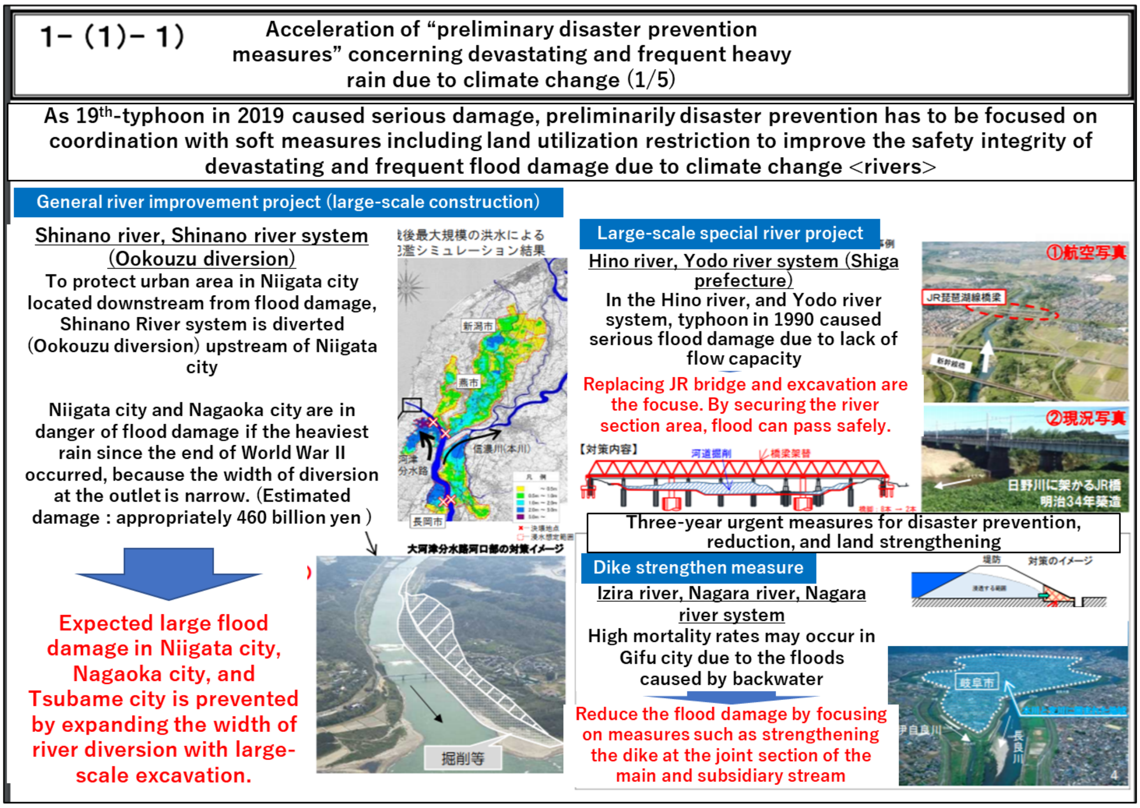
The MLIT also released original raw data. The MLIT initially presented only processed data despite requests from opponents for the disclosure of such data, which prompted distrust. More than 200 press releases were subsequently provided in a year (practically equating to the daily release of data).

Source: Project Research Team, Interview with the government staff member in charge at that time.

(2) Disclosure of Information

There was a need to improve the governance of water resources and make it accountable to residents. The government have now made all information on the budget, various studies, hydrological information, risks of flooding, hazard maps, flood damage status, and recovery plans available online in Japan (Figure 2.6). The government also publicizes a basic plan to develop water resources in each basin, the status of committees for river development plans, materials on recent climate change, and countermeasures for large-scale flooding and dam management.

Frequently disclosing the relevant hydrological and meteorological information of disasters, such as floods, droughts, and landslides, is particularly crucial to safeguard people's lives. The MLIT is promoting the disclosure of information by developing hardware such as optical fiber networks, surveillance cameras (CCTV), and software such as river GIS, and the Water Information National Land Data Management Center. For example, information on radar rainfall, real-time river levels, real-time images, dam operation, and disasters is disclosed in the River Disaster Prevention Information. The data on water storage levels, inflows, discharges, and the water quality of dams under the jurisdiction of the MLIT, the Japan Water Agency, and prefectures are publicized in the Database on Dams.



Source: MLIT website

Figure 2.6 Examples of Information Disclosure of the Study Group

2.3 Evaluation of Policies and Projects

Policies should be evaluated to ensure their efficiency and effectiveness.

The policy evaluation system in Japan was introduced with the following three objectives:

- To establish a high quality, efficient, and people-oriented form of governance;
- To promote output-oriented governance; and
- To ensure thorough accountability to citizens.

The policy management cycle (plan, do, check, action) is established specifically through three basic evaluation methods: 1) policy assessment, 2) policy check-up, and 3) policy review, and four evaluation methods: a) individual public works evaluation, b) individual research and development issue evaluation, c) policy evaluation of regulations, and d) policy evaluation of special taxation measures (Table 2.2). The effects and problems of the implemented policies and projects are always monitored and reflected in policy planning and budget application.

Table 2.2 Evaluation Method and Details of Policies and Projects

Evaluation Method	Evaluation Details
1) Policy assessment (pre-evaluation)	Method of evaluating the planning of new measures from the perspectives of necessity, efficiency, and effectiveness.
2) Policy check-up (post-evaluation)	Representative evaluation method used by the MLIT in which performance indicators and their target values are set for each policy, and performance is measured periodically to evaluate the degree to which the target has been achieved.
3) Policy review (post-evaluation)	Existing policies and themes of high public interest are selected, and the relationship between the implementation of the policy and its effects is analyzed and evaluated in detail, as well as policy effects with external factors in mind.
a) Evaluation of individual public works	For individual public projects, evaluation occurs at each of the following stages: i) when adopting a new project, ii) after a certain period has elapsed since adopting the project (re-evaluation), and iii) after completing the project (post-completion evaluation).
b) Evaluation of individual research and development proposals	Preliminary, interim, and end-of-term evaluations are conducted for each research and development theme.
c) Policy evaluation of regulations	Pre- and post-evaluations are conducted for the new establishment, revision, or abolition of regulations by law or government ordinance.
d) Policy evaluation for special taxation measures	Pre-evaluation is conducted when requesting a new introduction of special tax measures, expansion, or extension, and post-evaluation is conducted periodically for existing measures.

Source: MLIT

2.4 Project Re-evaluation

Through project re-evaluation, projects should be reviewed due to changes in socioeconomic conditions. Only effective and efficient projects should be continued

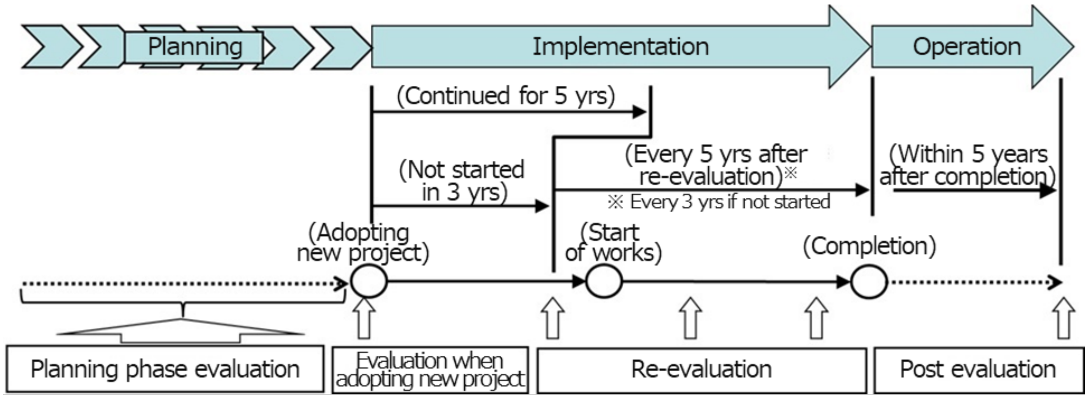
Even after a project is implemented, the details and need for the project should be reviewed frequently. The implementation of large projects often takes a long time during which the social conditions or need for the project might change. Introducing a review system could streamline the project and increase the transparency of the implementation process.

The evaluation of projects in Japan are classified into three stages: evaluation when adopting a new project, re-evaluation, and post-evaluation after completion (Figure 2.7). The government introduced the project re-evaluation system in 1998. Projects are re-evaluated when implementation is not started after a certain period of time (three years for national projects, and five years for subsidized projects[6]); ongoing projects of more than five years should be re-evaluated to decide whether to continue or cancel. The evaluation results and the reasons for the decision should be publicized. The perspectives for re-evaluation include 1) the need for the project regarding changes in socio-economic conditions, the investment effect of the project, and project progress, 2) prospects of the project progress, and 3) the possibility of cost reduction or an alternative plan.

[6] There are four types of public projects: 1) projects under the direct control of the national government (direct control projects), 2) projects under the subsidy of the national government to local governments (subsidized projects), 3) projects in which local governments bear both the cost and maintenance work (local independent projects), and 4) projects undertaken by independent administrative agencies.

Re-evaluation is handled by 1) local branch offices of the direct control projects, 2) government agencies for their projects, and 3) local governments, local public corporations, or companies for subsidized projects, local independent projects, and independent administrative agency projects. The project re-evaluation does not require directly involving residents, but obtaining feedback from prefectures and ordinance-designated cities.

Improvements to project re-evaluation is proposed through the experience. To ensure the effectiveness of re-evaluation, in the event of any significant changes in project progress, re-evaluation should be executed promptly regardless of the re-evaluation interval (three or five years). Conversely, the review process should be simplified if there is no significant change in the project progress.



Source: MLIT website

Figure 2.7 Flow of Project Progress and Evaluation (Public Works Projects under Direct Control)

Reigniting the Debate over Whether the Kawabe River Dam Should be Built

The Kawabe River Dam is an arch-type concrete dam planned in the Kawabe River, a tributary of the Kuma River in Kumamoto Prefecture. The Kawabe River Dam is planned for multi-purpose development to control floods, promote irrigation, and hydropower. Strong opposition over compensation and the need for the project has occurred. Construction of the dam has not commenced. More than half a century has elapsed since the plan was first announced. There are three main reasons for this:

i) Compensation: Once the plan was announced, Itsuki Village, which would be submerged, immediately expressed opposition. The dam was designated as a special area[7]. The project covers a livelihood restoration scheme. A total of 55 requests submitted by Itsuki Village were broadly agreed to and all the negotiations for compensation with residents was completed after 18 years.

ii) Arguments in favor of the dam: Questions arose about the effectiveness of the dam. The MLIT explained its purpose by citing scientific data from the perspectives of flood protection effectiveness, power generation output, and environmental impact. The MLIT also explained from a flood protection perspective that the water retention capacity through forestation might be limited.

iii) Water use plans: One of the purposes of the dam was to supply irrigation water, but the Ministry of Agriculture, Forestry, and Fisheries withdrew from the project after failing to gain the understanding of some

[7] Dams are designated under Article 9 of the Act on Special Measures for Water Source Area: Dams with a particularly large number of submerged houses; ones with a particularly large area of submerged farmland; ones where the fundamental conditions of the water source area have significantly changed unlike others; and the water source area of dam is not included in those prefectures that significantly benefit from the dam.

target farmers. The Electric Power Development Corporation also withdrew from hydroelectric power generation. The Kawabe River Dam was then repurposed as a flood protection dam.

A series of committees and debates were held for open discussion, as shown in Table 2.3:

Table 2.3 Timing and Frequency of Various Discussions

Year	Kawabe River Dam Construction Project Council	Review Committee of Flood Protection on the Kawabe River System	Project Re-evaluation	Residents' Discussion Meeting on the Kawabe River Dam	Meeting for Studying Flood Protection without Dams	Kuma River Flood Protection Measures Council
1995	9 times					
1996						
2001		3 times		9 times		
2003						
2006						
2008						
2009		●Project Cancelled				
2011					12 times	
2015			5 times			
2017						9 times
2019						
2020	A large-scale flood ocurred in July 2020 in the southern part of Kumamoto Prefecture.					

Source: Project Research Team

- Kawabe River Dam Construction Project Council: The council comprised academic experts, heads and councilors of the prefecture, and related municipalities. Feedback from the residents was solicited, and public hearings were held.
- Review Committee of Flood Protection on the Kuma River System: The committee comprised academic experts and the MLIT. In addition to disclosing scientific and objective information, explanations for the ordinary citizen were also discussed.
- Project Re-evaluation: The dam project was re-evaluated five times. Although the MLIT announced in 2009 that the project would be cancelled, it was finally decided to continue the project activities, limiting them to maintaining the submerged area and dam-related facilities.
- Residents' Discussion Meeting on the Kawabe River Dam: The meeting was organized by the prefectural government attended by the MLIT, residents, civil society organizations (CSOs), and academic experts. The disputed issues, namely, flood protection and the environment, were addressed.
- Meeting to Study Flood Protection without Dams: The governor of Kumamoto Prefecture in 2008 stated that the prefecture would target "dam-free flood protection," expressing opposition to dams. A meeting was then held that was attended by the director general of the Kyushu Regional Development Bureau of the MLIT, the governor, and the mayors of municipalities in the river basin.
- Kuma River Flood Protection Measures Council: This council was formed by the director-general of the Kyushu Regional Development Bureau of the MLIT, the governor of Kumamoto Prefecture, and the municipal mayors in the river basin. A discussion was held on dam-free flood-protection measures for the Kuma River. Ten alternative plans were prepared, combining river channel excavation, raising the height of river dikes, and the construction of a flood-retarding basin in 2019. However, the project cost of each alternative was huge and the construction time too long. The final policy remains undecided.

- Flood in the Southern Part of Kumamoto Prefecture of July 2020: Torrential rains occurred in the southern prefecture. Severe damage was caused with dozens of fatalities, resulting from the overflow and dike breaks in 12 sections of the Kuma River. The governor announced a plan to scrap the policy started in 2008 and decided in 2009 to request that the national government construct a dam of the water-flowing type[8].

2.5 Turning Conflict into Cooperation: Consensus Building in Inter-basin Water Supply

The conflicting interests among individual regions or basins hindered the inter-basin water supply in the Yoshino River System, but the entire region succeeded in harmonizing all interests by setting a common development goal.

For the Yoshino River System, interests among the stakeholders were coordinated. By targeting the economic development of the whole Shikoku region by overcoming the conflicting interests between prefectures, the final goal was achieved. The development plan for the Yoshino River Basin is explained in Theme 2: Plan-based Management 2-1 Management Planning. The case of the Yoshino River Basin is introduced below from the perspective of building consensus among the basins.

(1) Background

Since the Kagawa Water Development Project spans across multiple river basins and prefectures, the interests of prefectures conflict with each other and finding consensus among the prefectures was difficult (Figure 2.8). Kagawa Prefecture was unable to manage sufficient water supply for agriculture and daily life within the prefecture. It has been envisaged to divert water from the Yoshino River which flows in Tokushima Prefecture and has abundant water volume. The Yoshino River Comprehensive Development Project was formulated in 1996, including water diversion for the Kagawa Water Supply Project. However, Tokushima Prefecture, the main water supplier, expressed its opposition.

Source: Kagawa Canal Management Office, JWA

Figure 2.8 Yoshino River Comprehensive Development Plan

(2) Various Conflicts of Interests

The Tokushima Prefectural government argued both the merits and demerits of water utilization and floods of the Yoshino River for Tokushima Prefecture. Tokushima opposed water diversion to Kagawa. There were also concerns that the water diversion would worsen the river environment by reducing the volume of water in the Yoshino River.

The Sameura Dam in Kochi Prefecture would divert water to Kagawa. A total of 387 ordinary households and 56 public buildings would be submerged. Opposition in Okawa Village was particularly strong, since they considered that the dam construction had no advantages at all for the Village.

[8] These are dams that specifically aim at flood protection and do not require water storage during normal times. During floods, they temporarily store floodwater to reduce flood damage in downstream areas.

Consensus building faced difficulties even in Kagawa Prefecture, the recipient of the water resources. Farmers would establish Farmers' Associations (an agricultural irrigation area improvement and management association called a Land Improvement District in Japanese) to bear part of the costs of supplying irrigation water. Establishing the Farmers' Associations required the consent of two-thirds of farmer households. Some farmers opposed the construction of the Kagawa Water Canal since they could manage water from existing ponds and other water sources even during droughts (Theme 1-2: Water Rights).

(3) Critical Path Toward Implementing the Project

Tokushima Prefecture proactively applied to become an industrial city under the Act for Promoting Establishment of the New Industrial Cities[9] enacted in 1962. An industrial city is required to secure a stable water source. It was agreed to construct the Sameura Dam in 1966 following negotiations with residents in the submerged area (three towns/villages in Kochi Prefecture) for compensation. It took more than a decade. Negotiations continued even during the initial impounding of the dam. An agreement was finally reached on the condition that the government would guarantee to replace the village roads, construct resettlement land, compensate for public facilities and household buildings, and take other financial supporting measures. Over the course of approximately two years, Kagawa Prefecture explained the project to farmers, the Farmers' Associations, and others on approximately 400 occasions in total and eventually obtained their consent.

(4) Current Status of Water Source Area

The controversy and opposition movement were extended over the dam construction. The compensation negotiation for resettlement finally reached an agreement. However, issues of depopulation[10] and the aging population continue to arise. The issues were spurred by the closure of the flourishing mine and residents' relocation from the water source area after completion of the Sameura Dam. The population of Okawa Village was 1,300 when the dam was completed in 1975 but decreased to 366 as of 2020. It became the village with the second lowest population in Japan. To coexist with the downstream areas, efforts to renovate the village are being made, including a tree thinning project to grow a water-retaining forest. The residents are the project owners. With support from the agencies concerned and securing a budget from the Water Source Area Development Fund, the project is ongoing.

[9] The act aimed to contribute to the balanced development of the country and national economy by improving the infrastructure conditions for locating new industries and building urban facilities, thus preventing excessive population and industry concentration in large cities, correcting regional disparities and stabilizing employment.

[10] Depopulation: A social phenomenon in which the population decreases mainly in mountainous areas; it is difficult to maintain settlements.

CHAPTER 3 REFLECTING RESIDENTS' VIEWS IN PROJECTS

3.1 Establishment of Water Governance for Each River Basin

Water governance should involve experts, civil society, and residents in addition to the relevant public agencies. The mechanism should be established and adapted to local conditions in each basin.

Establishing water governance facilitates meeting the diverse needs of each sector and local communities. Since the circumstances differ from basin to basin depending on their socioeconomic conditions, activities of civil society, history, and culture, the mechanism of water governance should be established so that it best fits the basin. Needs cannot be managed on a top-to-bottom basis by ministries that have clear responsibilities and laws under their jurisdiction (Figure 3.1). (Theme 2-2: River Basin Planning)

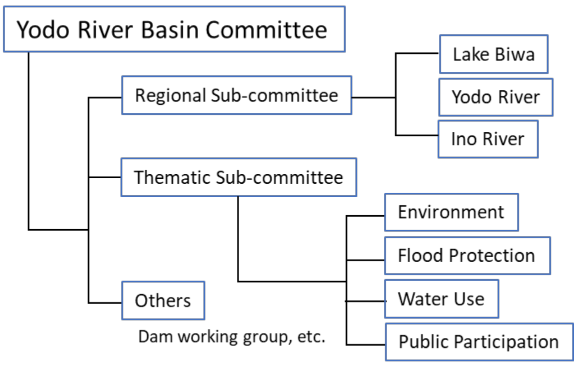
Source: Japan Water Forum Takemura Kotaro

Figure 3.1 Vertically Segmented Administration Model

The River Law was revised to require feedback from academic experts as well as public hearings to reflect the opinions of the people concerned[11] regarding river improvement plans. Various consultation forums (committees, councils, round table meetings within the basin) have been established. The timing to establish forums, forum frequency, and the composition of the forum members vary significantly from river to river. Four models of characteristic committees are introduced below.

(1) Innovative Approach: Yodo River Basin Committee

In the Yodo River Basin, various concerned parties, including academic experts and residents, were involved from the early stages and discussed various issues keeping in mind transparency and objectivity. Under the committee, three regional sub-committees, four thematic subcommittees (environment and water use, flood protection, water use, and public participation), and several other working groups and various study groups were established (Figure 3.2).



Source: Project Research Team prepared based on "The background of Yodo River Basin Committee, Kinki Regional Development Bureau"

Figure 3.2 Composition of the Yodo River Basin Committee (Feb. 2001–Jan. 2005)

[11] At a Diet session held on May 7, 1997, the Director General of the River Bureau of the Ministry of Construction stated as below. There were 109 Class A river systems and approximately 2,700 Class B river systems; in the future, basic policies would be set for all of these systems and development plans would be made accordingly. In Class B river systems in particular, depending on the characteristics of the river, it was possible that little or no work would be done. In such a situation, this clause was put in place with the idea that those hearings were not always necessary for all rivers. For those river systems that included large-scale structures such as dams and weirs, it was natural to have hearings on the opinions of residents and others.

The MLIT did not take on a secretariat function, such as selecting committee members, managing the committee, and preparing drafts for the committee. The selection of committee members was discussed in 2000 at a preparatory meeting by four academic experts to ensure neutrality. The committee members were selected from researchers, lawyers, NGOs, and residents following an open process. A consultant company functioned as the secretariat. The audience could express their views at any time and in various ways (Figure 3.3), all of which were later disclosed via committee documents and online. The committee were open to the public and the papers, documents, and minutes were posted on websites. Workshops, group discussions, and round table discussions were held to ensure that both academic experts and residents could join the discussions. Instead of discussing specific projects, the participants first recognized the issues in the basin and then discussed potential solutions. The committee discussions provided opportunities to learn and raise awareness. On one occasion, even academic experts changed their opinions about dams.

Source: Yodo River Basin Committee

Figure 3.3 The 85th Committee (April 8, 2009, Hirakata City)

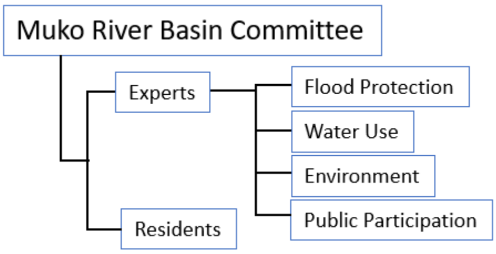
The opinions of the committee and government were in conflict. Even after six years, the basic policy of river development remained undecided. The committee was suspended in 2007. The Review Committee in the Yodogawa River Basin Commission established by the Water and Land Management Bureau of the MLIT reviewed the basic policy for river development and the river improvement plan.

(2) Resident Participation from the Basic Policy Stage: Muko River Basin Committee

The Muko River featured an example of a basin committee that involves residents from the beginning of basic policy. The River Law does not require local residents' opinions when formulating a basic policy for river development. However, Hyogo Prefecture recognized that residents should participate and discuss the plan from the basic policy stage. The committee worked on comprehensive flood protection measures from the perspective of the entire basin including urban areas. The preparatory meeting composed of the concerned agencies, representatives of academic experts, and residents prepared the concepts of the River Basin Committee including its members and discussion processes, and disclosure method. The Muko River Basin Committee was established in 2004 with academic experts and publicly recruited residents as members Figures 3.4 and 3.5).

Source: Muko River Basin Committee News 32

Figure 3.4 The 68th Committee (Sept. 16, 2010, Itami City)



Source: Project Research Team prepared based on "Hyogo Prefecture website"

Figure 3.5 Structure of the Muko River Basin Committee

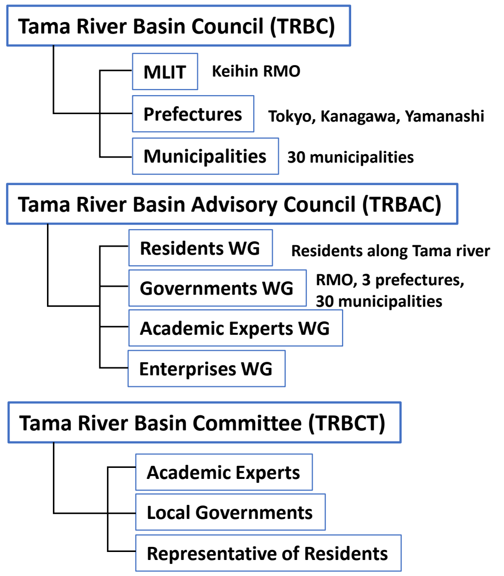
The basin committee organized a total of 49 meetings. The consultation process was opened to the public to obtain feedback from residents, and discussions were continued until most of the members agreed. Complete consensus was not achieved on some parts of the development plan and construction of a new dam. The decision was made to adopt comprehensive flood protection measures in urban areas including a flood retarding basin and rainwater storage.

(3) Three Consultation Forums: Tama River Basin Committee

In the Tama River in the Tokyo metropolitan area, CSOs have actively conserved the river environment since around 1970. Based on these activities, three forums were formed to discuss river plans (Figure 3.6).

1) Tama River Basin Council (TRBC): Following the Tama River Summit[12] in 1986, the Council was established in 1987 consisting of local governments in the basin with the Keihin River Management Office (RMO) of the Kanto Water and Land Management Bureau of the MLIT as the secretariat.

2) Tame River Basin Advisory Council (TRBAC): The Council was established in 1998 by CSOs, companies, academic experts, local governments in the basin, and the Keihin RMOs of the MLIT and prefectures to exchange opinions. After the river improvement plan was formulated, the exchange of opinions continued.



Source: Project Research Team prepared based on "Tama River System Improvement Plan, MLIT"

Figure 3.6 Structure of Tama River Basin Conferences

3) Tama River Basin Committee (TRBCT): The Committee was established in 1999 to discuss the draft of the river improvement plan. It comprises 16 academic experts, 7 citizen representatives, and 11 officials from prefectures and municipalities. The Keihin RMO of the MLIT serves as secretariat.

The river improvement plan was formulated based on feedback from these three forums. As part of the program of the TRBAC, residents, CSOs, members of local governments, academic experts, and the RMO staff jointly walked along the river and frequently exchanged opinions. This was the first case in which various Tama River stakeholders came together and discussed the matter from the same perspective (Figure 3.7).

Source: Keihin RMO

Figure 3.7 Joint Monitoring and Opinion Exchange in the Tama River Basin Consultation

The TRBAC established rules of dialogue at the initial stage of the planning process to achieve a loose consensus between planners,

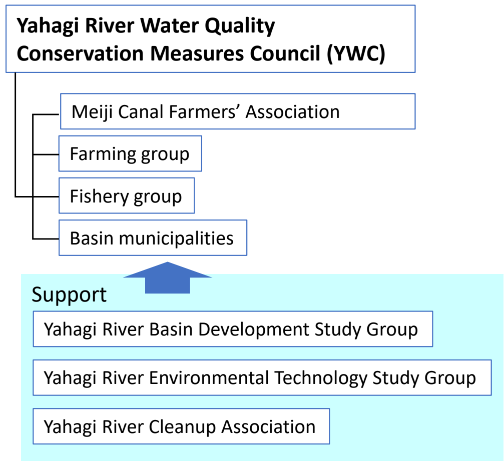
[12] In 1986, at the behest of the Ministry of Construction (now the MLIT), the Tama River Summit was held with the Minister of Construction, the governors of Tokyo and Kanagawa Prefectures, and the mayors of municipalities related to the river basin. Since then, similar enlightening activities are actively held on rivers everywhere.

residents, stakeholders, and others. The dialogue featured the Three Principles and Seven Rules. The Three Principles are 1) free speech, 2) thorough discussion, and 3) consensus building. The Seven Rules are 1) the views of participants should not be interpreted as official standpoints of their organizations, 2) no one should disturb others talks, 3) discussions should ensue in the spirit of fair play, 4) data with actual proof should be respected, 5) a consensus should be pursued after clarifying problems, 6) litigation issues should be treated as examples from an objective standpoint, and 7) when formulating programs, long- and short-term solutions should be distinguished and feasible recommendations should be pursued. The term "loose consensus" was the keyword to facilitate deepening discussion. If "complete unanimity" is targeted, the discussion would be difficult.

The collaboration of the TRBAC and TRBCT achieved consensus building on the basic policy. The MLIT generally considers whether the recommendation of the basic policy for river development by the TRBC are socially recognized. The TRBC and TRBAC worked together using the same materials for the preparation of the basic policy. The TRBC referred to the discussion results of the TRBAC and then returned the discussion results of the TRBC to the TRBAC for further discussion. Members of the TRBC also participated in discussions at the TRBAC and TRBCT.

(4) Bottom-up Approach: Yahagi River Water Quality Conservation Measures Council

A consultation forum was established under the initiative of the residents in the basin of the Yahagi River. This is an advanced example of a bottom-up approach and is referred to as the Yahagi River Method. Along with economic growth, the river flow became muddy due to sand and gravel mining in the upstream reaches, while the water quality was polluted in the middle to lower reaches due to industrialization in the 1960s. The water pollution began to adversely affect downstream agriculture and fisheries.



Source: Project Research Team

Figure 3.8 Structure of Yahagi River Water Quality Conservation Measures Council

The Agricultural Experiment Farm of Aichi Prefecture and the Meiji Canal Farmers' Association launched the Yahagi River Coastal Water Quality Conservation Council (YWC) to resolve the water pollution in 1969. The Council was a semi-governmental and semi-private organization, comprising six organizations related to agriculture, seven related to fisheries, and six related municipalities (Figure 3.8).

Beginning with a petition to the national and prefectural governments to establish water quality environmental standards, the YWC monitored contractors suspected of generating pollution and conducted a water quality survey. The activities were supported by the following organizations: 1) the Yahagi River Basin Development Study Group launched by the municipalities in 1971, which raised awareness through training sessions; 2) the Yahagi River Environmental Technology Study Group launched in 1986, which researched turbid water treatment technology for construction work; and 3) the Yahagi River Cleanup Association launched by downstream residents in 1973 taking the initiative in education activities and periodically visiting factories and development sites. The Yahagi River Basin

Committee was established in 2003 to formulate the river improvement plan. The chairman of the YWC participated in the Yahagi River Basin Committee as a member.

3.2 Trial and Error to Improve Decision-making

There is no single correct solution to achieve consensus. It is necessary to keep pursuing various consultation systems to achieve better water resources management.

The system for incorporating residents' opinions has been established in accordance with local conditions in Japan, but not everything has progressed smoothly. In some cases, reaching a consensus took a long time or even proved impossible. It is difficult for people with diverse interests and concerns to reach a unanimous consensus. Consensus building should not aim at complete unanimity of opinion but at a state where everyone can accept and allow differences in opinions.

It is necessary to adopt appropriate measures by selecting the most suitable method for reflecting opinions, taking into consideration the purpose, target group, budget, and time constraints. Many river basin committees invite public comments on the draft plan to reflect the opinions of residents. To facilitate smooth communication, various consultation systems should be established (Table 3.1). The methods of public feedback include posting on the websites and public relations of the RMOs, holding public hearing and briefing sessions, public notices, and the distribution of briefing materials. People can express opinions, and opinions are collected from the public via email, postal mail, fax, and posting to an opinion box. The opinions received and responses are also published on the website. While the public comment system has the advantage of allowing anyone to participate, it is difficult to deepen the discussion. The Yodo River Basin Committee received more than 1,000 opinions from residents and local governments before formulating the river improvement plan, all of which were posted on the website. The Committee explained to the public how the residents' opinions were reflected in the recommendations or in what form the opinions were referred to in the discussions on the river improvement plan.

Table 3.1 Examples of Various Consultation Structures

Communication Method	Purpose	Target
Public hearing	Gathering citizens' opinions by governments (to be held in general before decision-making).	Residents
Committees (study/review meetings and management meetings)	Setting the issues and goals, and combining all the opinions and study results	Key stakeholders, representatives, and academic experts
Workshop	Extracting ideas through collaborative work and discussions, and identifying the key points for consensus building	Citizens with a strong motivation for participation
Task force	Proposing solutions to specific practical issues	Citizens with an interest in the issue and representatives of concerned groups
Briefing	Preventing the spread of incorrect information, and providing accurate information to key stakeholders	Main parties concerned and the media
Mediation	Mitigating of conflicting interests with the assistance of a third party	Stakeholders with conflicting interests

Source: Role of Information Disclosure in Consensus Building for Public Project, Journal of Construction Management Vol. 5, 1997

CHAPTER 4 COMMUNITY AND PRIVATE SECTOR PARTICIPATION

4.1 Water Environment Conservation Activities through Public–Private Partnership

> The public and private sectors should cooperate in water environment conservation. The public sector offers institutional and financial support. Voluntary actions by local communities, residents, NGOs, and companies are essential for daily on-site activities, which government organizations cannot cover.

(1) NGOs, NPOs, and River Partner Organizations

In basins of the Tama and Tsurumi Rivers where civic activities are advanced, there are many CSOs. As the common platform to bring these CSOs together, the network organizations Tama River Center and NPO Link Tsurumi River Basin Networking (npoTR Net) have been established. The npoTR Net serves as the secretariat and conducts the following projects in cooperation with local governments, companies, and various schools:

- Survey, research, planning, and implementation of projects in relation to the water cycle, ecosystems, environmental conservation, and safety in rivers and basins;
- Preservation of water culture and historical assets, and river-oriented urban development projects;
- Development of human resources;
- Provision of information and support to school education and civic activities; and
- Promotion of projects for communication, partnership building, and public relations.

The MLIT institutionalized river cooperating organizations in 2013 (Figure 4.1). These organizations contribute to river maintenance and conserving the river environment. By establishing mutual trust between the MLIT and each organization, these organizations promote river management in a manner befitting the regional conditions. Private organizations such as NPOs apply to the RMOs as river cooperating organizations. The advantages of working under this status include improved social credibility, simplification of the procedures required for exclusive use of part of the floodplain, and cooperation among government organizations.

Source: MLIT website

Figure 4.1 Logo of River Cooperating Organizations

(2) Citizen Participation through Workshops

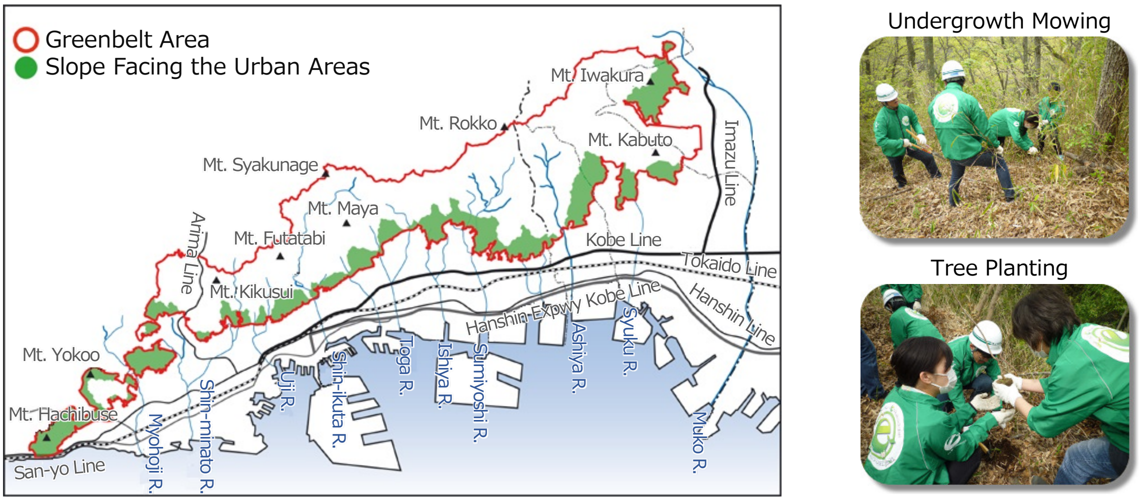
Workshops on the water environment are held throughout Japan by various entities, including NPOs and other CSOs, local governments, and RMOs of the MLIT. The National Water Environment Exchange Association, an NPO, organizes the Good Rivers and Creating Good Rivers workshop in which CSOs, the MLIT, and local governments discuss rivers and the water environment nationwide. This is an open selection-type workshop, which attracts more than 50 applications from all over Japan at a time, bringing together 400–500 people. The participants present and discuss the objectives and contents of initiatives implemented in their respective regions. Good initiatives are selected and awarded. The event started in 1998 and reached the 22nd iteration in 2019, with a total of approximately 1,200 applications.

Tamakazu Aquarium, a club mainly comprising elementary school students, won the grand prix for its activity titled Protecting the Akashi River: Nurturing the Clear Flow of the Akashi River. The club has surveyed the Akashi River since 2007, removing non-native species and cooking with them so as to reduce waste, and releasing native and endangered species. It introduced the aquatic organism survey and works to remove alien species.

(3) CSR Activities by Companies

There are also cases where companies are involved in environmental conservation as part of their Corporate Social Responsibility (CSR). The Rokko Sabo Office of the MLIT and Hyogo Prefectural Government are promoting Green Belt Forestation in cooperation with CSOs and companies that are engaged in forestation as part of their volunteer, recreational, and CSR activities (Figure 4.2). As of 2020, 26 CSOs and 20 companies are engaged in forestation activities. The main activities of the companies are logging, seed collection, rising seedlings, tree planting, surveying, and observation. The Rokko Sabo Office provides support by lending shovels and other equipment, providing technical guidance, and other means in addition to providing the activity sites.

Water Stewardship promotes water sustainability by encouraging companies to not only manage water related to their own operations, but also to actively steward water in their local communities. Suntory Holdings Limited launched the Natural Water Forest Program in 2003 to grow a forest that nurtures water; they have expanded the program to 21 locations in 15 prefectures, covering approximately 12,000 hectares. The company achieved its goal of recharging more than twice the amount of groundwater pumped by Suntory Group factories in Japan in 2019.



Source: Rokko Sabo Office of the MLIT

Figure 4.2 Forest Development Activities in Rokko Mountain Range Greenbelt

4.2 Activities for Water–Environment Conservation

> Japan continues to preserve the water environment by valuing the wisdom and experience passed down from one generation to the next. These activities are based on the United Nations Sustainable Development Goals and the Paris Protocol.

In recent years, a strong will to solve various social, economic, and environmental issues in an integrated manner has been shared internationally. It includes the SDGs, Education for Sustainable Development to achieve the SDGs, and the Paris Protocol which indicates a change from low carbon to decarbonization. As public awareness of the environment is enhanced, a variety of initiatives to conserve the water environment have been implemented by various entities.

(1) Forest–Village–River–Sea Project

The Third National Biodiversity Strategy[13] approved by the Cabinet in 2007 covers the linkage of forests, villages, rivers, and oceans as the core objective. The government policy promotes the conservation and restoration of forests, villages, rivers, and oceans as a continuous space. The Ministry of the Environment (MOE), acting as the secretariat, launched the Let's Connect and Support Forests, Villages, Rivers, and Seas Project in 2014. This project promotes the conservation of the local natural environment. It aims to contribute to the local society and economy. The project also promotes the creation of a regional recycling symbiosis zone (Figure 4.3).

Source: Forest–Village–River–Sea Project website

Figure 4.3 Symbiotic Sphere with Inter-Region Circulation

The Forest, Village, River, and Sea Project provides various forms of support for activities undertaken by local governments or private organizations. For example, the MOE helps organizations in setting a clear image with recognition of issues and countermeasures for implementation. It is important to support the formulation of new plans and initiatives, and utilize existing budgets and mechanisms as far as possible. The project aims to realize regional recycling that strives toward a favorable balance among the environment, economy, and society. The project contributes to SDGs 7 (Energy for All and Clean),

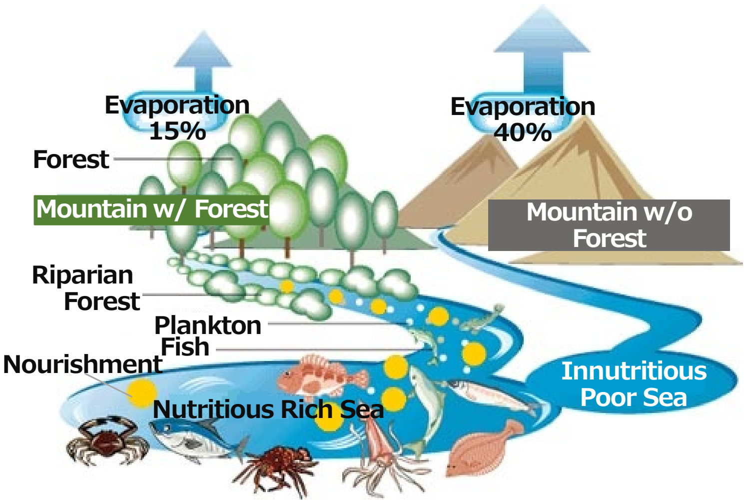
[13]National Biodiversity Strategy: A basic national plan for the conservation and sustainable use of biodiversity based on the Convention on Biological Diversity and the Basic Act.

11 (Building Communities that Permits Long Living), 14 (Protecting the Abundance of the Oceans), and 15 (Protecting the Abundance of Land) among the 17 SDGs.

(2) Forests with Fish

The term "Forest with Fish" or "Uo-tsuki-rin" in Japanese is a unique activity. The term has existed since the Edo period (1603–1868). It is one of the Preservation Forests designated by the Forest Act[14]. As of 2018, approximately 60,000 hectares have been designated as Forests with Fish. The functions of Forests with Fish are 1) preventing sediment runoff and turbid river water, 2) providing clear fresh water, and 3) providing nutritional substances and feed for river and marine life. When rain falls on a mountain without a forest, most of the water evaporates or flows into the river without nutrients for fish and shellfish, leaving the nutrient-poor sea downstream. Forests with Fish are maintained in a wide range of land in a basin, including coastal areas, along the upper reaches of rivers, mountain slopes, and along the lower reaches of rivers (Figure 4.4).

Hokkaido's Increasing Fish by Tree Planting Campaign was inspired by the Forests with Fish concept. Fishermen in Hokkaido launched a regional campaign with the catchphrase "100 years to regain the natural beach of 100 years ago" in 1988. This campaign attracted attention to the fishermen's tree-planting activities in the mountains. Recently, fishermen and ordinary citizens have enhanced Forests with Fish in the upper reaches of rivers nationwide (Figure 4.5).



Source: UMI & NAGISA Foundation (former Marine Blue 21), OPRI, Ocean Newsletter No. 23 (July 2001)

Figure 4.4 Fish Breeding Functions of Forest

Source: Tree Planting for Fish Breeding Campaign Regain the 100-year-ago Natural Beach

Figure 4.5 Tree Plantation

[14] The purpose of the Forest Act is to preserve and cultivate forests and promote forest productivity, thereby contributing to the preservation of national land and development of the national economy. It stipulates forest planning, protected forests, and other basic matters concerning forests.

4.3 Individuals and Companies in Disaster Management

Governments should promote initiatives to involve residents, local communities, CSOs, and the private sector in disaster management.

Based on lessons from the disasters that have occurred in Japan in recent years, governments, residents, and companies are all expected to share their knowledge of disaster risks and prepare for various disasters, such as floods, earthquakes, and landslides. Governments are promoting a conversion to Society with Water Hazard Awareness. All of society should prepare for large-scale flooding beyond the capacity of existing facilities. The government formulated the Vision for the Society with Water Hazard Awareness in 2015, and promoted multilayered measures consisting of both hard and soft aspects in a systematic manner.

(1) Roles of Individuals in Rebuilding Flood-conscious Societies

Residents should prepare for disaster management plans with enhanced disaster information. Municipalities and RMOs are promoting an evacuation action plan called My Timeline by providing online template sheets and support videos. Municipalities and NGOs are holding courses on My Timeline preparation for residents (Figure 4.6). The plan helps people consider how to evacuate and save their own lives. By utilizing hazard maps prepared by municipalities, people should recognize their own flood risks and evacuations. People should review their plans with their family members in daily life. Studying at a workshop is recommended because others' opinions are informative.

Source: MLIT

Figure 4.6 Course on My Timeline Preparation (March 2019, Ryugasaki City)

(2) Response by Local Communities and Companies

Flood fighting teams, who protect their own communities from flooding, can be traced back several centuries and remain in operation to date; there are approximately 14,000 members nationwide. During floods, flood fighting teams work on-site to mitigate flood damage by patrolling levees, issuing warnings, calling for evacuations, guiding residents in evacuations, reinforcing levees, installing flood prevention facilities, and operating gates (Figure 4.7). During normal times, training, patrols and inspections are conducted regularly. The teams are volunteers and usually work in their own occupations. In an emergency, they are engaged in flood prevention activities under the status of part-time staff of the local government. This status facilitates providing allowances for engaging in activities and compensation in the event of an accident. Since the establishment of the modern state, a legal system was established to support these activities, such as financial support for equipment and materials, and the provision of disaster information. In recent years, the number of members has decreased due to urbanization and industrialization. Maintaining the teams and succession of flood fighting technology are becoming problematic (Theme 6: River Management, Chapter 5).

Companies are expected to contribute to disaster management by utilizing their human, land, and building resources and materials. The Flood Fighting Act was revised in 2005 to institutionalize the participation of companies to provide logistic support, patrolling, and the transportation of sandbags in coordination with flood fighting teams. Companies are flood protection partners with municipalities. Based on an agreement between municipalities and the construction industry association, local construction companies execute flood protection activities, such as installing large sandbags, mobilizing their own heavy equipment, and emergency recovery.

Source: MLIT website

Figure 4.7 Flood Protection Activities and Training

(3) Inclusive Disaster Countermeasures

It is necessary to strengthen the supporting measures for disaster-vulnerable people. The number of elderly victims of disasters has increased in recent years. For example, 260 people were killed in the 2018 torrential rains in western Japan; 70% of the victims were aged 60 or older. Medical institutions and welfare facilities are suffering due to floods. There is a need to improve the evacuation preparedness of the elderly and people with disabilities. As to the location of medical institutions and facilities for the elderly and people with disabilities, it is necessary to regulate construction in dangerous areas and strengthen disaster preparedness. In evacuation shelters, there are issues such as ensuring privacy, preventing violence, providing women's goods, providing baby and nursing supplies, and accepting people with disabilities.

4.4 Award System

> Awarding private organizations and individuals may motivate them to conduct disaster management and environmental conservation.

Governments and related organizations have established the following award systems:

(1) **Award System of Flood Protection Activities**: The Flood Control Act stipulates the Award to Flood Protection Meritorious Person by the Minister of Land, Infrastructure, Transport, and Tourism (Figure 4.8). The Prime Minister and MLIT award organizations or individuals who achieve distinguished flood protection. Governors, mayors, and the heads of Water and Land

Source: MLIT website

Figure 4.8 Vice Minister Presenting the Award Certificate

Management Bureau RMOs of the MLIT also provide these awards.

(2) **River Contributor Awards**: The Japan River Association awards individuals and organizations who contributed to society from the perspectives of culture, environmental protection, international contributions, academic research, regional development, flood protection, and water use. In 2020, 56 individuals and 45 organizations were honored. More than 4,000 awards have been awarded since its establishment in 1949.

(3) **Japan Water Prize and Japan Stockholm Junior Water Prize:** The Japan Water Prize was established in 1998 to support various activities conserving the water cycle and managing flood disasters. The award ceremony is held in the presence of His Imperial Highness Prince Akishino, the honorary president of the award. The Japan Stockholm Junior Water Prize was established in 2001 as part of the prize to select Japanese representatives to the Stockholm Junior Water Prize, an international competition for young researchers in Sweden. To date, Japanese representatives have won the Grand Prix or Runner-up Grand Prix three times.

CHAPTER 5 LESSONS LEARNED

(1) **Water resources could be managed by establishing water governance that involves local communities and stakeholders from the planning stage.** Japanese experience shows that a top-down approach driven by government organizations cannot respond to various needs of local communities. A legal framework also needs to be established to arrange governance. The River Act was revised to promote public participation in the decision-making processes of policies and plans for river basin improvement in Japan. Access to information through a variety of means is a prerequisite for the consensus building process.

(2) **Governance should be established in each river basin according to local conditions.** To reflect a wide range of opinions from academic experts and residents, a committee or forum should be formulated. It may take a long time to reach a consensus among a wide range of stakeholders. There is no single right answer for how to reach a consensus. The Yodo River Basin Committee and other river committees took innovative approaches. A comprehensive understanding of the situation and issues is needed.

(3) **Mechanism of reviewing projects may improve transparency and accountability.** Changes in socioeconomic conditions may reduce the necessity of projects. Governments need to review and revise project activities according to changes.

(4) **It is important to strengthen cooperation among the public and private sectors and local communities for environmental conservation and disaster management.** Local communities and residents need to prepare for disasters in accordance with local conditions. The private sector may provide solutions to various issues by utilizing its resources. The government may support these activities through financial support, training, and awards.

THEME 2 PLAN-BASED MANAGEMENT

THEME 2-1 MANAGEMENT PLANNING: FORMULATING THROUGH COORDINATION AMONG SECTORS & REGIONS WITH LONG-TERM PERSPECTIVES

ABSTRACT

Water resource management plans need good coordination among multiple sectors and regions, as well as consistency with higher-level plans, such as national development plans, national land development plans, SDGs, and climate change strategies. Water resource management plans should aim to utilize water resources properly by overcoming problems such as floods, droughts, and deterioration of water quality. Water resource projects are essential for achieving national growth in a resilient, sustainable, and inclusive manner.

After World War II, Japan resumed developing water resources that were the only natural resources available for hydropower generation, irrigation, municipal water supply, and industrial use. Japan also implemented flood protection projects. In the 1960s, the government started formulating the National Comprehensive Development Plan (NCDP), which includes the multi-purpose development of water resources. The NCDP aims to direct national land development from a long-term perspective.

Water resource projects require a long-term commitment for implementation. The Japanese government formulated multiyear plans for flood protection and created a special account independent of the general account. In addition, the government formulated comprehensive management plans for water resources, which the cabinet decided on as high-level plans above the ministerial level. The government formulated a plan based on scientific and social data by coordinating and optimizing water utilization among multiple objectives and users.

CHAPTER 1 INTRODUCTION

Good coordination with national development plans, development strategies, and other higher-level plans are necessary for managing water resources. In addition, budgetary commitments with a long-term perspective are crucial.

Appropriate water resource management is necessary to prevent disasters such as floods and droughts as well as to prevent deterioration of the water environment and water quality, which affect ecosystems and undermine sustainable development. Without an adequate water supply, people's daily lives and industrial production would be disrupted, affecting hydropower generation, agricultural production, and eventually the nation's growth.

Water resource management is thus critical to achieving quality growth, which aims at resilient, sustainable, and inclusive growth. Water resource management should be positioned as the key element in national development plans, and the government should commit to securing financial and human resources. Since national development plans include various sectors, water resources policy should be mainstreamed into other sectoral policies. A long-term perspective is necessary for water resource management. Thus, governments should promote the projects of water resources management based on multiyear plans formulated. This theme describes how Japan positioned and coordinated its water sector in its National Comprehensive Development Plan (NCDP) and how it promoted projects based on various multi-year plans.

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

Relationships between Water Resources Management Planning and the SDGs:

(1) Formulate a water resource management plan addressing vulnerabilities such as climate change, disasters, and economic and social issues:

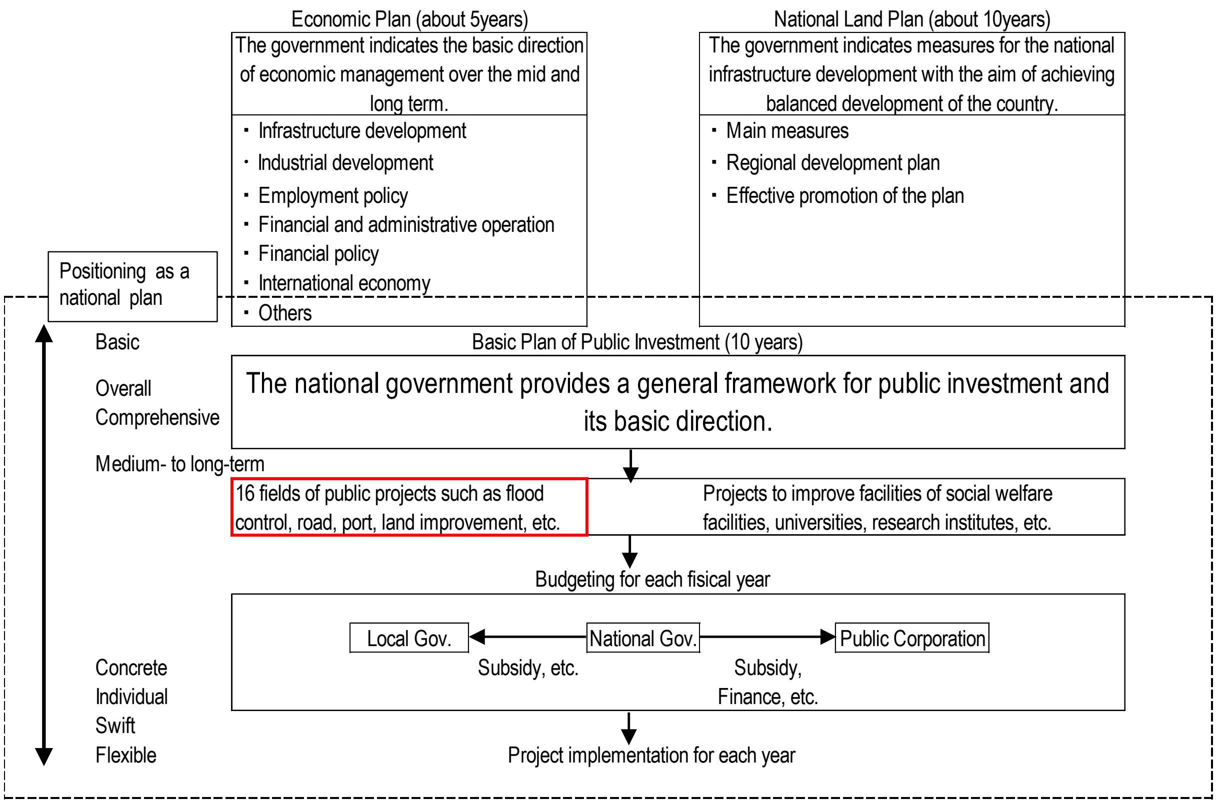
SDG 1. "No Poverty", 2. "Zero Hunger", 3. "Good Health and Well-Being," 6. "Clean Water and Sanitation," 11. "Sustainable Cities and Communities," 13. "Climate Action"

CHAPTER 2 NATIONAL DEVELOPMENT PLANS AND WATER RESOURCES MANAGEMENT PLAN

2.1 Consistency between National Development Plans and Water Resources Management

Water resources management should be planned within the framework of the long-term and the wide-ranging higher-level plans (such as the national development pan) while aligning with other sectoral policies.

Water resource management projects require long-term planning, construction, and operation, and have long-term effects and impacts. Project plans should be consistent with other sector policies within a framework of wide-ranging and higher-level plans, such as the Economic Plan, National Land Plan, SDGs, and climate change strategies. As shown in Figure 2.1, water resource management projects in Japan have been promoted in line with National Development Plans which consists of the Economic Plan and the National Land Plan.



Note: Matters related to public investment
Source: "Maintenance System of Social Infrastructure," Committee on Overseas Activities, Japan Society of Civil Engineers (Ed.), 1997

Figure 2.1 Consistency between Public Works and National Development Plans

2.2 Linkage with National Development Plans

The Economic Plan, National Land Plan, and national strategies should be aligned with the water resources management plan. In Japan, during the post-war reconstruction, water resources development became a key element for the national land development to support high economic growth.

In the post-1945 reconstruction of Japan, water resource development was a core integrated part of regional development. The government formulated specific regional comprehensive development plans to promote multipurpose water resource development[1]. The National Comprehensive Development Plan (NCDP) was reformulated five times since 1962. Water resource management is an important component of the NCDP. Infrastructure development, including water resource development, has contributed to improving the income and living standards of each region.

(1) Specific Regional Comprehensive Development Plans for Post-War Reconstruction

After World War II, there was substantial development of water resources to support land restoration, the development of power sources, and food production. Water is one of the few natural resources available in resource-poor Japan. During the development of water resources, a series of strong typhoons brought unprecedented flood damage to rivers and riverine areas in many regions of the country. Therefore, there is an urgent need for land conservation and disaster prevention. The specific Regional Comprehensive Development Plans (RCDPs) were formulated based on the Tennessee Valley Authority (TVA) model in the United States. The Economic Stabilization Headquarters[2] established the Council for the Study of Comprehensive River Development and initiated a nationwide survey of 24 rivers. The Ministry of Agriculture and Forestry (now the Ministry of Agriculture, Forestry, and Fisheries) also launched a national agricultural water use project on four rivers and began river development to irrigate farmland and increase food

Source: Prepared based on the website of Kitakami River Dam Integrated Management Office, MLIT

Figure 2.2 Location Map of Five Large Dams in Kitakami River System

[1] Twenty-one regions were selected as specific regions.
[2] After the war, between 1946 and 1952, an organization was established to stabilize the economy, which later became the Economic Planning Agency.

production.

The Kitakami River Development Plan is introduced as a successful example of a specific RCDP. The Kitakami River forms a canyon on the border between Miyagi and Iwate Prefectures. During heavy rain in the upper reaches, the area around Ichinoseki City, located upstream of the canyon, experienced flooding. Typhoons Kathleen in 1947 and Ione in 1948 caused unprecedented casualties and damage to houses and farmlands. Iwate Prefecture experienced power shortages. The scheduled daytime brownout was introduced once a week. The remote villages were left without power and impoverished. The distribution lines did not cover the villages in the Kitakami mountain area. The Kitakami River basin was designated as a specific region under the Comprehensive National Land Development Law. Five multipurpose dams were constructed including the purpose to reduce concentration of flood peak flows towards Ichinoseki City (Figure 2.2).

Five dams supplied 40-50% of the prefecture's electricity demands from 1975-1984. Other projects have been promoted in association with dam construction. These include irrigation water projects and land reclamation projects to expand farmland and increase food production. The construction of the Shijyushida and Gosho Dams alleviated the flood risk in the central part of Morioka City, the capital of Iwate Prefecture and enhanced land use in downtown Morioka.

(2) National Comprehensive Development Plan (NCDP)

The NCDP presents the basic direction for all-inclusive national development from a long-term perspective. The NCDP aimed to resolve overcrowding, delegate certain functions to specific regions, and reduce the disparities in income levels which expanded along with the economic growth. The NCDP covers three issues: i) balanced development in the country, ii) national land safety, and iii) socioeconomic activities in harmony with the natural environment. In 1962, the first NCDP was enacted and has been revised four times every ten years. Each NCDP was planned based on the historical context at the time. Seven development goals were established: (1) building a national land structure, (2) ensuring equity, (3) reducing overcrowding, (4) efficient investment, (5) spatial support of industrial policy, (6) effective use of resources, and (7) national land conservation. The Comprehensive National Land Development Act was substantially revised in 2005 as part of the National Spatial Planning Act, replacing the NCDP. This represents a shift to mature society planning to cope with social changes such as declining population, low birthrate, aging population, and regional disparities.

The NCDP was effective in terms of ensuring equity and investment efficiency and implemented spatial support for industrial policy. The NCDP has also contributed to improving the national infrastructure network and dispersing industrial functions to rural areas. The high population in Tokyo is an example of overcrowding in major metropolitan areas. The issue of alleviating the congestion is yet to be resolved. Efforts exerted in the field of water resources are described below:

1) 1st NCDP (1962): To respond to increasing water demand, the plan proposed the following: 1) development of multipurpose reservoirs, 2) advanced use of lakes, and 3) construction of river mouth barrages.
2) New NCDP (1969): From the viewpoint of national land conservation and water supply, the plan proposed i) construction of facilities, including multipurpose dams, river mouth barrages, and water supply conduits; ii) expanding the use of retarding basins and lakes; and iii) comprehensive development of a series of water management facilities to facilitate integrated management of the river system.
3) 3rd NCDP (1977): As part of national land management, this plan proposed the integrated management of river systems and the conservation and development of water resources. It also proposed securing water for industrial relocation and achieving a spatial balance in national land use.
4) 4th NCDP (1987): This plan proposed the development and conservation of water resources from the perspective of i) improving the water environment by integrated management of river systems, ii) ensuring a stable supply of water, iii) improving safety against droughts, and iv) ensuring safety against water-related disasters, jointly to form a safe and prosperous country. The plan presented the water resource development for each region and basin.
5) Grand Design for the 21st Century (1998): To secure the stable and effective use of water resources: i) to achieve a "water-saving society" in the basin; ii) to strengthen drought countermeasures; iii) to respond to flood protection and water use in river systems; and iv) to manage sediment comprehensively.

The NCDP was a response to the need to restrain or prevent economic inequities, such as regional disparities, congestion, depopulation, and external diseconomy as a result of high economic growth[3]. The NCDP aims at planning and inter-ministerial coordination for efficient investment in infrastructure to support national land development. To formulate the NCDP, i) one national agency should have the authority and capacity for national land development, ii) basic statistical data should be in place, and iii) local governments should be decentralized.

(3) Long-term Flood Protection Plan

Flood protection projects are constrained by the fiscal system and financial situation. In Japan, since the 1870s, the government has implemented flood protection projects and introduced Western technology to construct modern continuous levees to confine floodwaters within river channels and to develop plains protected by these levees. The government formulated the first long-term plan and budget in response to the major floods in 1910. This plan covered 20 rivers and the construction period was 18 years. A Special Account for the Flood Protection Fund was established to manage the budget for flood protection. In 1921, the Second Flood Protection Plan was formulated for 81 rivers, and in

[3] " National Comprehensive Development Planning in Developing Countries," Overseas Economic Cooperation Fund, May 1995.

1933, the Third Plan was formulated for 105 rivers. The Erosion and Flood Protection Emergency Measures Act[4] was enacted in 1960 which led to the formulation of a long-term flood protection plan.

2.3 National Water Resources Management Plan

> The national water resources management plan should guide the development, conservation, and use of water resources maintaining consistency with the higher-level plans with consideration of long-term forecasts of water demand and supply.

(1) Water Plan

The government formulated a National Comprehensive Water Resources Plan in line with the NCPD. This plan serves as a guideline for various comprehensive measures concerning water resources. Table 2.1 exhibits the long-term water demand outlook and basic goals for development and conservation.

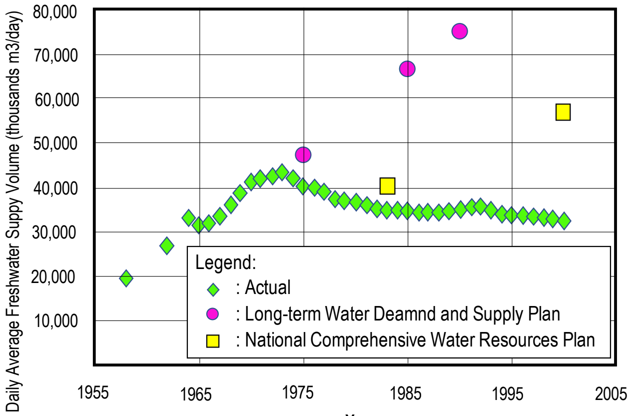
Table 2.1 Overview of Three National Comprehensive Water Resources Plans

Plan	Overview
Long-term Water Demand and Supply Plan (1978)	➢ National water demand and supply plan formulated based on the 3rd NCDP, which promoted the settlement scheme. ➢ Basic goal: Long-term stabilization of water demand and supply.
Water Plan 2000 (1987)	➢ Formulated in line with the 4th NCDP to create multipolar-decentralized national land. ➢ Strengthened multifaceted functions such as water quality and environmental functions as well as water demand and supply balance. Basic goals: 1) Establish a stable water supply system. 2) Improve the security of water supply against droughts. 3) Transform to a new water use society (reevaluation of the multiple values of water).
Water Plan 21 (2000)	➢ Formulated based on the "Grand Design for the 21st Century", which aims at creating a multi-axis national land structure. ➢ Establishing a sound water cycle system and adding cultural aspects of water. Basic goal: Target year: 2010-2015: 1) Establish a sustainable water use system. 2) Conservation and maintenance of the water environment. 3) Restore and foster water culture.

Source: Project Research Team

[4] A law aimed at promoting the urgent and systematic implementation of erosion and flood protection projects to conserve and develop national land and to stabilize and improve the lives of the people.

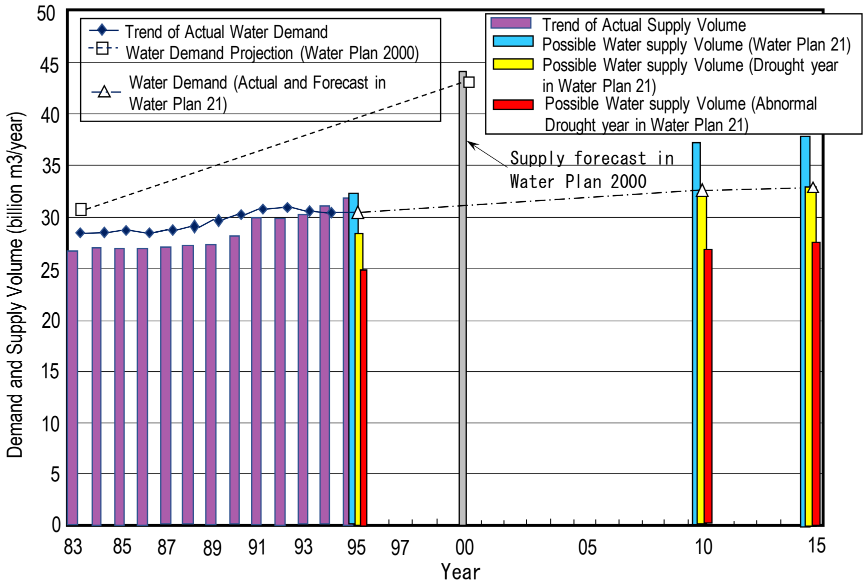
The Long-Term Water Demand and Supply Plan and Water Plan 2000 (National Comprehensive Water Resources Plan) forecasted water demand based on the increasing trend during a period of high economic growth. The forecast and actual demand were significantly different, as shown in Figure 2.3. Uncertain factors in the forecast were: 1) the dynamic socioeconomic framework, 2) difficulties in predicting the water-saving efforts of the industrial sector and changes in the industrial structure, and 3) unclear effects caused by measures such as price policies for water-saving.



Source: Analysis and Evaluation of Japan's Water Demand Forecasting System, Nishioka Takashi, Nasu Shingo

Figure 2.3 Comparison of Projected and Actual Water Demand in Japan

To address discrepancies in the Water Plan 2000, at the time of formulating Water Plan 21, the future demand was re-forecast based on the actual demands (Figure 2.4). When socio-economic conditions change significantly, water demand forecasts should be reviewed at the intermediate stages of the plan period.



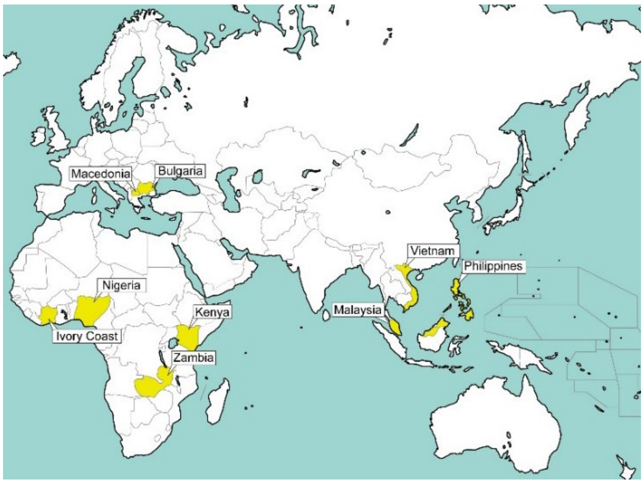
Source: Results of Policy Review for Fiscal Years 2004 and 2005 (Evaluation Report) Water Resource Policy–The State of Water Resource Planning–MLIT, March 2006.

Figure 2.4 Water Demand Projections in Water Plan 21

(2) Japan International Cooperation Agency (JICA) National Water Resource Development Plan

The JICA contributed to preparing national master plans for water resource management in ten developing countries (Figure 2.5). The objectives of the national master plan are as follows:

- To understand the uneven distribution of water resources across the country and to verify the effectiveness of inter-basin water diversion.
- To select priority areas for projects in various water sectors, such as water resources, water use, flood protection, and water environment throughout the country.
- To provide useful information for inter-state consultations for the management of water resources in international rivers.
- To provide information necessary to adjust the appropriate allocation of the national development budget for water resource management from a long-term perspective.



Source: Prepared based on "Study on Approach for Integrated Water Resources Management – Review of the JICA Master Plan of National Water Resources Management – Final Report," July 2011, JICA

Figure 2.5 Target Countries covered by the National Water Resources Development Plan Supported by JICA

As a case study, the National Water Resource Development Plan in Malaysia is introduced below:

National Water Resources Development Plan in Malaysia

The plan was formulated from 1979 to 1982. It contributed to water resources development and management in accordance with Malaysia's national development goals. The target year for the plan was set at 2000, with a 20-year development planning horizon.

1) Objectives

Based on the country's social and economic development goals, a framework was established for ensuring consistency in development planning and project implementation related to water resources and rationalization of their management and operation. The recommendations covered various sectors and aspects including a) National water resources policy, b) Project implementation plan, c) Financial policy, d) Administration, e) Institutions, f) Laws, and g) Future considerations.

2) Background

With the rapid development of the country, water shortages were deteriorated. The authority to develop and manage water resources was dispersed among many public agencies. Without central coordination of the various agencies, the development and management of a wide range of water resources were carried out in a disjointed manner. This led to conflicts in water use and possible duplication in the activities and functions of various agencies.

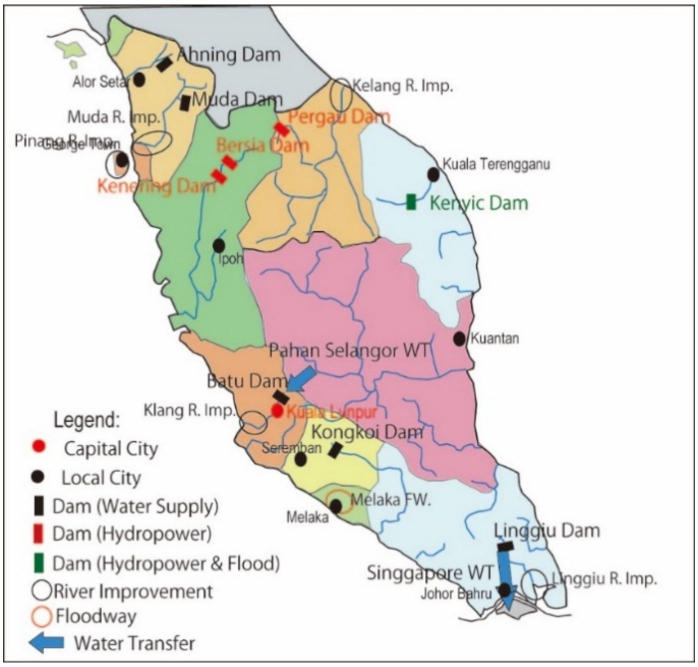
3) Recommendations

The basic objective of the National Water Resources Policy was to address water shortages, thereby contributing to the nation's economic development, regional development, and the improvement of environment and social welfare. The specific goals are:

- To ensure normal water use by maintaining the target discharge (flow rate) on major rivers.
- To improve social welfare and support industrial development by expanding water supply.
- To raise the self-sufficiency ratio of food by expanding irrigation facilities, thereby enhancing the real income of farmers.
- To protect human life and reduce flood damages through flood protection projects.

Table 2.2 presents the recommended measures in the National Water Resources Development Plan and the implementation status.

After the formulation of the National Water Resources Development Plan, Malaysia achieved high economic growth. A gross domestic product (GDP) growth rate of over 9% per year was achieved in the latter half of the 1980s, triggered by the Look East Policy, which advocated for economic and social development and the establishment of an industrial base. Economic growth temporarily stagnated due to the Asian currency crisis in the latter half of the 1990s. However, with the subsequent promotion of high-tech and knowledge-intensive industries, the economy recovered, achieving a high GDP growth rate of approximately 5%. This resulted in increased demand for urban water, an increase in the potential flood damages, and deterioration of the water environment. The projects recommended in the National Water Resources Development Plan have been implemented (Figure 2.6).



Source: Prepared based on "Study on Approach for Integrated Water Resources Management – Review of the JICA Master Plan of National Water Resources Management – Final Report," July 2011, JICA

Figure 2.6 Major Water Resources Facilities Developed in the Malay Peninsula

Table 2.2 Recommendations in the National Water Resources Development Plan

Measures for Facility Projects		
Category	**Development Target (Target Year 2000)**	**Recommendations**
Water Use Facility	➢ Water Supply Coverage: 75%→100%. ➢ Rice Self-sufficiency Ratio: 69%→85%. ➢ Hydropower Development: 1,604 MW across Malaysia.	➢ Dam Development (50 dams including multipurpose dams). ➢ Water Supply Facility Improvement Plan (Water supply:10,300,000 m^3/day). ➢ Improvement of Irrigation Facilities (Irrigation area: 545,000 ha). ➢ Hydropower development plan (20 dams、Installed capacity: 1,604 MW).
Flood Protection Facilities	➢ Flood damage reduction for 50% of the population in flood-prone areas.	➢ Flood Protection Dams (12 dams including multipurpose dams). ➢ River Improvement (Total Length: 850 km). ➢ Construction of Floodway (Total Length: 82 km). ➢ Construction of polder dike (12 locations).
Water Environment Improvement Facilities	➢ River Water Quality: BOD at 5 mg/L or below.	➢ Sewerage facility projects (11 cities). ➢ Factory-wastewater treatment facilities (20 cities).

Water Resource Management Plan	
Category	**Recommendations**
Low Water Management	➢ Improvement of hydrological observation. ➢ Introduction of river maintenance flows. ➢ Formulation of management plans of water rights. ➢ Development of water management plans for unusual drought. ➢ Introduction of permit systems for groundwater development and use.
High Water Management	➢ Formulation of plans to develop flood forecasting, warning, and evacuation systems. ➢ Development of land use plans for flood-prone areas. ➢ Setting design flood discharges for intermediate years for construction until completion of full scale levee system.
Water Environment Management	➢ Formulation of river use and conservation plans. ➢ Development of basin management plans. ➢ Development of wastewater monitoring and regulation system plans to improve inland water quality. ➢ Setting of river water quality standards.

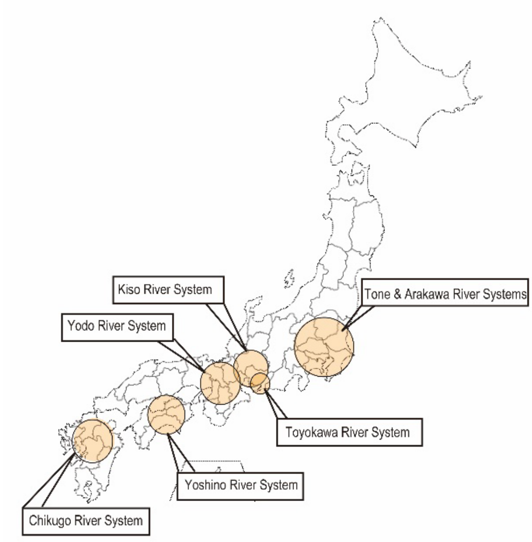
Organization and Institutions	
Category	**Recommendations**
Organization	➢ Establishment of National Water Resources Committee and Federal Water Resources Department to enable centralized supervision and coordination of national water resources development and management. ➢ Establishment of State Water Resources Committees and State Water Resources Departments to oversee and coordinate water resources development and management ranging over wide-areas, and to facilitate consultation and coordination with the federal government. ➢ Establishment of the Water Agency to oversee implementation and management of specific water resources development projects.
Institutions	➢ Specific provisions of the National Water Resources Law that legally provide for integrated and coordinated administration by federal and state governments in the planning, project implementation and operational phases of water resources development and management. ➢ Partial cost-sharing system by beneficiaries of water development and management projects. ➢ Government subsidy program for water resources development and management project costs. ➢ Sewerage Utility Fee Collection System. ➢ Cost-sharing system for multipurpose dam development projects.

Source: "Study on Approach for Integrated Water Resources Management – Review of the JICA Master Plan of National Water Resources Management – Final Report," July 2011, JICA

CHAPTER 3 WATER RESOURCES DEVELOPMENT PLANS FOR IMPORTANT RIVER BASINS

In Japan, in response to the industrial development and the increase in urban population, the government formulated plans for the development and management of water resources in nationally important river basins.

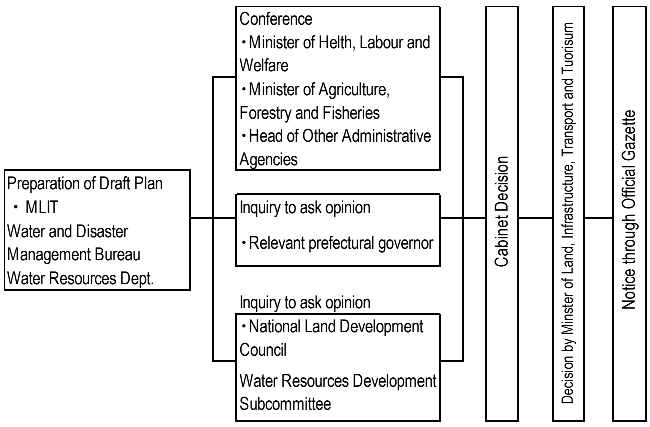
Since the 1950s, Japan experienced remarkable restoration and growth in industry, and concentration of the urban population, accompanied by improvements in living standards. Tokyo, Osaka, and other metropolitan areas faced severe water shortages due to the dramatic increase in water demand. There is a challenge in the coordination of subsectors and stakeholders.



Source: Prepared based on website of MLIT

Figure 3.1 Location Map of River Systems for Water Resources Development

The Water Resources Development Promotion Act was enacted in 1961. The Minister of Construction (now the Ministry of Land, Infrastructure, Transport and Tourism, or MLIT) designated river systems that required extensive water resource development to support industrial development and urban population growth (Figure 3.1). The government formulated the Water Resources Development Basic Plan (Full Plan) (Theme 1-1: Legislation and Organization). The Full Plan for the five large river systems covered 17% of the country's land area, 46% of the population, and 52% of the shipment value of industrial products. Urban water use accounted for approximately 50% of the national demand.



The Source: MLIT Website

Figure 3.2 Process Flow for Formulating the Basic Plan for Water Resources Development

A Council was formed with representation from the MLIT, the Ministry of Health, Labour and Welfare (MHLW), the Ministry of Agriculture, Forestry and Fisheries (MAFF), and heads of other administrative agencies to discuss the Full Plan (Figure 3.2). The Cabinet approved the plan, which is positioned higher than the ministry-level plans. The Plan is not just a list of projects but a data-based analysis that presents clear goals and specific solutions or projects. The Plan serves as the basis for comprehensive development and rationalization of the use of water resources. It presents: 1) demand outlook and supply targets by water users, 2) basic matters concerning the construction of facilities necessary to achieve the supply goals, and 3) other important matters related to the comprehensive development and rationalization of the use of water resources. The content was to reflect changes in socioeconomic conditions.

CHAPTER 4 ADAPTATION PLANNING TO CLIMATE CHANGE

The Japanese government is shifting their flood protection policy to the concept of "River Basin Disaster Resilience and Sustainability by all", a comprehensive and multi-layered approach for the entire basin. There is also a shift to a "stable supply of water" based on risk management by optimizing the use of existing facilities and ensuring the function of the entire system through the coordination of structural and non-structural measures.

4.1 River Basin Disaster Resilience and Sustainability by All

Table 4.1 shows the estimated average rates of change in the rainfall depth, discharge (flow rate), and the recurrence frequency of floods under two climate change scenarios in Japan, namely an increase in the atmospheric temperature by 4°C and 2°C.

Table 4.1 Rate of Change in Rainfall, Discharge, and Flood Frequency due to Climate Change

Climate Change Scenario	Rainfall	Discharge	Flood Frequency
2° C increase	Approx. 1.1 times	Approx. 1.2 times	Approx. 2 times
4° C increase	Approx. 1.3 times	Approx. 1.4 times	Approx. 4 times

Note: The target rivers are those managed by MLIT, and the average values are shown. Discharge (flow rate) was calculated based on the runoff model used for each water system. Rate of change of rainfalls for 2ºC scenario is an estimate for the period from the end 20th century to the end 21st century. One for 4ºC scenario is for the period starting from before the Industrial Revolution.
Source: Proposal for Flood Protection Planning in the light of Climate Change, Revised Edition, MLIT, April 2021

In response to increasing flood risks, conventional structural measures alone cannot resolve flooding issues. Throughout the basin, relevant organizations should be engaged in multi-layered measures, including urban planning and crisis management. In July 2020, the Council for Infrastructure compiled a report on "Water-related Disaster Countermeasures in light of Climate Change".

➢ Important aspects of countermeasures:

1) Resilience: In the event of the worst possible water-related disaster, to avoid loss of life, minimize economic damage, achieve early recovery and reconstruction, and build a strong and flexible national infrastructure to enhance the resilience of economic activities.

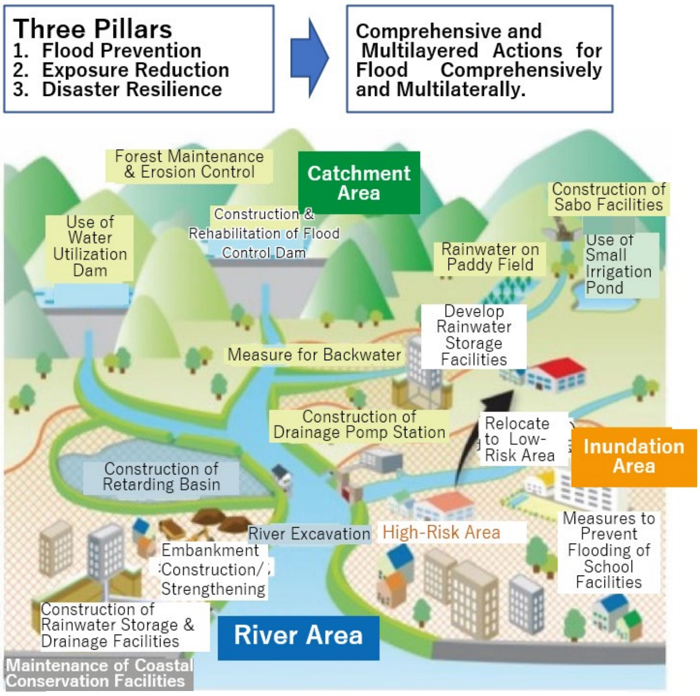
2) Sustainability: In the event of a major disaster, a region should be able to recover and rebuild quickly to maintain sustainable development and improve its international competitiveness, thereby contributing to Japan's growth strategy.

3) Inclusiveness: All actors in the basin should be aware of water-related disaster countermeasures, collaborate and act accordingly, and innovate by integrating various new technologies.

➢ Measures:

Facility plans prepared with past rainfall and tide levels should be revised to consider increased rainfall and rising tide levels due to climate change.

The flood protection strategy "River Basin Disaster Resilience and Sustainability by all" should encompass coastal areas, the catchment area, river area, and the inundation area of the river basin (Figure 4.1). All parties are involved in various measures in a comprehensive and multilayered manner. The River Management Offices (RMOs) continue to implement conventional flood protection measures. Local governments need to regulate land use in at-risk areas and relocate houses from risk areas. Local communities prepare evacuation plans.

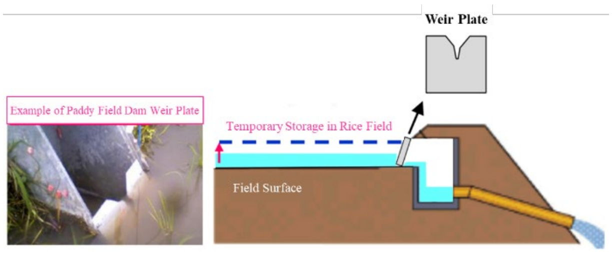


Source: MLIT Website

Figure 4.1 Schematic Diagram of New Strategy Flood

Existing facilities are also used to reduce flood risks. To release part of the stored water in the water supply dams preceding flooding, a flood protection capacity was created. The details are explained in "Theme 8: Dam Management".

Paddy field dams increase rainwater storage capacity by placing weir (overflow) plates on the draining outlets of the paddy fields to reduce outflow during heavy rains (Figure 4.2). Subsidies are provided to encourage local collaborative activities.

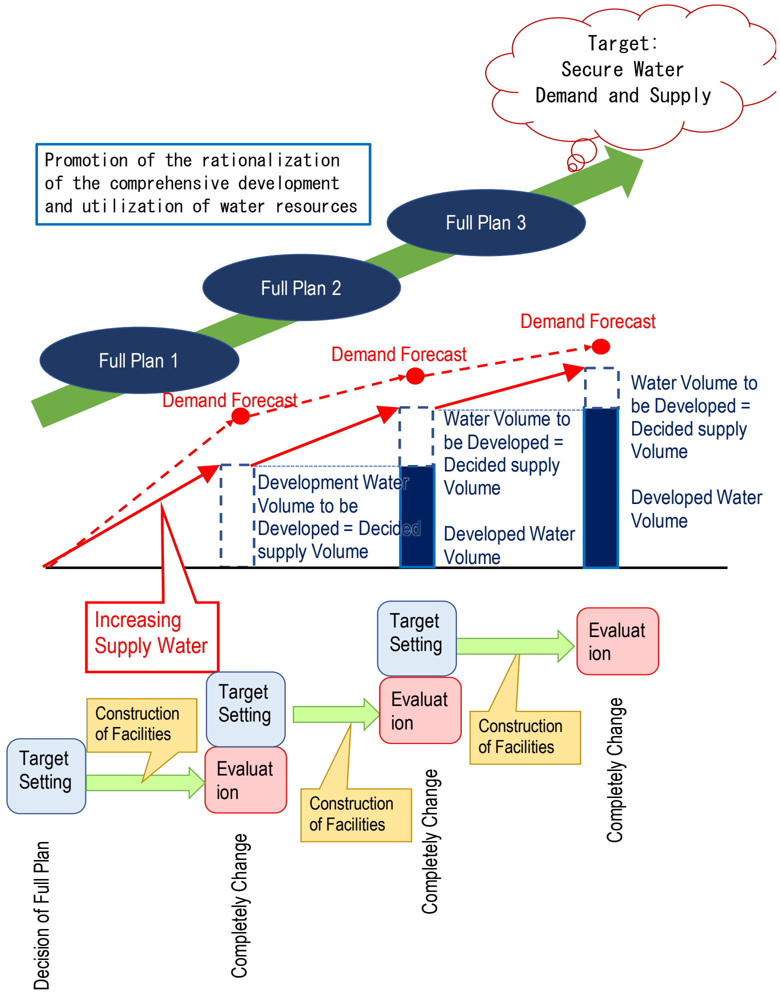


Source: Cabinet Office

Figure 4.2 Paddy Field Dam

4.2 Shift from Development Promotion to Risk Management

Japan has shifted its water resources policies from the demand-driven "promotion of water resources development" to the risk-managed "stable water supply." This is in response to the declining water supply due to the recent instability of precipitation. Since 1961, when the Water Resources Development Promotion Act was enacted, the government took the "target-setting" approach: setting a target year and achieving the supply goal (Figure 4.3). Owing to past efforts to construct water resource facilities, the amount of water planned is generally being secured. At present, there are issues such as lowering the stability of water use due to recent lower rainfall and increased variability, as well as a declining population. Given this context, the government is proposing a risk-managed policy for a "stable water supply"[5] (Figure 4.4). The recent policy is outlined below.



Source: Prepared based on "Explanatory Material for the Next Basic Development Plan (draft)," the Water Resources Department, Water and Disaster Management Bureau, MLIT

Figure 4.3 Water Development Image

(1) Basic Principles:

1) Risk management plan: Managing significant risks of low occurrence probability, such as earthquakes, large-scale accidents due to aging of the water infrastructure, and critical droughts.

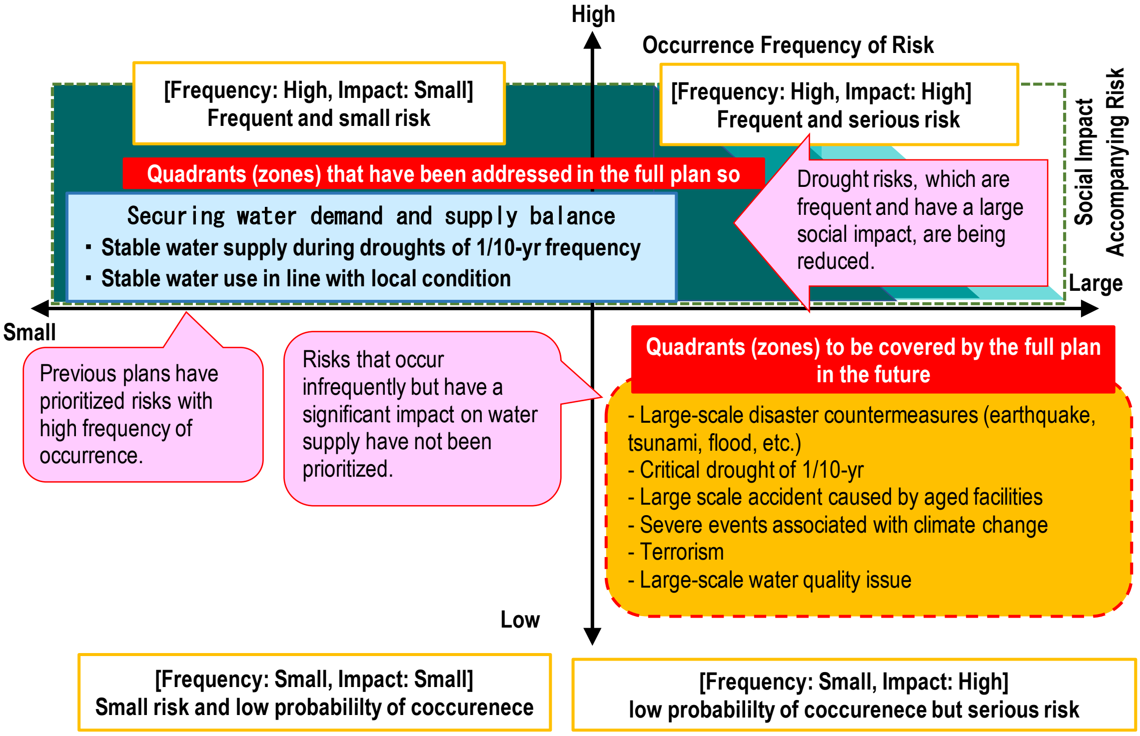
2) Comprehensive plan ensuring the safety level of water supply: Steady implementation of measures in line with the local conditions through a comprehensive evaluation of the water supply and demand balance, considering the uncertainties.

[5] MLIT, https://www.mlit.go.jp/common/001169848.pdf, slide #5 of the same document with the Source of Figure 4.4, checked on 24th February 2022.

(2) Methods:

1) Full utilization of existing facilities: extending their service life and optimizing the use of existing facilities.

2) Securing the performance of the entire system by coordinating structural and non-structural measures: managing risks and uncertainties flexibly, swiftly, and comprehensively.



Source: Prepared based on "Explanatory Material for the Next Basic Development Plan (draft)," Water Resources Department, Water and Disaster Management Bureau, MLIT.

Figure 4.4 Target Quadrant of the Full Plan

Development based on Full Plan for Yoshino River System

There are challenges in the security of water supply due to significant water shortages in the Shikoku Region, in the Kagawa Prefecture, on the north bank of the Yoshino River flowing in Tokushima Prefecture and the Uma area in Ehime Prefecture. The first 3 plans up to 2002 were goal-setting plans. The latest Full Plan changed to a risk management plan. Facilities constructed since the initial planning are shown in Table 4.2 and Figure 4.5.

Table 4.2 Facilities Constructed after Preparation of First Full Plan for Yoshino River System

Facility	Completion	Purpose
Sameura Dam	1974	➢ Water supply to the four prefectures of Shikoku Region, maintenance of normal functioning of river flow, power generation, and flood protection.
Tomisato Dam	2001	➢ Urban water supply, power generation, and flood protection for Ehime Prefecture.
Shingu Dam	1975	➢ Irrigation water supply, industrial water supply, power generation, and flood protection in Ehime Prefecture.
Ikeda Dam	1975	➢ Securing the water level for the Yoshino River North Bank and Kagawa Water Canals from the reservoir, maintaining the normal functioning of river flow, power generation, and flood protection.
Kouchi Diversion Facility	1978	➢ Water supply from the Setogawa and Hiraishi Rivers in the Yoshino River System to the Kagami River, securing water supply for urban use in Kochi Prefecture (in cooperation with the Kagami Dam) and power generation.
Kagawa Canal	1974	➢ Irrigation and urban water supply in Kagawa Prefecture.

Source: Prepared by the Project Research Team based on the website of Yoshino River Integrated Management Office, MLIT

Source: Basin Map: Website of Yoshino River Integrated Management Office, Shikoku Regional Development Bureau, MLIT, Photograph: "Structural and Non-Structural Measures in the Next Basic Plan for Water Resources Development in the Yoshino River System (Draft)", February 20, 2019, Water Resources Department, Water and Disaster Management Bureau, MLIT.

Figure 4.5 Location Map of Completed Facilities under Full Plan in Yoshino River System

In addition to securing the current level of water supply, the plan presents measures to secure the minimum necessary water supply and enable early recovery in the event of a worst-case drought, large-scale natural disasters, or temporary interruption of water supply due to aged facilities under climate change. Table 4.3 shows details of the risk management measures during normal times.

Table 4.3 Details of Risk Management-Type Measures in Full Plan for Yoshino River System

Category of Countermeasure		Countermeasure
Structural measures	Projects that do not change the water supply volume or supply area.	To enable flexible implementation of necessary improvement and upgrade of existing facilities, all the renovation projects are comprehensively listed.
Non-structural measures	Measures to secure water supply.	Countermeasures from demand side: ➢ Promote the use of water-saving devices and raise awareness of water-saving. ➢ Transfer of water rights to emerging users. Countermeasures from supply side: ➢ Groundwater conservation and use. ➢ Promote the use of rainwater and recycled water.
	Measures to ensure necessary water supply in case of emergency.	Preliminary measures in case of emergency: ➢ Flexible preparations even under the normal flow conditions such as restricted water abstraction. ➢ Establishment of emergency water supply. ➢ Preparation of “drought-action schedule”. ➢ Concluding mutual support agreements and preparation of Business Continuity Plans (BCP) in the event of disasters. Flexible response in case of emergency: ➢ Disseminate information and call for water conservation from an early stage.

Source: Outline of the "Basic Plan for Water Resources Development in the Yoshino River System" (Approved by the Cabinet on April 19, 2019)

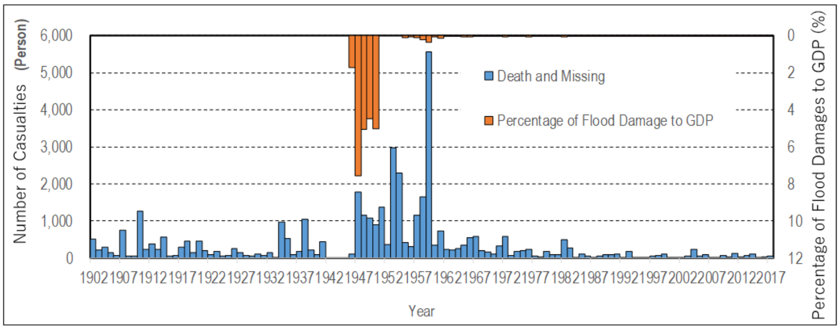
CHAPTER 5 CONTRIBUTION TO SOCIETY THROUGH WATER RESOURCES MANAGEMENT

In Japan, the consistent planning and development of water resources has guided disaster management and water utilization, to support high economic growth.

5.1 Effects of Water Resources Development in Japan

(1) Flood Protection and Drought Mitigation

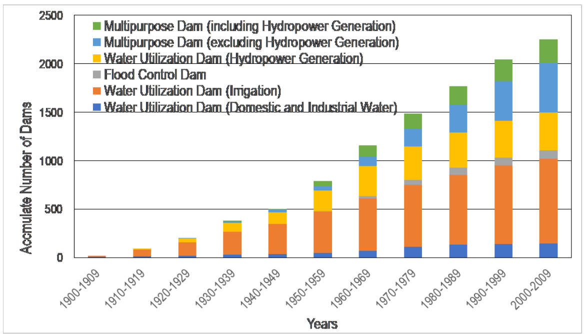
Investment in flood protection reduces flood damage (Figure 5.1). Japan is vulnerable to floods because major cities are located downstream of key rivers, and the population is increasingly concentrated in these major cities. After 1945, flood damage frequently occurred until the 1950s, with more than 1,000 casualties and the average annual economic loss amounting to 1% to 10% of the gross domestic product (GDP). The government allocated limited investments to flood protection due to the expanded military preparedness and wars since the 1930s. The flood discharge in the downstream areas increased due to the concentration of river discharge, resulting from the construction of continuous high levees on the upstream river reaches. From the 1960s to the 1990s, the national government invested 1% of the GDP in flood protection, which reduced the loss of life. However, flood damage continues to occur, with the further concentration of population and assets in urban areas.



Note: Nominal GDP and amount of damages
Source: GDP data, "Changes in Japan's Postwar Finances and Future Challenges" 1946-1950, Ministry of Finance,
"Annual economic report" long-term economic statics 1955 to 2019.
Amount of flood damage and number of casualties: "Statistical survey on flood damage" 2018 MLIT

Figure 5.1 Number of Casualties due to Flooding and Flood Damage as %GDP

The peak of dam construction in Japan was in the 1960s to the 1970s, when approximately 700 dams were built, mainly multipurpose dams (Figure 5.2). These dams were effective in reducing the number of casualties and the level of flood damage (Figure 5.2). After WWII, the flood protection capacity was 10 million m^3 (mcm). It increased to 4,352 mcm by 2004, a 430-fold increase. The MLIT and the Japan Water Agency (JWA) owned 93 dams in 2001. These dams regulated floods in the 15 years from 1987 to 2001, with a total flood peak cut of

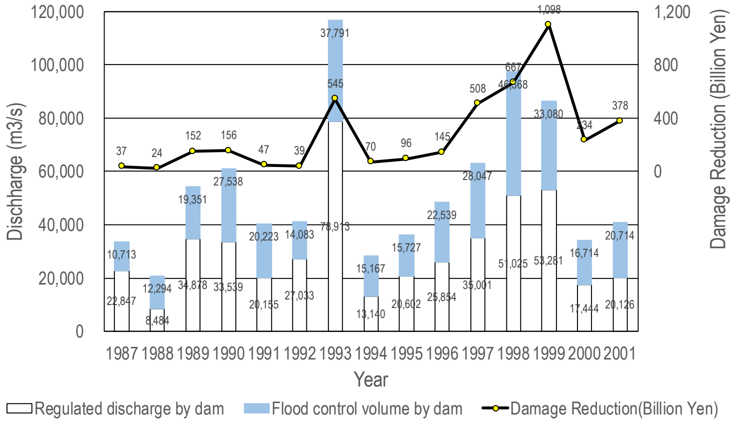


Source: Prepared based on data from "Dams in Japan"

Figure 5.2 Increase in Number of Dams Constructed

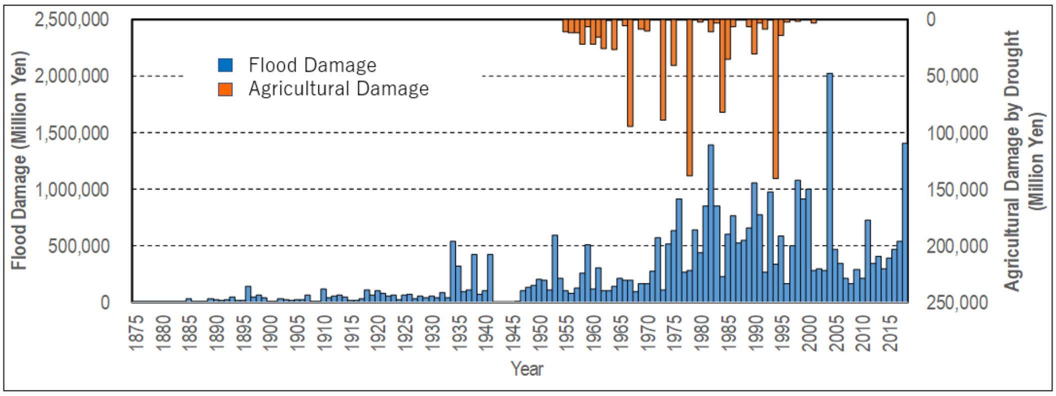
approximately 340,000 m^3/sec. The total reduction in flood damage was approximately 4.2 trillion yen[6] (Figure 5.3).

Through the development of water resources, the national government ensured the supply of sufficient water and mitigation of drought impacts on agriculture (Figure 5.4).



Source: Water resources in Japan (2008) MLIT

Figure 5.3 Actual Flood Protection by Dams and Estimated Damage Reduction



Note: Cost of flood damage from 1875 and drought damage from 1955 (nominal damage).
Source: Cost of flood damage "Statistical Survey on Flood Damage" 2018 MLIT, Cost of drought damage "Crop Statistics Survey" MAFF.

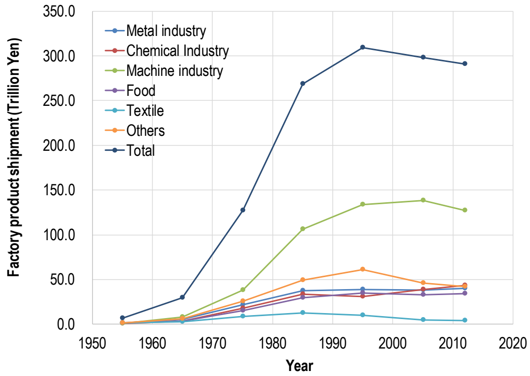
Figure 5.4 Amounts of Flood and Drought Damages

(2) Water Utilization Effect

1) Industrial Water

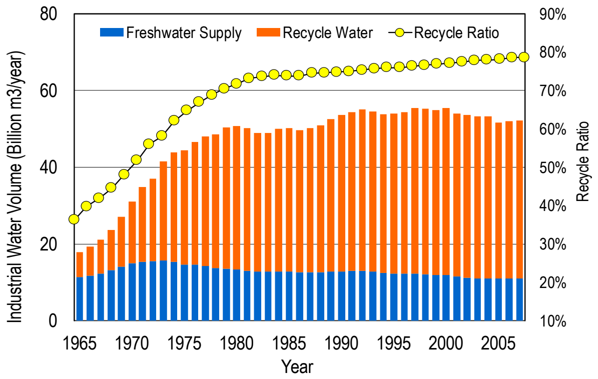
Industrial water facilities supported a large increase in industrial product shipments. The value of product shipments in 1985 was nine times that in 1965 (Figure 5.5). Industrial water demand increased significantly since the 1980s. The use of recycled water increased in line with the growth in industrial water demand (Figure 5.6) (Theme 5: Urban Water Management, Section 3.1).

[6] "The Role of Dams and Hydropower Generation: What Should the Future Hold as Global Warming Progresses?" Japan Commission on Large Dams.



Note: Data for plants with 30 or more employees
Source: Industrial statistical survey

Figure 5.5 Growth in Product Shipments

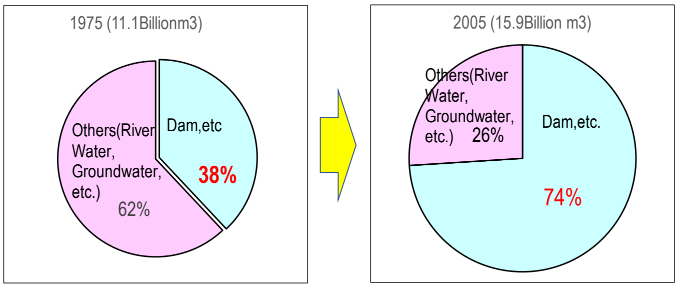


Note: Data for plants with 30 or more employees
Source: Industrial statistical survey

Figure 5.6 Changes in Industrial Water Demand and Supply

2) Domestic Water

With increased economic growth, there was an increase in the income of each household, per capita water use, and domestic water demand. This prompted water resource development to meet the growing social water demand as well as to support the quality of life of the population. The construction of multipurpose dams can reduce the amount of investment required compared to the construction of single-purpose dams. In 2005, the total water supply for domestic use was 15.9 billion m^3,of which 74% was supplied by dams. The water supplied from the dams in 2005 was approximately 2.7 times that in 1975 (Figure 5.7).

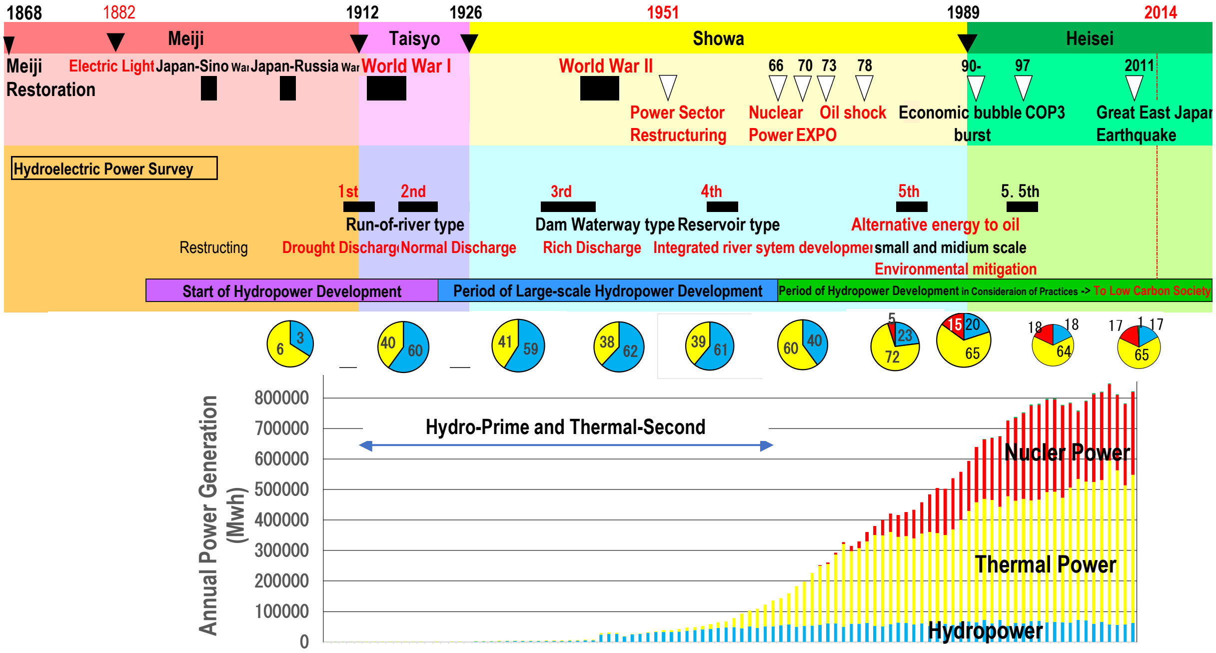


Note: 1975: 11.4 Billion m^3 x 0.38 = 4.3 Billion m^3, 2005: 15.9 Billion m^3 x 0.74 = 11.8 Billion m^3
Source: "The Role of Dams and Hydropower" Japan Commission of Large Dam

Figure 5.7 Effect of Dams on Domestic Water Supply

3) Hydropower Generation

Hydropower generation contributed greatly to the domestic power supply after 1945, and to the industrial power supply during the industrial development from around 1950 to 1970. During the reconstruction period after WWII, a large amount of electricity was required; however, it was difficult to import fuel for thermal plants. The government promoted the construction of dams for hydropower generation during such period as was called the "Hydro-Prime and Thermal-Second" (Figure 5.8).

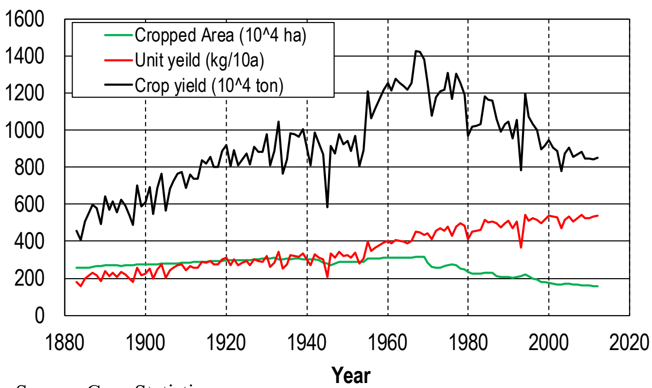


Source: Preparation based on "History and significance of hydropower generation in Japan and international activities under the IEA Implementation Agreement for Hydropower Technologies and Programmes," Akiyama Takashi, New Energy Foundation, July 31, 2015, the Japan Electric Power Industry History Database."

Figure 5.8 Growth and Composition Changes in Electricity Generation in Japan

4) Irrigation Water

From the latter half of the 1940s to around 1970, the land area for paddy cultivation increased to enhance food production (Figure 5.9). The demand for irrigation water increased in line with the increase in crop area, and water resource development contributed to agricultural development.

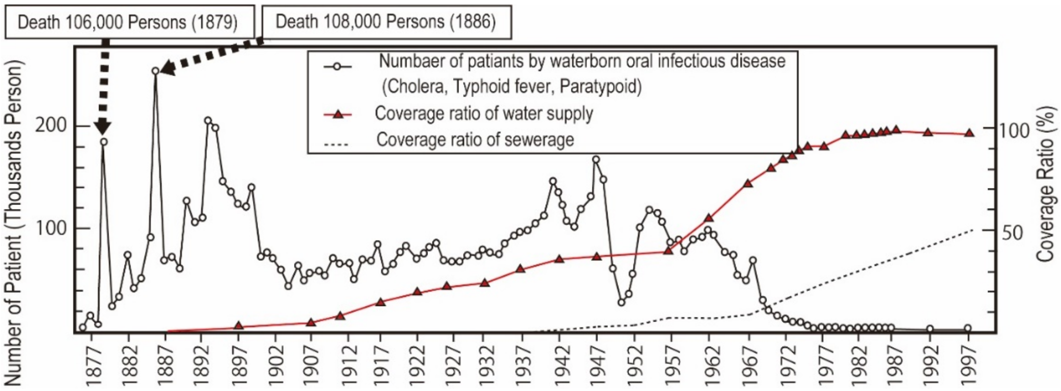


Source: Crop Statistics

Figure 5.9 Trends in Paddy Rice Yields

5) Infectious Disease

Infectious diseases were reduced by the development of water supply systems. From the 1850s to the 1890s, Japan experienced major cholera and dysentery epidemics. In 1879 and 1886, the number of deaths from cholera rose to over 100,000. The government established water supply systems in cities to improve the sanitary condition and prevent waterborne diseases (Figure 5.10).



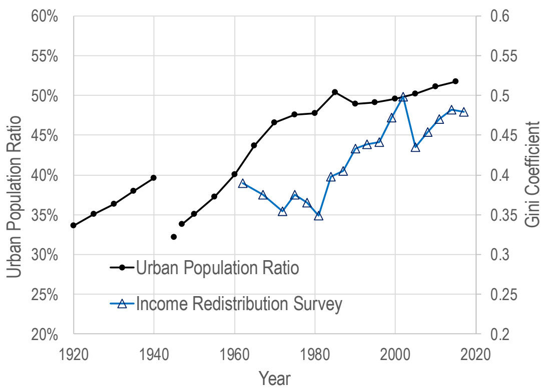
Source: "Urban Development and Public Health" Nakatsuji Hideji WHO insight No.44(2010)

Figure 5.10 Number of Patients with Waterborne Oral Infections and Water Supply and Sewerage Coverage

(3) Reduction of Disparity and Poverty

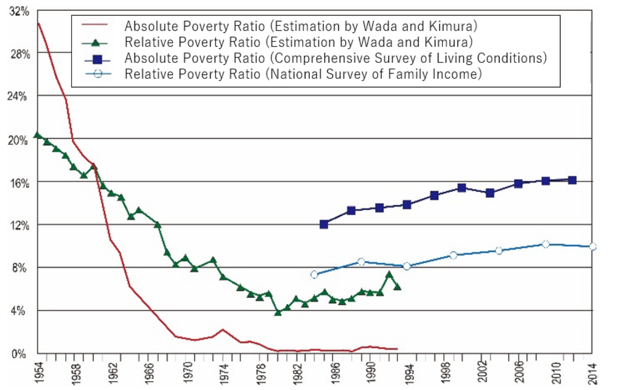
During the high economic growth, the social structure of Japan changed dramatically as the population moved from rural areas to cities. Along with industrialization and urbanization, the water demand in urban areas increased. Developing water resources can reduce income disparities and poverty. This supports an increase in productivity and a decrease in unemployment in urban areas. Although the number of rural farmers significantly decreased from the 1960s, the paddy field area and unit yield per land area increased, and worker productivity improved (Figure 5.9). The Gini coefficient has decreased since 1960, and there was clear income equalization from the 1950s to the 1970s (Figure 5.11). The poverty ratio exhibited a downward trend between 1954 and 1980. According to the MHLW, after the "bubble economy" ended in 1991, the Gini coefficient based on "original income" continued a gradual increase to reach 0.57 in 2014. However, owing to the policy measures for "income redistribution" through taxes and social securities, the Gini coefficient after the income redistribution remained almost constant at about 0.36-0.37, with no further change in income disparity[7].

[7] https://www.mhlw.go.jp/stf/wp/hakusyo/kousei/19/backdata/01-01-08-09.html



Sources: "Population Census", Ministry of Internal Affairs and Communications, "Income Redistribution Survey", Ministry of Health, Labor and Welfare and data in "Income disparity in Japan – Factors for Increasing Disparity," Yugami Kazufumi, JIL Labor Policy Report Vol. 3, 2003.

Figure 5.11 Ratio of Urban Population to Total Population and Gini Coefficient

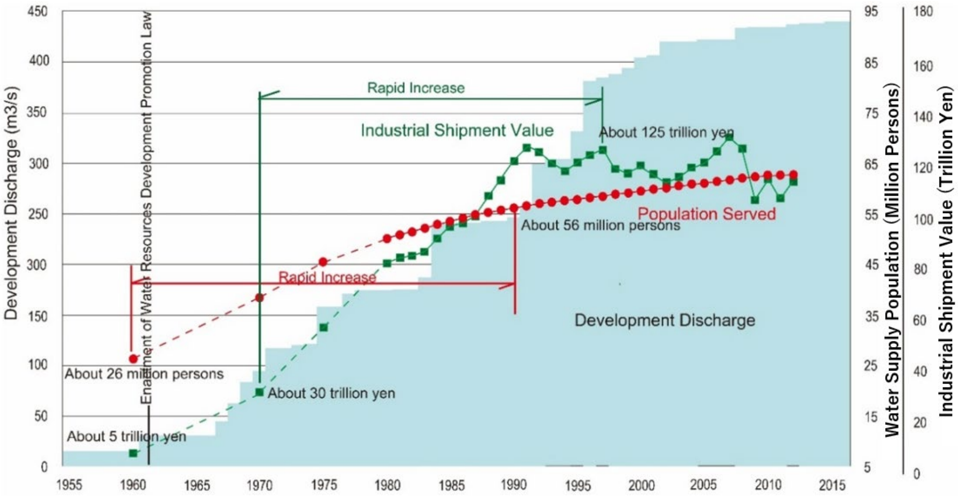


Note: Wada-Kimura's estimation set the poverty line at the average consumption per member of the welfare-recipient households in 1960 (about 40% of that of general households). The "Comprehensive Survey of Living Conditions" and "National Survey of Family Income and Expenditure" set the poverty line at 50% of the median of equivalized disposable income.
Source: Did Japan become an Unequal Society?: Japan's Income Disparity in Comparative Historical Perspective," Moriguchi Chiaki, Economic Studies Vol. 68, No. 2, Apr. 2017.

Figure 5.12 Lowering of Poverty Ratio in Japan

5.2 Development Effects in the River Systems under the Full Plan

In river systems under the Full Plan, water resource development contributes greatly to economic growth. The Full Plan also supported the growth of population and industrial shipments. Household water use increased, as did per capita water use. Figure 5.13 shows the trends in the industrial shipments, population with water supply, and industrial shipment value in the river system under the Full Plan. The industrial shipment value increased rapidly from JPY 5 trillion in 1958 to JPY 125 trillion in 1997. The population served with the water supply also increased rapidly from 26 million in 1958 to 56 million in 1990.



Source: "Explanatory material for the Concept for the Formulation of the Next Basic Plan for Water Resources," MLIT

Figure 5.13 Level of Water Development, Industrial Shipment Value and Population Served with Water in the River Systems under the Full Plan

CHAPTER 6 LESSONS LEARNED

(1) **Consistent planning could guide disaster risk reduction and water resource management, leading to quality growth.** Water resources management is essential in achieving resilient, sustainable, and inclusive quality growth. Poor management of water resources causes improper utilization and may exacerbate the risk of floods, droughts, and deterioration of water quality. This may affect the nation's growth. Japan could manage water resources effectively based on national land development plans, national water management plans, and long-term flood protection plans. the government should include water resources management in national development plans in coordination with other sectors. Also the governments should position water resources management plans above the ministry-level plans as a "higher-level plan".

(2) **To address issues in the water sector, water resource management plans should be prepared based on scientific data, clarifying the goals, effects, and inputs.** To support the implementation of the water policy, the plans should be prepared based on sound evidence. If the plan looks a single list of projects, implementing agencies face difficulties in securing resources and budgets.

(3) **To obtain commitment to the budget required to implement the water policy and planned projects, a long-term plan may be prepared to support implementation.** Since water resource projects are by nature long-term projects, a multiyear commitment is required to steadily promote projects rather than allocating budgets year by year. The Japanese government has formulated long-term plans for flood protection and water resource management. A special account for these projects was then established, independent of the general account.

(4) **A review system should be created and maintained to continually review the relevance of projects.** Socioeconomic changes and technological progress may affect water demand and the relevance of planned projects. At the end of Japan's high economic growth period, the reuse of industrial water and water-saving efforts led to a large gap between predicted and actual demand. A long-term sector plan, like the flood protection plan in Japan, tends to cause rigid allocation of financial resources, which makes it difficult for the project to adapt timeously to economic trends and fiscal conditions.

(5) **To cope with an increase in flood risks due to climate change, a "River Basin Disaster Resilience and Sustainability by all" approach should be considered.** Conventional structural measures such as levees and dams alone cannot cope with the increasing severity of flood damage under climate change. Relevant organizations in the river basin should cooperate in reducing flood risks and be engaged in multi-layered measures, such as land use plans, relocation from risk areas, urban facilities, and storing flood water in paddy fields and irrigation ponds.

THEME 2-2
RIVER BASIN PLANNING:
OPTIMIZING MANAGEMENT USING RIVER BASIN AS A PLANNING UNIT

ABSTRACT

To maximize the effectiveness of water resources management in river basins, plans should be formulated based on the characteristics and practices of each river basin. In these plans, consistency across sectors and regions of the river basin is indispensable. In Japan, the river basin is a planning unit for integrated water resource management. River management offices of governments dedicated to river management should explore optimizing the management of floods and droughts and the conservation of the environment from the river basin perspective. The safety levels for floods and droughts are selected based on the importance of river basins, the feasibility of managing measures, and the development of disaster management measures. River management offices need to efficiently manage flood protection structures distributed throughout the entire river basin. The plan should ensure all water users in a river basin to intake water from the river. The plan should also aim to conserve habitats, ecosystems, scenery, water quality, and recreation. River basin plans are formulated at two stages of the master plans, covering the basic policy and action plans for managing structures and measures. In this context, field offices need to be established to respond to local needs, building trust with concerned organizations, such as local governments, local communities, universities, and other organizations. Japan recently started initiatives to recover water cycles that have deteriorated due to socio-economic changes resulting from urbanization and growth. Within this system, multiple organizations need to jointly formulate and implement river basin plans to recover the water cycle including groundwater.

CHAPTER 1 INTRODUCTION

> The proper planning of river basins is necessary to secure a sufficient water supply and protect the environment, as well as for disaster management. Using river basins as a planning unit for water management, facility development and water management can be optimized. A healthy water cycle can be realized by ensuring consistency among sectors and regions and reflecting residents' opinions throughout the basin.

The water retention function of river basins is at risk of declining, and surface soil erosion may increase as a result of urbanization, deforestation, and agricultural development. This can lead to exacerbating flood damage, unregulated water intake, causing ecosystem and water quality to decline, as well as reduce water flow, precluding any intake of water.

Water resources need to be managed from the river basin perspective. Using river basins as a planning unit, the facilities of water resources management can be distributed effectively to manage disaster risks and conserve the environment throughout the river basin. Also, non-structural measures can be deployed.

National and local governments as the river administrators are tasked with the management of river basins in Japan. River Management Offices (RMOs) as the river administrators are located on the ground for each river basin and responsible for formulating plans for water resources management. This theme explains the methods used for the management of water resources based on river basin planning in Japan.

Water resources management is closely related to the Sustainable Development Goals (SDGs), and the relationships between human resources, technology development and the SDGs are shown in the following box.

Relationships between River Basin Management and the SDGs:

(1) Reduce damage through basin-wide measures, including "river basin disaster resilience and sustainability by all: SDG1, "No Poverty", SDG11, "Sustainable Cities and Communities", and SDG13, "Climate Action"

(2) Ensure availability and sustainable management of water and sanitation for all: SDG6, "Clean Water and Sanitation"

(3) Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.: SDG15, "Life on Land"

CHAPTER 2 PLANNING FOR THE IMPROVEMENT AND MANAGEMENT OF RIVERS

2.1 Management of Meteorological and Hydrological Observation

Water resources management is possible on the basis of hydrological and meteorological data.

Information on the natural characteristics of river basins (e.g. hydrology, meteorology, and hydrogeology) is fundamental for the development of water resources management plans. Additionally, data on water use trends, land use, and socio-economics, among others factors, are also need to understand the status of river basins and conduct scientific analyses. If the collection of sufficient observational data is not possible, estimates must be made based on traces of past floods and anecdotal evidence. In recent years, satellite observation data have also become available for use in this field.

In Japan, a number of organizations conduct hydrological and meteorological observations, whose findings are mutually shared and used. The Japan Meteorological Agency observes all aspects of the weather, with approximately 1,300 rain gauge stations nationwide. The Ministry of Land, Infrastructure, Transportation, and Tourism (MLIT) conducts observations related to hydrology, including data related to dam management, oceanography, and meteorology for river management and land conservation. The Ministry of Agriculture, Forestry, and Fisheries (MAFF), local governments, and the private sector also conduct observations for their own purposes.

The hydrological observation services provided by the MLIT include establishing gauge stations, observing and processing data, storing data, reporting, publishing, verifying observation results, and maintaining and managing gauge stations. Among these, observational items include precipitation, radar rainfall, river water level, flow rate, water quality, sediment quality, and groundwater level and quality.

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- Self-recording rainfall meters: (1) one gauge station for each area showing similar precipitation characteristics, (2) one gauge station approximately every 50 km^2, and (3) location of river structures in which the observation data is used for the operation, 4) consider to use observation data obtained by other organizations.
- Water gauge stations: (1) before and after the confluence or separation points of important tributaries or distributaries, upstream and downstream from weirs and floodgates, (2) points of discharge measurement sites, and (3) the hydraulic conditions therein, including narrow passes, retarding basins, lakes and marshes, reservoirs, inland water, and river mouths.

[1] "Rules for Hydrological Observation Services" and "Detailed Rules for Hydrological Observation Services" "Guidelines for Quality Verification of Hydrological Observation Data

The resulting observed hydrological data have been accumulated within the corresponding databases: (1) a database limited to the MLIT's intranet and (2) the "hydrology and water quality database", which is available to the public on the MILT's official website. In the latter, the data to be disclosed are classified into rainfall, water level, discharge, water quality, bottom sediment, groundwater level and quality, snow depth, management quantities of dams and weirs, and sea conditions. The number of gauge stations registered in the database exceeds 6,000 nationwide.

2.2 Basic Policy for River Improvement Plans

In Japan, the "Basic Policy for River Improvement" is formulated as the master plan of water management in river basins. Based on this policy, a "River Improvement Plan" that specifies the goals for the immediate future (20-30 years), with detailed river improvement works and maintenance, has been formulated as an action plan.

The "Basic Policy for River Improvement" and "River Improvement Plan" were formalized in accordance with the 1997 revision to the River Law. Table 2.1 shows the outlines of the policy and the corresponding plan. The history of the revision of the law is described in "Theme 1-1: Legislation System and Organization".

The "Basic Policy for River Improvement" is formulated taking into consideration the occurrence of floods, the status of water resources use, the status of water resources development, and the status of river environment. The term "river improvement" is used in the sense of ensuring the comprehensive management of rivers in the river basin, including water use and environment, rather than being limited to river improvement for protection against flooding. Since the plans needs to be evaluated scientifically and objectively on a national level, the River Council under the Panel on Infrastructure Development collects the opinions of academic experts with specialized knowledge.

The "River Improvement Plan" clarifies the river improvement goals for the next 20 to 30 years and the specific details of river improvement works, including individual projects. This plan is reviewed over time, as necessary. The improvement projects specified in the river improvement plan are typically implemented in stages. Since the project is directly related to the safety of local residents and their environment, opinions are collected from residents, local governments and academic experts. Basin governance is being established for public consensus building through the participation of various stakeholders (Theme 1-3: Public Participation and Decision-Making Process).

Table 2.1 Outlines of the Basic Policy for River Improvement and the River Improvement Plan

Item	Basic policy for river improvement	River improvement plan
Formulation	River Administrators under the River Law: Minister of the MLIT for Class A Rivers and Prefectural Governors for Class B Rivers.	River Administrators under the River Law: Minister of the MLIT for Class A Rivers and Prefectural Governors for Class B River.
Procedure	· Consultation of the Social Infrastructure Development Council (Prefectural River Councils for Class B River Systems) · To be published after formulation.	· Consultation of the relevant local governments. · Consultation of academic experts and local residents. · To be published after formulation.
Contents	· Description of the Basic Policy of River Improvement from a long-term perspective. · Description of the concept of river improvement without specifying the details (e.g. individual projects).	· Clarification of the goal of river improvement over a 20~30-year period. · Identification of details of river improvement, including individual projects.

Note: Small rivers managed by municipalities (locally designated rivers and ordinary rivers) are excluded from the table.
Source: MLIT, Technical Criteria for River Works, Practical Guide for Planning (March 2008)

2.3 Flood Protection

Japan has implemented river improvement works in order to protect the assets in the floodplain in accordance with the socio-economic significance of individual rivers. The target levels of protection are indicated in terms of hydrological probabilities. Economic evaluations are conducted to evaluate the validity of given projects.

Japan has implemented floor protection by integrating hardware and software measures and is enhancing its integrated approach (Theme 2-1: Management Planning, Chapter 4). This section explains the planning methods of the structural measures.

(1) Safety Level of Flood Protection

Historically, Japan developed water resources and flood protection measures to ensure the quality and quantity of rice production (Theme 1-1: Legislation and Organization, Chapter 2). Currently, 51% of the population and 75% of the assets are concentrated in the floodplains, which cover only 10% of the Japan's area.

In modern river improvement projects of the Meiji period (1868-1912), the maximum design scale of flood protection was configured based on the maximum flood experienced to date. After World War II, however, river improvement projects adopted the concept of expressing the design scale in terms of annual exceedance probability. This concept makes it possible to promote efficient and rational flood protection measures. At the same time, an economic survey on flood protection was conducted to evaluate the economic validity of individual projects. The design scale is determined by comprehensively considering the importance of a given river, the economic benefits of its management, and damage caused by previous floods. Currently, the design scale is set according to the categories listed in Table 2.2.

Table 2.2 Importance of Rivers and Safety Level of Flood Protection Plan

Importance Level of River	Design Scale (Annual Exceedance Probability of Target Rainfall)	Management Category	Land Use
Class A	Over 200 years	Major sections of important rivers administrated by the national government	River sections in which large cities are found in the floodplain, sections where nature restoration projects are implemented, sections of dams under the jurisdiction of the national government, and sections that stretch over multiple prefectures.
Class B	100 to 200 years	As above	As above
Class C	50 to 100 years	Among the river sections administrated by the national government, sections entrusted to prefectures. River sections administrated by prefectures	Urban section
Class D	10 to 50 years	As above	Other sections
Class E	Less than 10 years	As above	Other sections

Note: Small rivers managed by municipalities (locally designated rivers and ordinary rivers) are excluded from the table.
Source: MLIT, Technical Criteria for River Works, Practical Guide for Planning (March 2008)

For comparison, the safety flood protection levels in other countries are shown below:

- Netherlands: Once every 10,000 years (for storm surge measures) and once every 1,250 years (for the major Delta work rivers)[2]
- United Kingdom (UK) (Thames River): Once every 1,000 years (for storm surge measures) and once every 200 years (for flood measures)[2]
- United States (USA) (Mississippi River): Once every 500 years[2]
- France (the Seine River): Once every 100 years[2]

The safety protection level in the Netherlands considers both economics and probability theory, as well as land use and topography, in the protected areas. In the UK, project assessment determines the safety flood protection levels by taking into account the economy and its impact on the environment.

(2) Basic Flood Protection Plan

The Basic Policy for River Improvement and River Improvement Plan contains a designated flood protection plan. This plan defines the flood discharge to be distributed to each flood-protection facility in the system. In other words, the plan defines the amount of flood discharge retained by each flood storage facility and the amount of flow in each river channel. Based on these measures, the flood retaining and protection facilities can be planned, designed, and constructed (Figure 2.1). Flood protection plans should be designed in the following order (Figure 2.2):

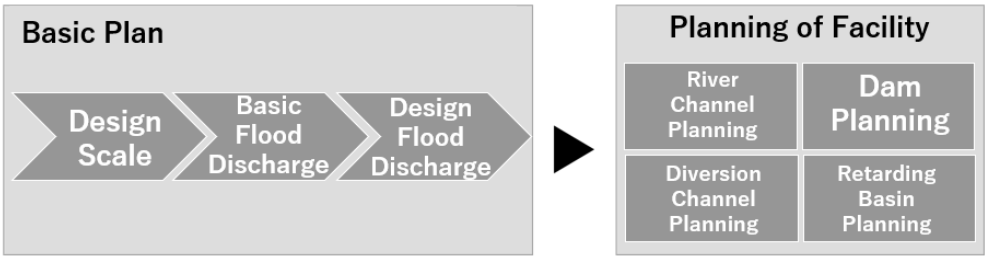
Flood protection plans should be designed in the following order: (a) design scale, (b) basic flood discharge, and (c) design flood discharge (Figure 2.2):

[2] River Subcommittee meeting handouts (January 31, 2007, River Bureau, MLIT)

1) Design scale: The design scale of flood protection plans is determined comprehensively as described in (1) safety level of flood protection.

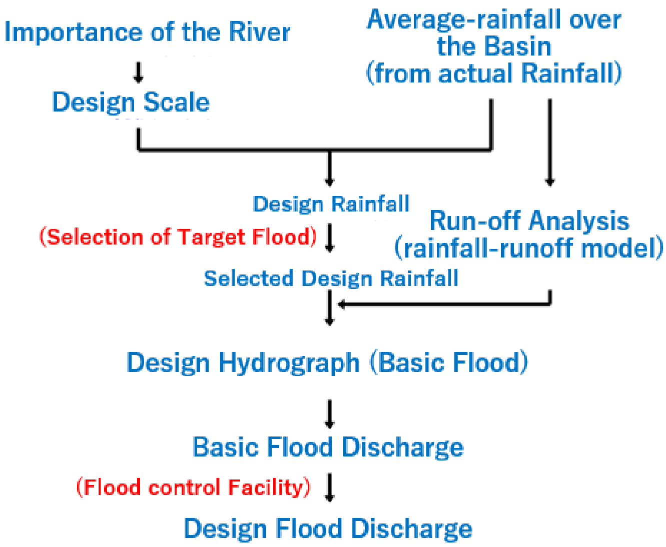
2) Basic flood discharge: Rainfall duration, rainfall pattern, and regional distribution are studied at each reference point. The rainfall patterns for multiple actual rainfall events are converted into the design scale; this is known as a hyetograph[3]. The resulting design hyetographs are input into a rainfall-runoff model to obtain the flood hydrograph[4]. From the group of planned hydrographs, a hydrograph showing the maximum flow rate can be obtained, and the peak flow rate is chosen as the basic flood discharge.

3) Facility planning and design flood discharge: Flood discharge is distributed across river channels, dams, and other flood protection facilities as the design flood discharge. The facilities that are taken into consideration include the existing river channel (levee construction, excavation, and widening), floodways, dams, and retarding basins. An example of the design flood discharge distribution is shown in Figure 2.3.



Source: Project Research Team

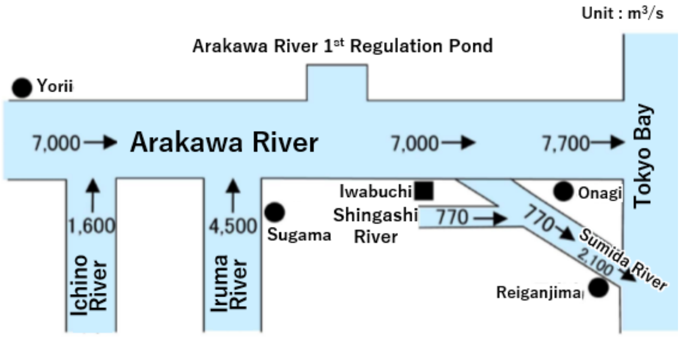
Figure 2.1 From Flood Protection Plan to Facility Planning



Source: Materials of the 6th Kinokawa River Basin Committee

Figure 2.2 Design Flood and Basic Flood Discharge

[3] Hyetograph: Graph with rainfall on the vertical axis and time on the horizontal axis.
[4] Hydrograph: Graph with discharge on the vertical axis and time on the horizontal axis



Source: Website of Arakawa Upstream Basin Office, MLIT

Figure 2.3 Example of Design Flood Discharge Distribution

(3) River Channel Planning

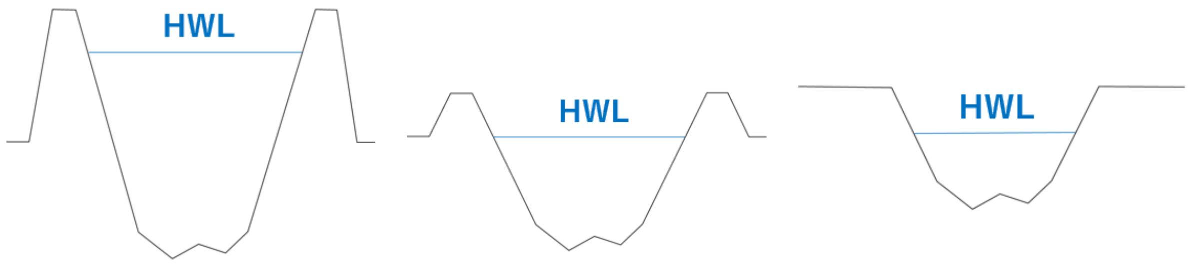
River channels are designed to discharge floodwater below the design flood discharge safely. A river channel refers to the land for river flow, usually enclosed by a levee, riverbank, or riverbed. As the alignment of the river channel usually changes with sediment transportation, it is important to fully consider whether the planned functions can last over an extended period of time, as well as whether the required maintenance is possible. In the following, some perspectives to be considered in river channel planning are listed:

- Ensuring quantitative safety (e.g. flow capacity)
- Ensuring qualitative safety (e.g. the safety of river management facilities in relation to sediment transport, such as erosion, and safety in relation to seepage lines in levees)
- Minimizing the total cost (including maintenance)
- The development and conservation of the river environment (e.g. conservation and restoration of the environment and harmonization with river use)
- Land use in areas along river levees
- The history and culture of the river and region

1) High Water Level (HWL)

HWL is the water level for the design of flood discharge. It is used to ensure that the height of the river water above ground level along the river is minimized. If the HWL is set much higher than the ground level, a flood with a magnitude exceeding the design scale may incur significant flood damage (Figure 2.4, Case I). If the estimated water surface gradient is sufficient, even after considering the conditions of the downstream channel, the HWL should be set at the ground level (Figure 2.4, Case II). If the HWL is set much lower than the ground level in the upstream reach, a significant portion of the floodwater may enter the river channel without flooding, threatening the safety of the downstream levee sections (Figure 2.4, Case III). To prevent and control erosion, the scouring and sedimentation of the channel must be evaluated. The structural layout should also be studied to determine the long-term stability of the river. This includes ground sills[5] and groin works[6].

[5] Ground Sill Works: A structure built across a river to prevent scouring of the riverbed and stabilize the river gradient.
[6] Groin Works: Structures installed at appropriate locations to mitigate water flow into levees or embankments.



(Case I) HWL is higher than ground level

(Case II) Ordinal HWL

(Case III) HWL is lower than ground level

Source: Project Research Team based on Technical Criteria for River Works

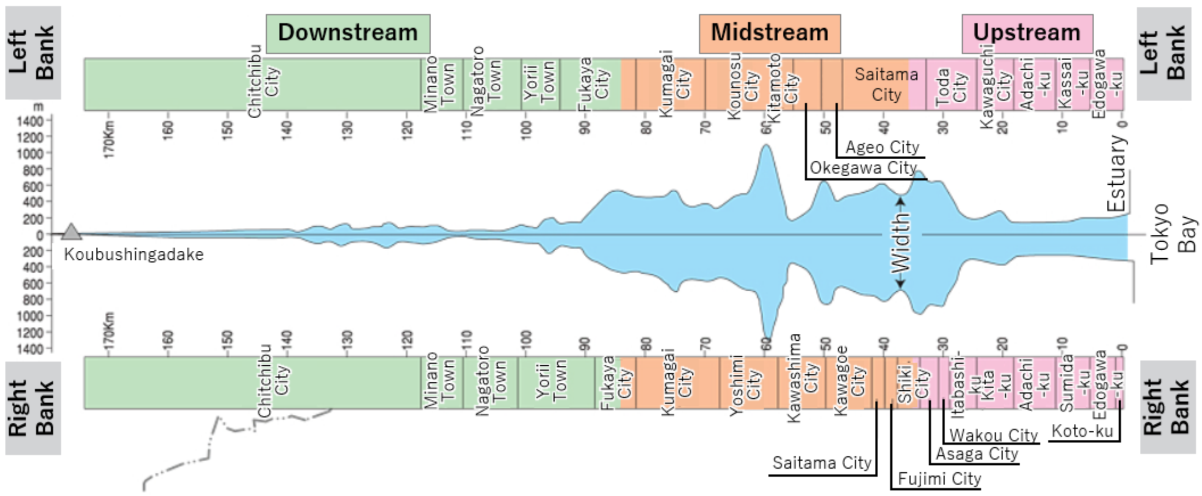
Figure 2.4 Flood Protection Plan to Facility Planning

(4) Flood Protection of Arakawa River

The Arakawa river is used as an example for the development of a flood protection plan. Originating in Saitama Prefecture and flowing into Tokyo Bay, it is an important river in the Tokyo Metropolitan Area, with a catchment area of 2,940 km^2. There is a population of 9.3 million within the river basin, and the estimated floodplain assets are worth approximately 78 trillion Japanese yen. Here, the targeted flood protection safety level was set at 1/200. The design flood discharge distribution is shown in Figure 2.3.

1) Width of Arakawa River

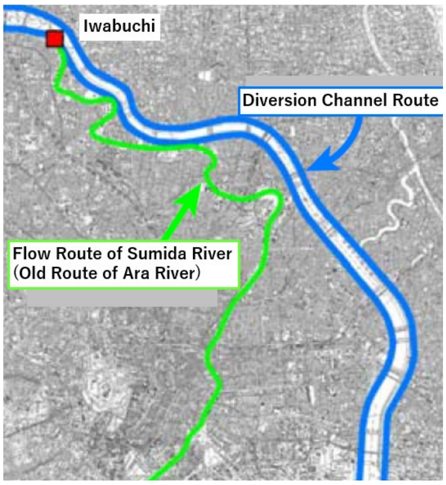
Normally, the river width is narrow in its upstream reach and wide in its downstream reach. However, for historical reasons, the Arakawa River is narrower in the downstream reach. The river area of the midstream is around 2.5 km wide, the widest river channel in Japan, while the downstream part of the river is about 0.5 km wide (Figure 2.5). The midstream area of the river was widened to provide a flood delaying function to protect the population and assets downstream from damage due to flooding. The downstream river channel was created by excavation work to discharge floodwaters into the sea swiftly.



Source: MLIT Website

Figure 2.5 River Width along the Arakawa River

In 1910, the river flooded, causing extensive damage to 270,000 houses and affecting 1.5 million individuals. This catastrophe led to the formulation of the Arakawa River Downstream Improvement Plan in 1911 and the construction of a 22-km diversion channel from Iwabuchi to the river mouth, which was completed in 1930. Figure 2.6 shows the current river channel in the downstream section. The construction of the diversion channel required the relocation of 1,300 houses and acquisition of approximately 11 km^2 of land, which included the relocation of railways, temples, and shrines.



Source: MLIT Website

Figure 2.6 Diversion Channel Route of Arakawa River

For the area upstream of Iwabuchi, the Arakawa River Upstream Improvement Plan was formulated in 1918 after flooding in 1910, 1913, and 1914. The plan included the construction of levees, the excavation of low-water channels, the widening of the river area, and a lateral levee. These projects were completed in 1954. The lateral levees, which are arranged perpendicular to the river flow direction (Figure 2.7), control and retard the flood flow, reduce the flow velocity, and protect the high water channel and cultivated land along the river. A total of 27 levees were constructed, 25 of which remained and functioned as flood protection.

Source: MLIT Website

Figure 2.7 Flood Flow near Lateral Levees (2007)

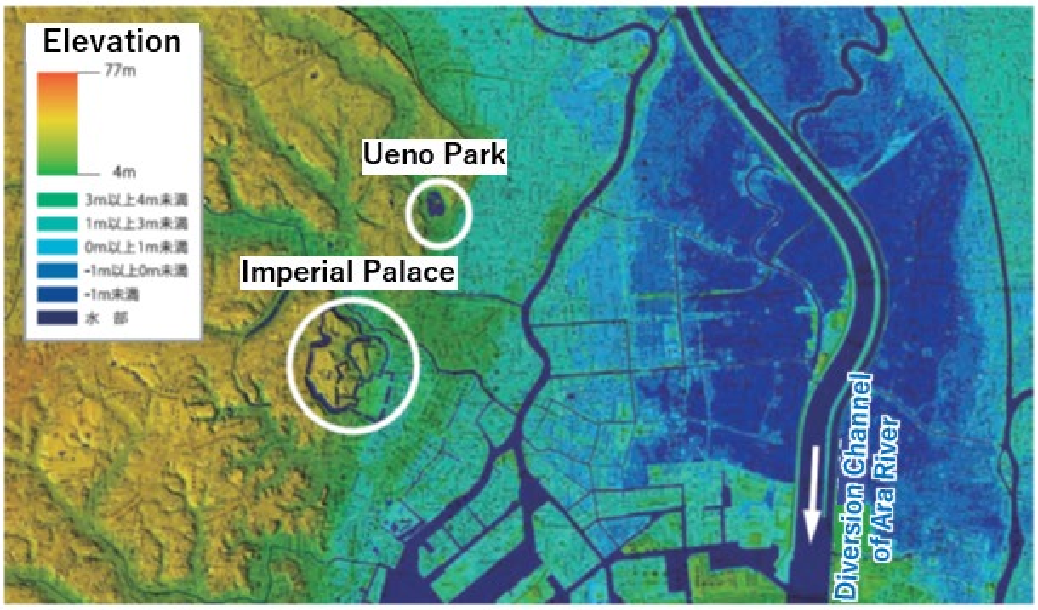
2) Development and Ground Subsidence in the Downstream Area of the Arakawa River

The construction of the Arakawa diversion channel took 20 years to complete and markedly increased the safety level along the river. As a result, the area around the diversion channel, which was rural, became more populated and urbanized. In the area downstream, ground subsidence[7] occurred due to the excessive extraction of groundwater, which became significant in the 1950s. Land subsidence

[7] The detailed explanation of ground subsidence due to excessive extraction of groundwater is shown in "Theme 7 Groundwater Management".

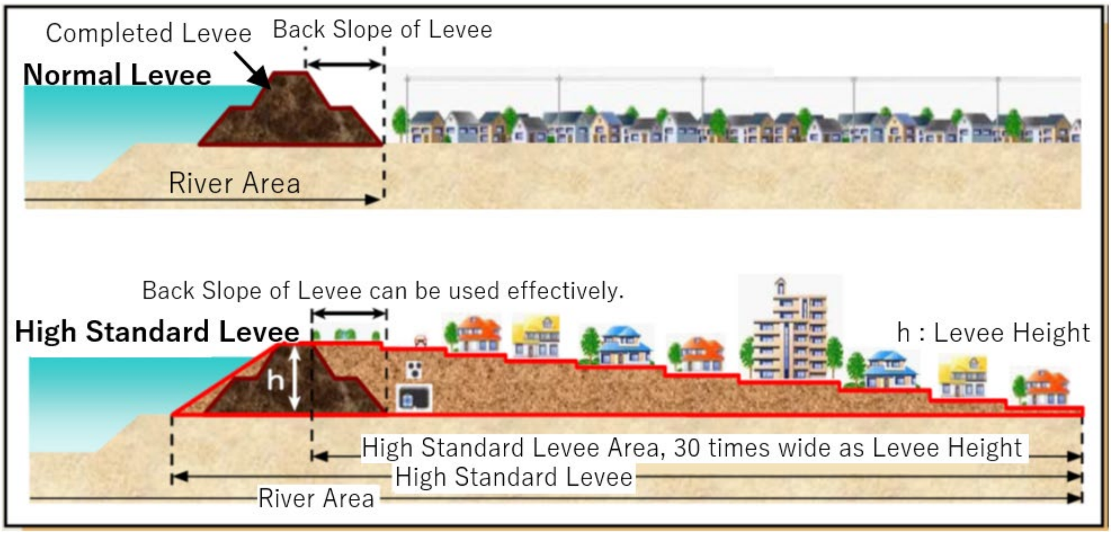
increased below the high-tide level, in the so-called zero-meter zone (Figure 2.8). The ground level along the diversion channel was lowered by a maximum of 4 m in the 1920s. The levees also subsided, and the embankment heightened.

Because the levee is tall in the downstream reach of the River, there is a risk of severe levee failure when a flood or tidal surge occurs, which could result in considerable damage and fatalities. The development of high standard levees is underway, which provide a wider levee top width than normal levees. The high-standard levee prevents breaching from abnormal floods that exceed the planned safety level and avoids catastrophic damage in the inundation area (Figure 2.9) (Theme 5: Urban Water Management).



Source: MLIT Website

Figure 2.8 Ground Level around the Arakawa Diversion Channel



Source: MLIT Website

Figure 2.9 Concept of High Standard Levee

(5) "Ceiling River" in Japan

The riverbed level of the "ceiling river" is higher than the surrounding ground level owing to sediment accumulation in the river. Sedimentation accumulated on the riverbed increases the water level and the risk of flooding. The repeated raising of the levee to prevent flooding eventually results in riverbed elevation above the surrounding ground level. The old Kusatsu River in Shiga Prefecture is a typical ceiling river in the country. Because the old Kusatsu River has an elevation of the riverbed that is higher than the surrounding land, the railway and roads run beneath the old Kusatsu River (Figure 2.10). Due to the severe flood damage that occurred around the river, the Kusatsu River diversion channel was constructed. The old Kusatsu River was subsequently abandoned.

Ceiling river on topographical map (edited map of geographical survey institute)

View of point 1 from the ground

View of point 2 from the levee
Railroad runs underneath it.

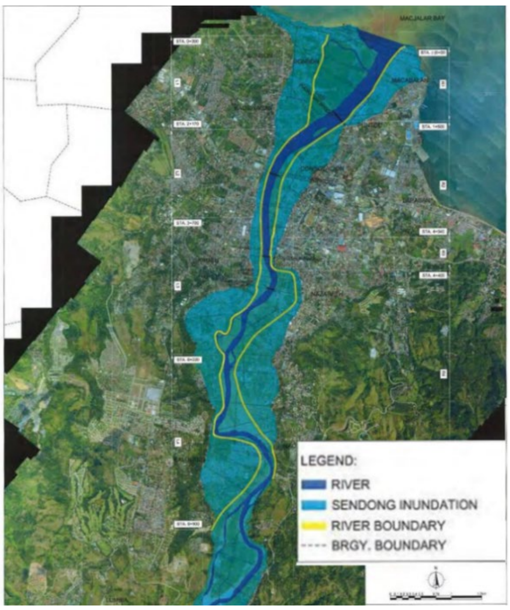
Source: Geographical Survey Institute

Figure 2.10 Example of Ceiling River

(6) Application of the Japanese Flood Protection Technology in Foreign Countries

Since Japan is a mountainous country, limited plains are the base of economic activities as well as flood-prone areas. Flood protection structures, such as levees and dams, have been built to protect human lives and assets. The experiences in Japan could be useful to other nations with similar natural conditions.

In the case of the Cagayan de Oro River of the Philippines, the Japan International Cooperation Agency (JICA) proposed constructing a levee in the floodplain off the current river channel to establish river area (Figure 2.11). The aim was to discharge the floodwater in the river area and to facilitate urbanized land use in the original floodplain protected by the levee. Simultaneously, the construction of structures in the river channel must be restricted to smooth discharge of floodwater through the channel.



Source: JICA

Figure 2.11 Floodplain and Riverine Areas (Cagayan de Oro River in the Philippines)

For example, in the Meghna River in Bangladesh, there is a low wetland area 3–5 m above sea level called the haor. During the rainy season, the entire wetland area of approximately 8,600 km^2 is submerged. The people in the haor area depend on a single-season rice crop as their main source of income. However, the crop is frequently submerged by the pre-monsoon flood, so-called flash floods, during the harvest season, making their livelihoods unstable. Many ring dikes have been constructed in the area to protect rice from flash floods during the harvest season. Despite this, ring dikes are sometimes damaged by flood overtopping. JICA proposed providing submergible levees to repair existing levees (Figure 2.12). Simultaneously, JICA proposed plans to enhance the livelihood of the local people, focusing on agriculture and fisheries, to enforce their abilities to prevent disasters by maintaining the repaired levee. The modern Japanese strategy involves elevating the levees and protecting inland areas from flooding. If this method were applied directly to the haor area, the construction cost would outweigh any of the economic benefits gained from the rice harvest, rendering the flood protection system economically unviable.

Source: JICA

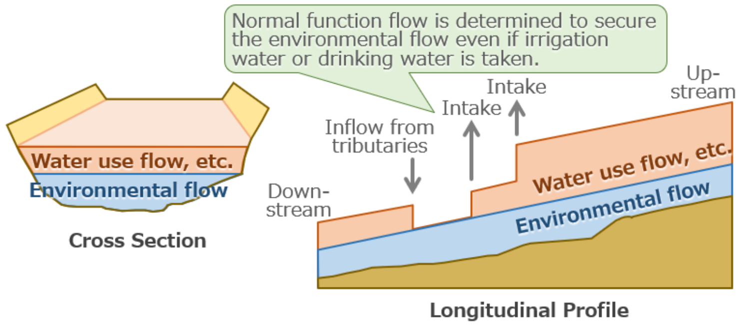
Figure 2.12 A Submerged Levee Protects Rice from Flooding (Haor District, Bangladesh)

2.4 Water use and Drought Management

> The priority of water use has historically been given to irrigation. Today, river management offices are managing water use in rivers by setting the safety level for droughts and management standard volumes to protect the water use of the existing water right holders and to ensure new users to retain access to water.

(1) Normal Function Flow

The normal function flow in Japan is set as a management target for low water management as the river discharge satisfies both the water use flow and the environmental flow at the reference point. Because the requirements of both flows vary depending on the river section and season, the normal function flow is determined by organizing these flows longitudinally for each season (Figure 2.13). Environmental flow is determined by comprehensively considering the following factors: navigation, fishery, tourism, maintenance of clean water flow, prevention of salt damage, prevention of river mouth blockages, protection of river management facilities, maintenance of groundwater levels, landscape, habitats of animals and plants, and securing rich interactions between people and rivers (Theme 1-2: Water Rights, Chapter 3).



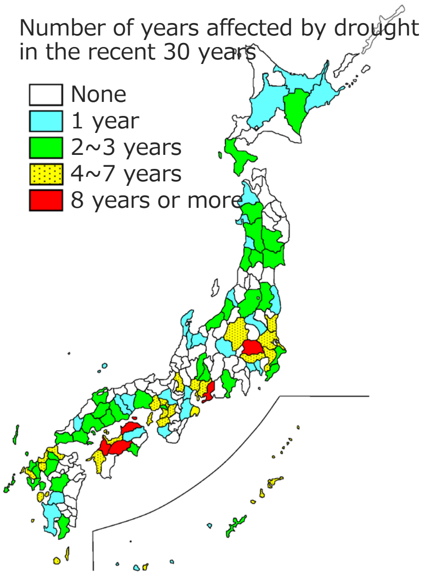
Source: Preparation of Project Research Team based on Hyogo Prefecture website

Figure 2.13 Image of Setting Normal Function Flow

(2) Safety Level

The safety level for drought management underpins the water resources management plan. In Japan, the water resources management plan is formulated to secure the intended river water use even in a drought year, which is considered to occur once almost ten years based on the river management experience. The year of the drought which has approximate ten years probability is called as the "benchmark year for low water management". For reference, the safety levels of water use in other countries are as follows:

- USA (California, San Francisco, New York): The most severe droughts in history.
- Australia (Southeast Queensland): A probability of once every 100 years.
- UK (London): A probability of once every 50 years.



Source: Japan Water Resources, 2014

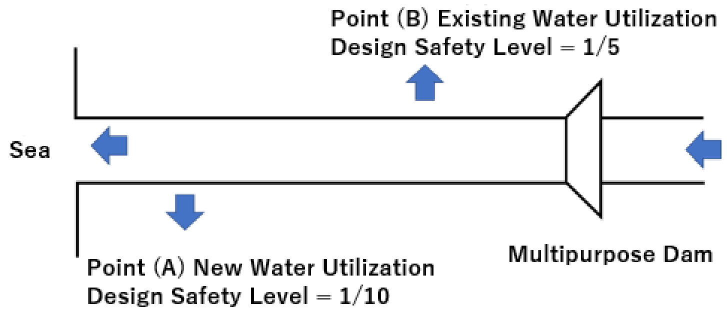
Figure 2.14 Impacts of Droughts in the Last 30 Years

During the actual drought operation, it is difficult to predict the drought level in advance; if the stored water in the facility decreases below the designated level, preventive measures, such as water intake restrictions, are launched. As can be seen in Figure 2.14, the water intake restrictions are actually instructed more frequently than the designated safety level once every ten years.

(3) Coverage of Costs by the Government for Supplying Water to Existing Irrigation Users

The capacity to store water to maintain the normal functioning of the river is a unique concept in Japan. River management offices (RMOs) bear the construction costs of supplying water to those who hold the existing rights of water use.

Figure 2.15 presents an example in which the national government covers the construction costs of providing irrigation water. As shown in the figure, a multipurpose dam should be constructed at a designed safety level of 1/10 to supply water to new water users at point A and to existing water rights holders for irrigation at point B with a safety level of approximately 1/5. If a drought equivalent to the probability of once every ten years occurs after the multipurpose dam is completed, as the existing irrigation users at point B take water released from the dam, new water users at point A may not be able to obtain water. To avoid this, when constructing multipurpose dams, the national government covers construction costs for securing existing irrigation users without disturbing water intake by new water users at a safety level of 1/10.



Source: Project Research Team

Figure 2.15 Diagram of the Water Use Point

2.5 Conservation of the Water Environment

Basic policies need to cover the principles of managing the environmental issues of ecosystems, scenery, water quality, and recreation. In this context, “nature-friendly river works” are considered the pillar for all river development (Theme 4: Water Pollution and Environmental Management and Theme 5: Urban Water Management). Figure 2.16 presents an example of these nature-friendly river works.

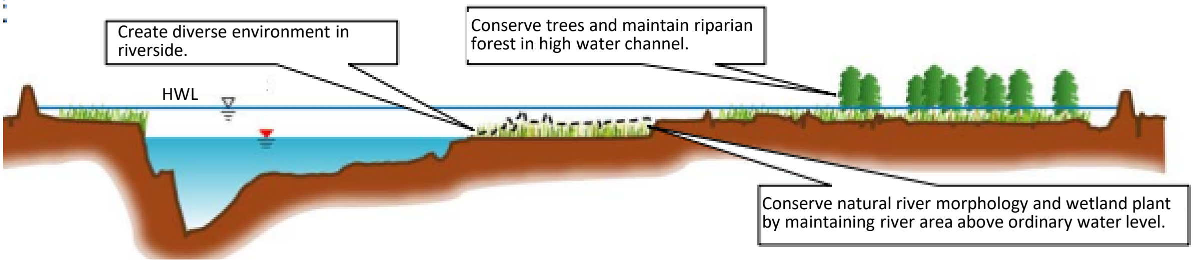
Source: MLIT Website

Figure 2.16 Nature-friendly River Works in the Iga River

For example, the following principles are formulated in the Ishikari River in Hokkaido:

- Protecting the physical forms of river shallows and pools, which are important habitats for fisheries.
- Preserving riverside forestry and waterfronts that harmonize with flood protection plans.
- Protecting beautiful scenery important for indigenous culture.
- Preserving fish migration and spawning grounds for salmon and other species.
- Monitoring environmental information and using them in planning facilities and maintenance.

The preservation plan includes the following actions. The riverside, covered by vegetation, forms a valuable habitat for fish and other aquatic organisms. The trees along the river should be preserved as much as possible to create a diverse water environment (Figure 2.17).



Source: MLIT Website

Figure 2.17 Environmental Conservation in the Ishikari River

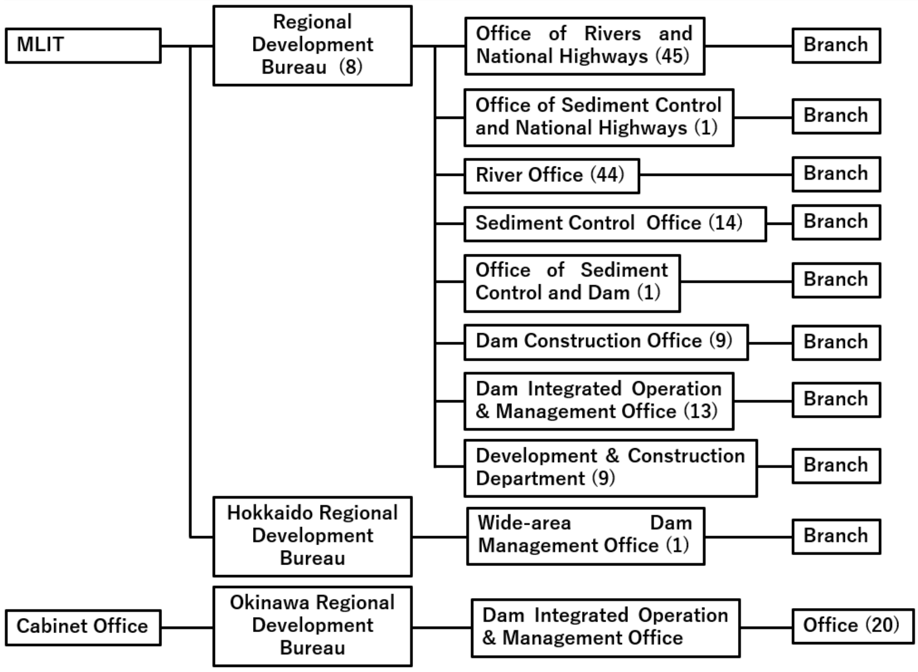
2.6 Institutional Arrangement

In water resources management, which seeks to manage nature, the issues and needs identified in the field must be reflected in day-to-day facility management. In Japan, local river management offices are established in each basin to fulfill this role.

Water resources management requires the participation of numerous wide-ranging stakeholders, including government, academia, local communities, civil society organizations, and the private sector. Each of them is involved in their respective positions for consultation and coordination at various levels. There is a need to build trust relationships in order to coordinate different opinions among the relevant parties. Water resources management relates to nature, which is constantly changing. The issues in this field must be addressed. Problems cannot be solved in conference rooms or indoors.

The MLIT has a river management office for each river basin and a branch office under the office (Figure 2.18). Approximately 140 offices are related to rivers, dams, and sediment control nationwide. The MLIT administrates socially important sections of Class A rivers, while prefectural governments administrate other river sections (Theme 6: River Management).

The river management offices are located close to municipalities, local communities, universities, and related institutions in the river basin and are responsible for identifying and responding to their needs. By exerting a variety of actions, such as formulating river improvement plans, drought coordination, flood protection, and community development, river offices build trusting relationships with related parties through day-to-day communication. Having an office in the field is also effective for developing national policies at the central level. The MLIT can identify the needs of river management offices. The system of "river counselors" was established to collect technical information using river surveys, planning, and management from researchers at universities and other institutions. Local governments mainly manage small- to medium-sized rivers and have regional offices.



Note: The numbers in ( ) indicate the number of offices related to rivers, dams, and landslides. There are approximately 600 offices in MLIT as a whole, including those for roads. However, these are not shown in the figure because of the lack of numbers categorizing them in detail.
Source: Project Research Team Based on Cabinet Secretariat Documents

Figure 2.18 National River-related Offices

CHAPTER 3 PLANS FOR WATER CYCLE RECOVERY

Japan started initiatives aimed at promoting a healthy water cycle by involving diverse stakeholders in accordance with the characteristics of each basin.

(1) Promotion of Basin Management

"River basin management" is promoted in cooperation with related agencies, implementing bodies, organizations, and local residents to ensure healthy water circulation systems through efforts to maintain water quantity and quality, as well as the condition of forests, rivers, farmlands, cities, lakes, and coastal areas. The River Basin Water Cycle Council was established to formulate a "River Basin Water Cycle Plan" defining basic policies (Theme 1-1: Legislation and Organization, Section 2.7). Similarly, governance is discussed in "Theme 1-3: Public Participation and Decision-Making Process".

To execute river basin management and its related activities, the Cabinet Secretariat released the "Guideline of River Basin Management" in 2018, which introduced the expertise of establishing river basin water cycle councils and formulating river basin water cycle plans. As a result, the innovations, insights, and expertise of ten case studies in 2018 and 13 in 2019 were widely shared in "Case Studies of River Basin Management". This guideline stresses the fact that finding incentives for activities, clarifying their benefits, and securing funding for activities are key to sustaining a healthy water cycle.

(2) River Basin Water Cycle Plan

The river basin water cycle plan should be formulated based on a range of insights and information, such as the quantity and quality of water and data on water use, groundwater, environment, culture, and water-related disasters, as well as considering the characteristics of the basin and other existing plans. The plan includes: (1) current and future issues, (2) principles and future goals, (3) goals for maintaining or restoring a healthy water cycle, (4) measures to achieve the goals, and (5) indicators to monitor the status of a healthy water cycle and the progress of the plan in stages according to local conditions.

By January 2020, 44 "Basin Water Circulation Plans" have been prepared by local governments nationwide and approved by the Cabinet Secretariat. The water environment (water quality/ecosystem) is typically a major element of the plan. Groundwater/spring and water use (rainwater use/water conservation) are also important issues. The area covered by the plan is not always a river basin, but is flexibly determined according to local conditions. By focusing on the water environment, the plan could cover the entire prefecture or city. For groundwater, this could involve local governments sharing the groundwater basin (Theme 7: Groundwater Management, Chapter 4). In terms of ocean water quality, this could involve the local governments surrounding the bay.

(3) Example of the River Basin Water Cycle Plan

As a case study, the "Healthy Water Cycle Plan of the Lake Inba Basin" in Chiba Prefecture is introduced in this section. Lake Inba is located in the northern part of Chiba Prefecture, to the east of Tokyo. Lake Inba is an aquatic habitat characterized by rich and pure water, supporting agricultural activity and providing rich fishing grounds. However, urbanization in the basin causes increase in the pollution load from domestic wastewater and obstacles to water use owing to the occurrence of blue-green algae and a decrease in aquatic plants. Malodor affects domestic water taken from the lake. Water quality in this location is the worst among all lakes in Japan. In 1985, the lake was subjected to the Act on Special Measures Concerning the Conservation of Lake Water Quality, and measures to protect water quality were implemented. As of 2016, approximately 780,000 people were living in a basin area of 494 km^2 (Figure 3.1). In recent years, the concentration of chemical oxygen demand (COD) has remained constant (Figure 3.2).

Source: Lake Inba Basin Healthy Water Cycle Conference

Figure 3.1 Location of Lake Inba

The following countermeasures are being implemented:

1) The protection of water quality by improving sewerage systems and agricultural drainage facilities, the promotion to install combined septic tanks, and the improvement of livestock waste treatment facilities.

2) Regulations for water quality protection include the application of tightened effluent standards, pollution load control, effluent control, and guidance for small businesses.

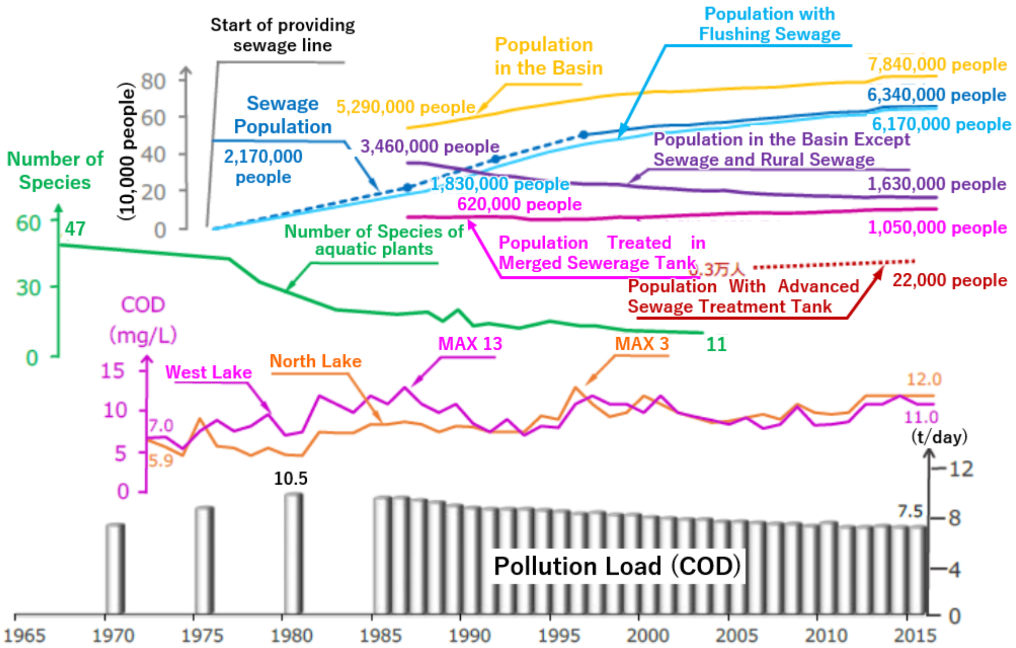
3) Purification of inflowing river water by nature-friendly river works, river cleaning, and channel dredging.

4) Purification of lakes using aquatic plants, maintenance of vegetation zones, and lake cleaning.

5) Installation of infiltration and storage facilities in urban areas, the improvement of permeable pavement, and the control of fertilizer runoff from farmland.

In 2001, Chiba Prefecture established the “Conference on Healthy Water Cycle in the Lake Inba Basin” and formulated the “Emergency Action Plan for Healthy Water Cycle in the Lake Inba Basin” in 2004. In 2016, based on the emergency action plan, a new “Plan for Healthy Water Cycle in the Lake Inba Basin” was formulated with a target of 2030. In addition to reducing the pollution load, it is also necessary to address new issues, such as the impact of secondary pollution (internal production) caused by the proliferation of phytoplankton and the massive overgrowth of water crops.

The plan has five goals with a number of measures as well as indicators for monitoring (Figure 3.3). These measures are being promoted by parties involved in the Lake Inba Basin (residents, schools, citizens’ groups, research institutes, users of the Lake Inba Basin, companies, municipalities in the basin, the prefectural government, the national government, and the Japan Water Agency. One of the features of these activities is that the model areas are selected based on the Emergency Action Plan, and the effects of the initiatives are clarified to create new initiatives through the PDCA cycle. In addition, the residents and the government exchange opinions, which are then reflected in the plans, working together as one. The status of implementing countermeasure activities toward the target and the evaluation indicators are displayed in a user-friendly webpage format.



Source: Healthy Water Cycle Conference of Lake Inba Basin, March 2017

Figure 3.2 Population Trends and Water Quality Indicators, COD, in Lake Inba

Source: Healthy Water Cycle Conference of Lake Inba Basin, March 2017

Figure 3.3 Basic Concepts and Goals of a Healthy Water Cycle Plan in the Lake Inba Basin

One of the features of these activities is that the model areas are selected based on the Emergency Action Plan, and the effects of the initiatives are clarified to create new initiatives through the PDCA cycle. In addition, the residents and the government exchange opinions, which are then reflected in the plans, working together as one. The status of implementing countermeasure activities toward the target and the achievement of the target against the evaluation indicators are displayed in a user-friendly webpage format (Table 3.1).

Source: Lake Inba Basin Healthy Water Cycle Conference Website

Figure 3.4 Activity of Lake Inba Basin Healthy Water Cycle (Removal of Alien Species)

Table 3.1 Target Achievement Status on Website

Target Achievement Evaluation Criteria	Target Value for 2015	Achievement Status in 2009	
Water Quality	★Chlorophyll a Annual average less than 0.75μg/L ★COD Annual average less than 7.5mg/L		Chlorophyll a is worse than in 2008; COD is unchanged.
Occurrence of Blue-green Algae	Occurrence of blue-green algae becomes less noticeable.		Both the number of locations and the number of days of occurrence decreased from 2008.
Clarity	Better clarity About 0.5m		About 0.2~0.3m, almost the same as in 2008
Odor	Less odor		Algae, sewage, and mold odors continue to occur, but the frequency of occurrence tends to stay flat.
Water Quality Suitable for Drinking Water	★Improves the function of 2-MIB and trihalomethane production		Algae, sewage, and mold odors continue to occur, but the frequency of occurrence tends to stay flat.
The Number of Users	Increase		As for the 2-MIB, it has greatly exceeded the target value. The trihalomethane production function has worsened since 2008.
Spring Water	Abundant Spring Water		Spring water was never dried.
Livings	Recovery of submerged plant Prevention of alien species		Submerged plant and rare species were found. Chelydra serpentina is continuously eliminated.
Water-related Disaster	Increase in Safety of flood protection		Progressed

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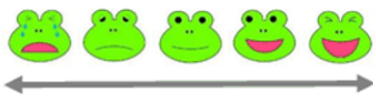
- Yet to achieve
- Further efforts are needed



- Achieved
- Steady Progressed

Source: Lake Inba Basin Healthy Water Cycle Conference Website

CHAPTER 4 LESSONS LEARNED

(1) **Water resources should be managed using a river basin as the planning unit.** A water resources management plan should be developed according to the individual characteristics and customary practices in the basin. The plan should also ensure consistency among sectors, set management goals, and optimize facility development and environmental management throughout the river basin. An extensive database of hydrological data is needed to develop this plan.

(2) **Master and action plans are crucial for effectively managing a river.** In Japan, the River Law stipulates that the RMOs should formulate the Basic Policy for River Improvement as a master plan for the comprehensive conservation and use of water resources, and the River Improvement Plan as an action plan with a timeline of for 20–30 years, specifying actions including individual projects.

(3) **To manage drought and flood disasters, targets of safety levels should be set for their development.** In Japan, the drought safety level has been generally set at 1/10, and the flood protection safety level is determined based on the importance of the target river basin. Storage facilities and levees are planned to satisfy these requirements.

(4) **Local offices are needed to respond to local needs in the field.** The RMOs should be established to help understand key local issues and the needs of water resources management. In addition, given the need to collaborate with various related organizations and local communities, it is important to build trusting relationships with these organizations.

(5) **Collaboration among various stakeholders is needed to recover from water cycle deterioration.** Urbanization has resulted in increased basin damage in the water cycle of river flow and groundwater in a river basin. Additionally, an increased water demand has increased groundwater exploitation and subsequent surface water rise, causing environmental function to decline, depleting spring water, and exacerbating water pollution. Japan began formulating river basin plans and management systems by engaging multiple stakeholders to establish a healthy water cycle.

THEME 3 FINANCE :
SHARING RESPONSIBILITIES AND COSTS AMONG STAKEHOLDERS

ABSTRACT

Water resources projects require significant amounts of funding over a long period. Therefore, it is important to legislate medium- to long-term development plans for national water resources and to commit securing a multi-year budget. Additionally, many organizations are involved in water resources management, including not only national and local governments, but also the private sector. National governments could promote the equitable development of national land and water resources by providing financial support to local governments and other organizations.

Moreover, it is necessary to combine various approaches for increasing financial resources. In Japan, a combination of construction bonds, fiscal investment and loan programs, water resources bonds, general funds, and project revenues enabled the construction of facilities to meet the rapid increase in water demand driven by high economic growth. Furthermore, legal mechanisms have been established for water users to share the construction and maintenance costs of facilities.

In Japan, farmers' associations historically manage many small-scale irrigation facilities. These associations collect levies from members to cover the construction, maintenance, and operation costs. Public-private partnerships could finance the management of water supply and sewage facilities. Such public-private partnerships are being expanded in Japan to manage declining financial viability because of the decreasing population.

CHAPTER 1 INTRODUCTION

A combination of various sources of funding is required to finance water resources management projects. In Japan, diverse methods of financing have been established and legislated, including cost allocation among water users (i.e., a subsidy system managed by the national government), special accounts, public bonds, and public-private partnerships (PPPs). In addition, master and long-term plans can demonstrate long-term commitment for financing.

As water resources projects are costly and time-consuming, it is necessary to secure stable and long-term financing sources. Additionally, cost allocation is required to coordinate the many organizations concerned. Further, farmers' associations in Japan manage irrigation facilities and provide sufficient financial resources for operation and maintenance. This theme explains the nature of the legal system used in Japan to secure project financing.

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

Relationships between Finance and the SDGs:

Frameworks facilitating sustainable financing over the long-term such as cost sharing by responsibility and roles as well as the diverse supports and procurement system.

SDG Target 17 "Partnerships for the goals"

CHAPTER 2 FINANCIAL FRAMEWORK OF WATER RESOURCES

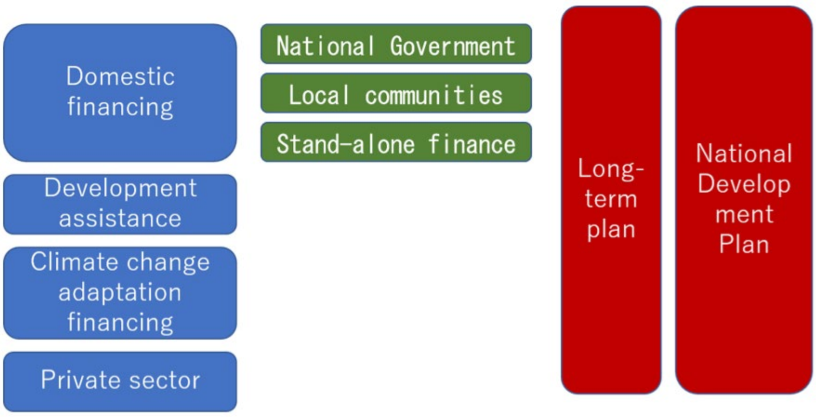
2.1 Legal System

It is necessary to draw up a significant and multiyear budget for financing water resources management. Therefore, the national commitment to financing sources should be secured through legislation of long-term plans and accounts.

(1) Financial Arrangement

The funds used for infrastructure development can be broadly divided into public and private funds. Public funds include, as presented in Figure 2.1: i) budgets of national and local governments; ii) government financing agencies, such as government-affiliated companies, government-affiliated funds, and export credit agencies (ECA); and iii) multilateral development banks (MDBs) such as the World Bank (WB) and Asia Development Bank (ADB). Private funds include iv) bank loans and v) institutional investors for infrastructure funds and project bonds. In recent years, funds such as the Green Climate Fund (GCF) have been established to support developing countries in addressing climate change issues, by providing grants, loans, and equity investments.

In Japan, water resources have been developed under the concept of cost allocation to water users and stakeholders. The government committed to securing long-term financing by associating its national development plan with special accounts dedicated to water resources and flood protection projects. Water supply, sewerage, and industrial water supply projects are mainly implemented by local governments, whereas hydropower generation is primarily implemented by private power companies. Private funds provide project financing for hydropower, water supply and sewerage, and industrial water supply. Specifically, PPPs are expected to stimulate private demand and improve efficiency using private know-how and technology. Nevertheless, such process faces many challenges, such as the low liquidity of assets, the long time required for project implementation, and political and socioeconomic risks. In the case of irrigation water, beneficiaries are required to bear these costs. Since flood protection is a public benefit, it is financed mainly by public funds.



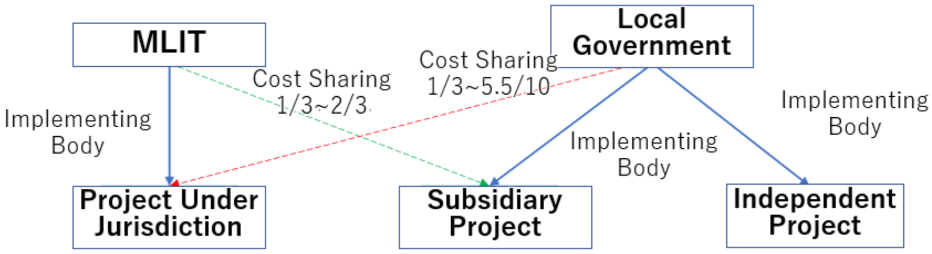
Source: Ishiwatari, M. and Akhilesh S. "Good enough today is not enough tomorrow: Challenges of increasing investments in disaster risk reduction and climate change adaptation." Progress in Disaster Science 1

Figure 2.1 Finance for Water Resource Development and Management

(2) Legal System of Cost Allocation for Water Resources Projects in Japan

Public finance plays a significant role in promoting water resources management in Japan. The government budget for public works has been declining from its peak of Japanese Yen (JPY)14.9 trillion in FY1998 to JPY 6.9 trillion[1] in FY2019. This represents approximately 3% of the gross domestic product (GDP). The project costs for flood protection (rivers, sediment disaster management, dams, seacoasts, and sewerage projects) of MLIT were JPY 1,007.4 and 278.1 billion based on the initial and supplementary budgets, respectively, with a total of JPY 1.29 trillion[2]. Of the total costs, the national projects of the MLIT were JPY 1.06 trillion while the subsidy to public works implemented by local governments was JPY 0.23 trillion.

In the case of national projects under the MLIT, prefectural governments bear 1/3 to 5.5/10 of the construction costs (Figure 2.2). Local governments along the river should share some costs because they receive benefits from these works. Local governments claimed that the system forced them to accept an automatic and compulsory burden on national projects in the 2010s. The sharing of maintenance costs was removed in 2011 onward, and the national government has borne such costs thereafter.



Source: Project Research Team

Figure 2.2 Cost Sharing in Projects under the Jurisdiction and Subsidiary Projects

Government-subsidy projects are designed to strengthen infrastructure and improve the national land in a balanced way by financing projects implemented by local governments. The cost sharing among the national and local governments, project owners, and beneficiaries is shown in Table 2.1. In the case of independent projects, the local government bears the cost of the entire project. Subsidies for river works were stipulated under the Old River Law of 1896, by which1/3 to 2/3 of project costs are covered by the national government's subsidies.

[1] Ministry of Finance
[2] The Water and Disaster Management Bureau, MLIT (This amount excludes costs for disaster recovery and reconstruction following the Great East Japan Earthquake.)

Table 2.1 Sharing of Project Costs

Purpose	River Type	Cost sharing	Basis
River Management Office (Flood Protection)	Class-A Rivers under the jurisdiction of the National Government	MLIT: 2/3, Prefecture: 1/3	The River Law
	Class-B Rivers under the Control by Prefectural Governments	MLIT: 1/2, Prefecture: 1/2	The River Law
Irrigation		Beneficiaries: 1/10; of the rest, the National Government (Ministry of Agriculture, Forestry, and Fisheries, MAFF): 3/4, Prefectural governments: 1/4	The Specific Multi-Purpose Dams Act
Water Supply		1/2 – 1/3 covered by government subsidies (Ministry of Health, Labor and Welfare, MHLW)	The 877th Administrative Notice of the Under Secretary of MHLW
Sewerage		Public Sewerage : Main Culverts: 1/2, Final treatment plant: 1/2 or 5.5/10 Basin Sewerage : Main Culverts: 1/2, Final treatment plant: 1/2 or 2/3)	The Sewerage Act Enforcement Order
Industrial Water Supply		Government subsidies cover up to 40% (Ministry of Economy, Trade, and Industry, METI)	Guidelines for Granting Subsidies for Industrial Waterworks Projects
Power Generation		Costs are borne by the power company (the company collects charges from consumers).	

Source: The River Law, Specific Multi-Purpose Dams Act, excerpts from “Japanese River, MLIT”

(3) History of Financial Systems

Local governments and communities historically executed flood-protection projects. During modernization in the 19th century, in 1896, with the enactment of the old River Law, the national government initiated national projects for flood protection in major rivers. After the great flood of 1910, the first flood protection plan was formulated for 20 rivers throughout Japan, which included improvement costs over 18 years. To ensure reliable implementation of the plan, a special account was set up according to the Flood Protection Special Accounting Act in 1911. This special account[3] was separated from the national general budget and financed by the general national account, local governments, and postal banking loans. The second flood protection plan was formulated in 1921, and the third in 1933 (Theme 2-1: Development Plan, Chapter 2).

The Agricultural Land Improvement Act of 1899 promoted agricultural investment, including the establishment of agricultural financing institutions. In 1906, under the Land Improvement and Encouragement Finance Regulations, the national government began subsidizing prefectural expenses

[3] In general, special accounts clarify the status of specific projects and fund management by handling specific revenue and spending, separately from the general national account.

for survey, design, and construction supervision. In 1908, the national government initiated individual land improvement projects in each prefecture.

Following the legislation of the Electricity Business Act in 1911, water resources were developed for hydropower generation, in addition to conventional irrigation use. The national government proposed a river water control project for storing flood water in reservoirs and utilizing them for power generation. Subsidies for this project type began in 1940. Afterwards, the comprehensive river development project began with the Specific Multi-Purpose Dams Act in 1957. Projects for flood protection and irrigation are financed by public budgets shared at a ratio of 2:1 between the national government and prefectural governments, while for power generation are financed by electric companies.

After the devastating floods caused by the Isewan Typhoon (also known as Typhoon Vera) in 1959, Japan established mechanisms to implement projects based on long-term commitments. The Act on Sabo and Flood Protection Emergency Measures was legislated in 1962 to formulate a long-term investment plan for flood protection. Consequently, a special account for flood protection was established for long-term finance.

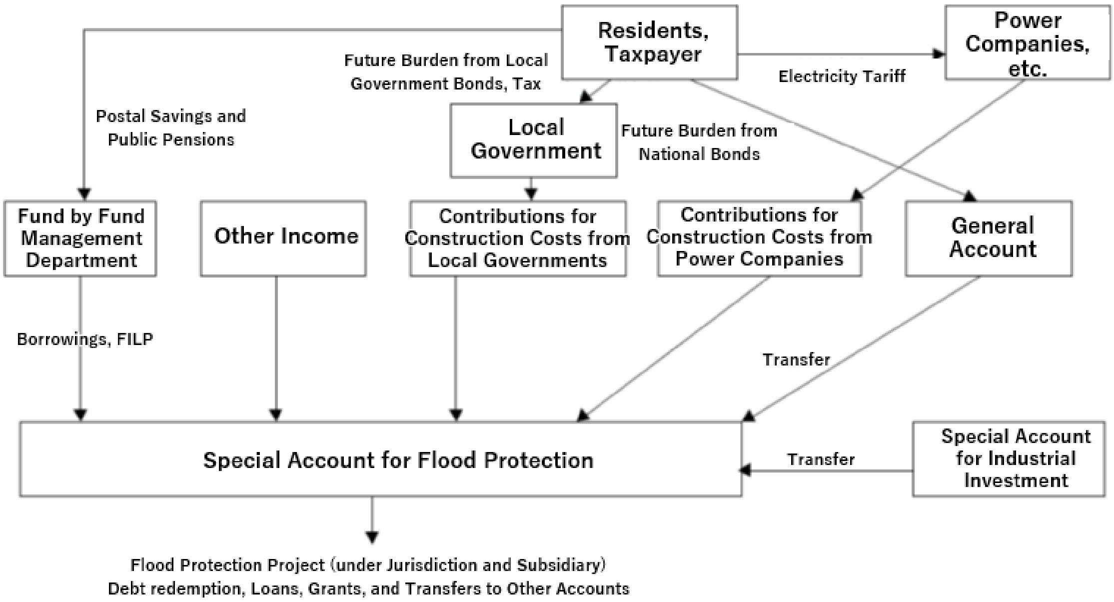
Furthermore, the national government formulated plans for the comprehensive development and management of water resources in river basins that are important for national management (Theme 2-1: Management Planning, Chapter 3). In the 1960s, to meet the rapidly increasing demand for water driven by the high economic growth, the old River Law, which focused on flood protection, was revised in 1964 to the new River Law that includes provisions for water development (Theme 1-1: Legislation and Organization, Chapter 2). In 1961, the Water Resources Development Promotion Act and Water Resources Development Corporation Act were legislated. This institutionalized long-term investment in developing water resources.

2.2 Framework of Diverse Funding

> Water resources management requires considerable amounts of funds financed by diverse schemes, such as subsidies, special accounts, government bonds, and fiscal investment and loan programs.

(1) Special Accounts

The special account for flood protection is independent of the general account revenue and expenditure. It was introduced to ensure a stable source of revenue for flood protection projects that require long-term investment regardless of the yearly availability of national finance. It greatly contributed to the implementation of flood protection and multi-purpose dam projects driven by high economic growth. As shown in Figure 2.3, the special account for flood protection was funded by transfers from the general account, local governments, and power companies, as well as borrowing from loans.



Source: "Problems of Flood Protection Projects and Flood Protection Policy" (Toshiyuki Kamimura, Toyo University)

Figure 2.3 Revenue Sources of the Special Account for Flood Protection

Owing to the tight situation of public finance in the 2000s in Japan, national spending was under scrutiny. The mass media and public claimed that special accounts with independent revenue sources promote projects inefficiently. In particular, the following issues have been raised: i) limited accountability, ii) inefficient project implementation, iii) unused or carried-over funds, and vi) incomplete monitoring. Under the Administrative Reform Promotion Act, which aimed to improve the efficiency of public administration, a special account for flood protection was integrated in 2008 with other special accounts into the special account for social infrastructure promotion projects. Further, the special account for social infrastructure promotion projects was abolished and included in the general national account.[4]

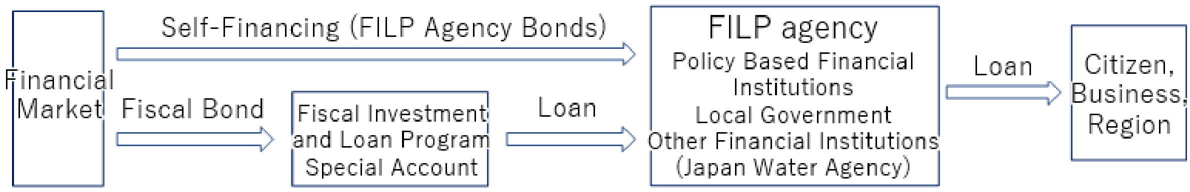
(2) Government Bonds for Construction

Public works are financed by issuing government bonds or by borrowing. As future generations will also benefit from public facilities, they should bear the costs as well. Government bonds for construction are issued within the amounts decided by the National Diet.

(3) Fiscal Investment and Loan Program (FILP)

The FILP is financed by funds raised through government credit or by issuing FILP bonds (government bonds). It is managed independently without relying on taxation. Additionally, it facilitates long-term, fixed, and low-interest financing as well as the implementation of large-scale and long-term projects, which cannot be carried out by the private sector alone. Originally, this program was financed by postal banking and pension funds. It was called "the second budget" because of its role in complementing the general account budget funded by taxes and government bonds. Figure 2.4 presents the FILP system.

[4] References: "Review of Special Accounts" (2003, Council on Fiscal System, etc.), "Key Policies for Administrative Reform" (2005, Cabinet Decision), "Review of the Special Account System long used" (2013, Budget Committee Research Office, Masakatsu Mikado), and "Special Account Guidebook" (2018, Main Account Bureau, Ministry of Finance)



Source: Prepared by simplifying " Structure of Fiscal Investment and Loan Program" by the Ministry of Finance.

Figure 2.4 The FILP Framework

(4) Charges for Use of River Water (Water Rights Fees)

Prefectural governments collect charges for river water use. These charges are exempted for use in domestic water supply, public power generation, and irrigation. Most of these charges are collected from private companies operating in the areas of power generation and industrial water supply (Theme 1-2: Water Rights, Section 3.3).

(5) Subsidies for Urgent Disaster Rehabilitation Works

Japan repeatedly suffered from typhoons and earthquakes in the 1940s and 1950s. Thousands of lives were lost almost every year, and assets and properties were seriously damaged. Disasters are unpredictable and often impose a significant financial burden on local governments.

The Act on Subsidies for Disaster Rehabilitation of Public Infrastructure was enacted in 1951 to support local governments. That is, the national government provides local governments with more than two-thirds of the total rehabilitation costs. The share of rehabilitation costs by local governments is determined based on their financial capacities. Furthermore, the national government covers debts of local bonds that are issued for local expenses. Consequently, local governments eventually bear only 1.7% of the project costs. In case of extremely severe disasters, the national government increases the support to the local governments by 10-20% of the project costs.

This scheme has the following characteristics:

1) It covers various public facilities of rivers, coasts, landslide protection, roads, ports, fishery ports, sewerage, and parks.
2) It assesses project costs immediately after disasters and promptly secures supplementary budgets.
3) It helps starting work promptly, often on the day of the disaster, before cost estimation by providing subsidies retroactively.
4) It aims at functional rehabilitation, and not necessarily reviving the original forms.
5) It provides a package budget to each prefecture covering all rehabilitation works so that prefectural governments have flexibility in project implementation.

(6) Farmers' Responsibilities for Irrigation Facilities

Farmer associations historically manage irrigation facilities in Japan. These associations are responsible for the construction of irrigation and drainage facilities, development of agricultural land, and their maintenance. An agreement by two-thirds of the relevant farmers is required to launch projects. Farmers benefiting from the projects join the farmers' association, pay the cost (levy), and provide compulsory labor services (Theme 1-2: Water Rights, Chapter 6). The levy is set independently by each farmer's association (Table 2.2).

Cost sharing for projects differs according to project classification, which is determined by project features, scale, and scope (Table 2.3, 2.4). The national government's management of projects aims at developing a nationwide food supply or fundamental facilities covering a wide region, while prefectural or municipal management projects promote local agriculture. Disaster prevention projects for agricultural land do not involve local burdens. Moreover, the national and prefectural governments contribute subsidies for large-scale repairs and improvements (Table 2.5).

Table 2.2 Levy examples (The Government-Managed Farmers' Association of Lake Inba)

Type	Unit Levy (per 10a)	Purpose of Use
Ordinary levy	Irrigation and drainage area: paddy: JPY 3,950; field: JPY 1,316. Area only for drainage: paddy: JPY 1,316; field: JPY 438	Management costs of the agricultural irrigation area (district) and association (farmers' association), savings, maintenance and operation costs of common facilities, etc.
Maintenance and management levy	Depending on the sub-district, JPY 3,100 to JPY 7,000 (paddy) (1/3 of the above for fields)	Repair, electricity, and management costs for facilities in the sub-district. Contributions for facilities managed by the prefecture, etc.

Source: Midori Net Lake Inba Website

Table 2.3 Example of Cost Sharing Ratio for Land Improvement Projects

Projects Classification	National Government	Prefectural Government	Municipal Government	Local
National Projects for Irrigation and Drainage	75	25	5	0
Prefectural Projects for Irrigation and Drainage	50	25	10	15
Prefectural Projects for Farmland-Disaster Prevention (maintenance of ponds, etc.)	55	37	8	0

Source: Guidelines for the share of Local Governments in National and Prefectural Projects for Land Improvement

Table 2.4 Management of the Farmers' Association by Scale

Project Type	Beneficiary Area (ha)	Management Entity
National Project	More than 3,000 (paddy) 1,000 (field)	The national government can transfer the rights for management to the farmers' association and municipalities Direct control by the national government helps in management when the facility is large and requires specialized management, or when beneficiary areas extend to two or more prefectures and requires water use coordination.
Prefectural Project	More than 200 (paddy) 100 (field)	The management is transferred to the farmers' association, unions of the farmers' association, agricultural cooperatives, prefectures, or municipalities.
Group Project	More than 5 (paddy)	The project owner directly manages the system.

Source: Ministry of Agriculture, Forestry and Fisheries, Japan Water Agency, Experience in Water Resources Development and Management in Japan

Table 2.5 Improvement Projects: Example of Responsibility Ratio for Repair Works

Project	Implementing Agency	Nation	Prefecture	Municipality	Local
Improvement Project of Water-Utilization Facility	Prefecture	50	25	10	15
	Farmers' Association, etc.	50	15	35	

Note: For prefectural projects, the total project cost per district is JPY 50 million or more, and the project cost per facility is generally JPY 100 million or more; for group projects, the total project cost per district is JPY 30 million or more, and the project cost per facility is JPY 2 million or more.
Source: Miyagi Prefecture data

(7) Public-Private Partnership for Water Supply and Sewerage Services

The risks of water leakage accidents are increasing in Japan due to the aging of water supply facilities and delays in adapting to seismic standards. Additionally, the business circumstances for water utilities are worsening due to declining and aging populations. To facilitate efficient management by utilizing the knowhow of the private sector, local governments has adopted the PPP. Hiroshima Prefecture established "Water Future Hiroshima Co." as a public-private joint venture (investment ratio: 35% by the prefecture and 65% by Water Co.), which achieved i) efficient management of facilities , ii) securing the assistance of a group of professionals, and iii) strengthening the facility-management system and research and development of high value-added technologies by introducing Information and communications technologies (ICTs). Specifically, the private sector is involved in the management of more than 90% of sewage treatment facilities. There are four types of PPP, as shown in Table 2.6.

Table 2.6 Types and Number of PPP for Water Supply and Sewerage Services

Type	Details of Privatization	Water Supply	Sewerage
Business Outsourcing	Part of and full outsourcing of the entire operation and management of the water treatment plant. Water utilities can benefit from the technical capabilities of the private sector in operations that require specialized knowledge. Further, efficient business operations are facilitated by private companies. Usually, the contracts are for three to five years.	1,845 locations (655 water utilities)	**Package outsourcing**: Sewage treatment plants: 531 locations Pumping stations: 893 locations Piping facilities: 38 contracts Total: 272 organizations **Designated administrator system**[5]: Sewage treatment plants: 62 locations Pumping stations: 81 locations Piping facilities: 33 contracts Total: 20 organizations
DB or DBO method	Performance-based contracts, which allow the private sector to utilize its knowhow. This results in more efficient operations compared to normal outsourcing. contracts for 5 to 20 years.	7 locations (8 water utilities)	Sewage treatment plants: 25 contracts Pumping stations: 1 contract Piping facilities: no contract Total: 23 organizations
PFI (conventional method)	Outsourcing to the private sector including financing with contracts for 5 to 20 years. The method of payment is specified in the contract, which was introduced by the revised Water Supply Act in 2011.	12 locations (8 water utilities)	Sewage treatment plants: 10 contracts Pumping stations: 0 contract Piping facilities: 1 contract Total: 8 organizations
PFI (concession method)	Private contractors can participate in business management including setting charge rates flexibly within a certain range.	No cases (2 companies are in preparation.)	Sewage treatment plants: 2 contracts Pumping stations: 1 contract Piping facilities: 1 contract Total: 2 organizations

Source: The Fourth Public-Private Partnership Promotion Council Meeting in 2019, "Public-Private Partnership in the Waterworks Business," Ministry of Health, Labor, and Welfare; "Study Group on the Implementation Status of Relevant Projects in the Sewerage Sector in Each Prefecture (Visualization Map of Public-Private Partnership) [April 2018 Edition]," MLIT, June 8, 2021

(8) Cost Bearing by the Private Sector

Urban development reduces the ground surface area for rainfall infiltration, accelerates the outflow to the river, increases flood flow, and lowers the groundwater level. In addition to river and sewerage improvement works, it is important to restrain rainwater from immediately outflowing to the river by constructing rainwater storing and infiltration facilities (Theme 5: Urban Water Management, Chapter 4). To promote water storage and infiltration facilities, the local governments can require the private sector to construct the facilities, provide subsidies for facility construction, and exempt taxes to reduce the maintenance and management costs. In recent years, water-related disasters have caused severe damage nationwide in Japan. Water disasters may become more frequent and severe as extreme rainfall increases owing to climate change. Thus, it is required to shift to "River Basin Disaster Resilience and

[5] Outsourcing of the management of public facilities to a private operator includes operation, maintenance, repair, and cleaning, but excludes the cases of exercising public authority such as compulsory collection of charges.

Sustainability by all" in which all parties involved in the basin, that is, the national government, local governments, private sector, and residents jointly implement countermeasures (Theme 2-1: Management Planning, Chapter 4).

CHAPTER 3 COST ALLOCATION IN WATER RESOURCES DEVELOPMENT

It is possible to promote water resources development by defining the cost allocation among users.

(1) Cost Allocation by the Specific Multi-Purpose Dams Act

An act[6] stipulates methods for cost allocation, which is calculated by the "Separable Costs Alternative Appropriate Expending Method" established in 1966. This procedure is based on i) the increase in construction costs if a new user adds one certain purpose, and ii) the facility cost if constructed solely for that single purpose. The river management offices bear the costs for flood protection as well as for maintaining river flow, securing a stable water supply to users with existing water rights (Theme 2-2: River Basin Planning, Chapter 2).

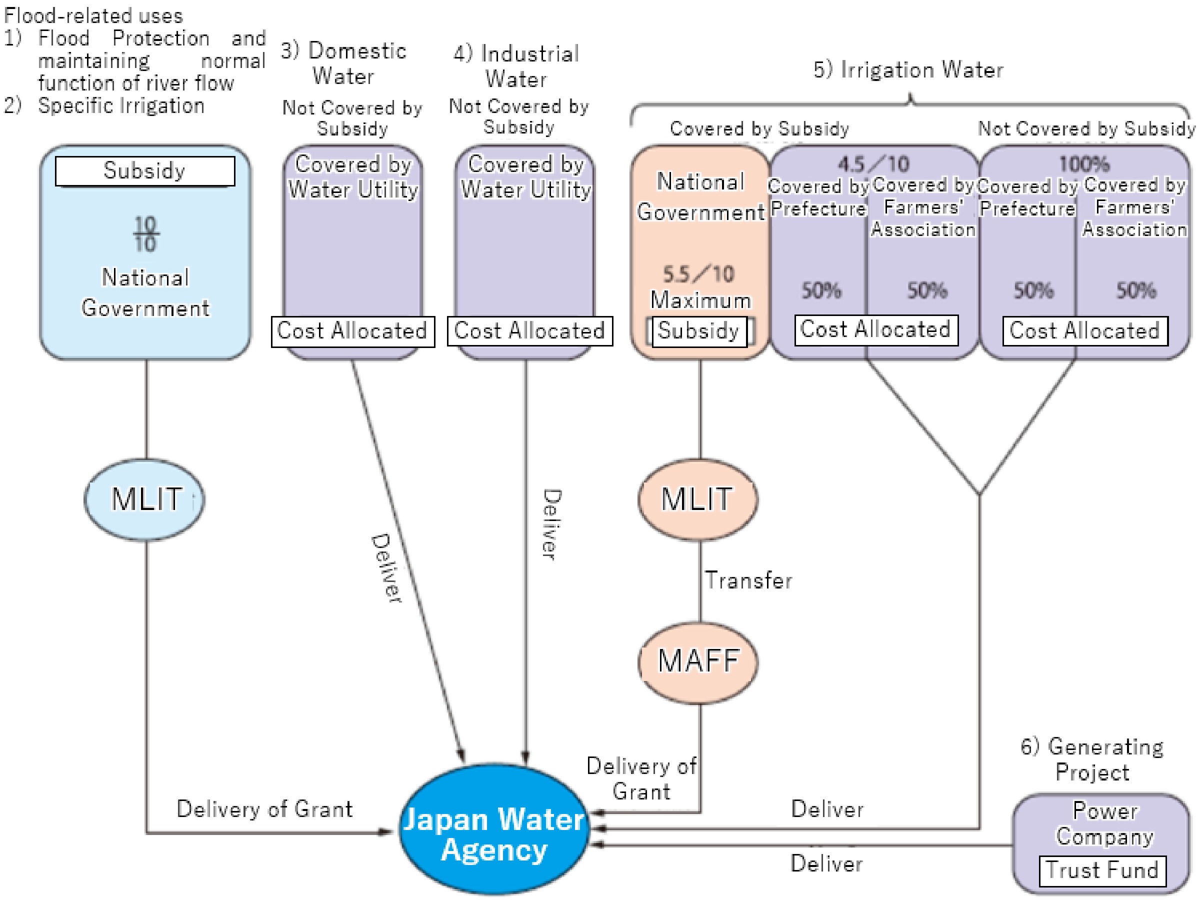
(2) Public Finance and Advanced Investment

The Water Resources Development Public Corporation (WRDPC) (currently, the Japan Water Agency (JWA)) uses the FILP system for investment in multipurpose dams. This helps water users with a weak financial base join the projects. The WRDPC receives long-term loans from the FILP or issues water resources development bonds to manage construction costs. Upon completion of construction work, WRDPC can recover funds from local governments and beneficiaries. In addition, WRDRC can construct dams prior to the decision regarding water allocation among water users. To meet the rapidly growing water demand driven by high economic growth, urgent dam construction is needed for flood protection and providing sufficient water supply. For example, the right for domestic water supply in Muroo Dam was initially not identified, but the local government of Nara Prefecture decided to use the volume after the completion of the construction. The dam has a storage capacity of 14.3 million m^3, of which a volume of 6.45 million m^3 of the capacity is allocated for domestic water use.

(3) Allocation of Maintenance Costs

Each water user bears maintenance costs based on the allocation ratio adopted for the construction cost. Cost allocation is determined by including the amount based on grants and subsidies by the national and local governments. Figure 3.1 shows an example of a dam managed by the JWA. The national government bears 100% of the cost for flood protection and maintenance of the normal function of river flow, with no cost borne by the local government. The beneficiaries bear the cost of water use through the water utility. Further, the national government provides subsidies of 55% for irrigation water use (subsidized projects).

[6] Specific Multi-Purpose Dams Act of 1957

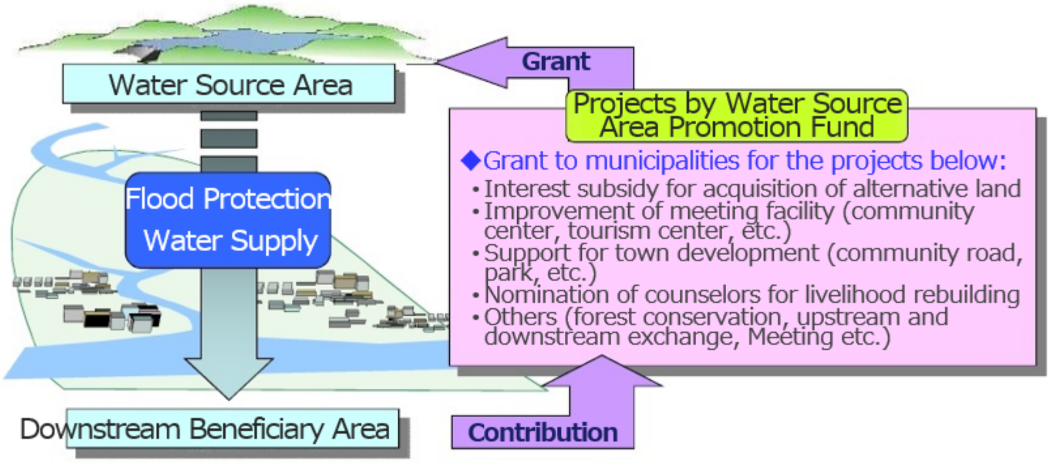


Source: JWA, Task Overview 2020

Figure 3.1 Cost Allocation for Management of Multipurpose Dams Managed by the JWA

(4) Support to Communities affected by Large-scale Projects

Social and economic inequity between upstream and downstream areas is a significant challenge in water resources development. While downstream beneficiary areas are more developed owing to the construction of dams, water source areas may experience depopulation and financial deterioration due to the disappearance of communities, loss of socioeconomic infrastructure, and aggravated public finance. To support the reconstruction of local communities submerged by the construction of dams, various financial sources are provided, including projects for developing water source areas, such as funds raised by beneficiaries, water resources taxes, and the introduction of taxes for water source areas (Figure 3.2) (Theme 9: Environmental and Social Consideration in Large-Scale Projects, Chapter 2).



Source: Japan Water Resources 2014 Ver.

Figure 3.2 Overview of Water-Source-Area Promotion Fund

CHAPTER 4 LESSONS LEARNED

(1) **To secure sustainable budgeting over a long construction period, a legal framework should be established.** Water resources management often involves large-scale construction projects that require considerable budgets and long construction periods. Thus, it is necessary to secure stable budgeting regardless of the nation's short-term economic and financial situation. In Japan, the development plan was established through legislation, and the budget was secured via measures such as the special account for flood protection.

(2) **Diverse mechanisms should be established to increase financial resources.** Water resources development involves various stakeholders, including the national and local governments as well as the private sector. Fiscal frameworks such as special accounts, construction bonds, subsidies, and loan programs contributed to the development of water resources to meet the rapidly growing water demand driven by high economic growth in Japan. To provide loans to local governments and organizations that have difficulty managing construction costs in a lump sum, Japan introduced a system of loans program (i.e., FILP) and water resources development bonds. These local governments repay the loans after the completion of projects.

(3) **To implement water resources development involving multiple water users, a cost-allocation system should be established.** It is difficult to determine the cost allocation for each project through negotiating among stakeholders, including water users. In Japan, an act clarifies the method of cost allocation and the division of roles among water users.

(4) **PPPs can improve water management.** Since Japan is facing difficulties in managing water facilities because of its aging and decreasing population, the government introduced PPPs to improve financial and technical situations using the technical know-how of the private sector.

(5) **Beneficiary farmers should pay levies and provide compulsory worker services to develop and manage irrigation facilities.** Farmers' associations historically play a significant role in developing and maintaining water sources and water utilization facilities in Japan. These associations require their member farmers to pay a levy or engage in compulsory labor services.

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.

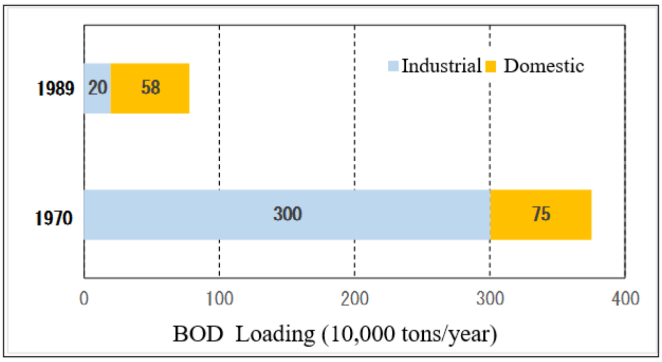
2.2 Wastewater Regulation

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.

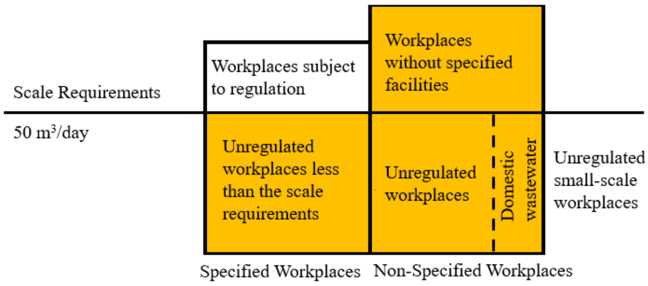


Source: Environmental Strategy of Water, Nakanishi Junko, Iwanami Publications

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 m^3/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

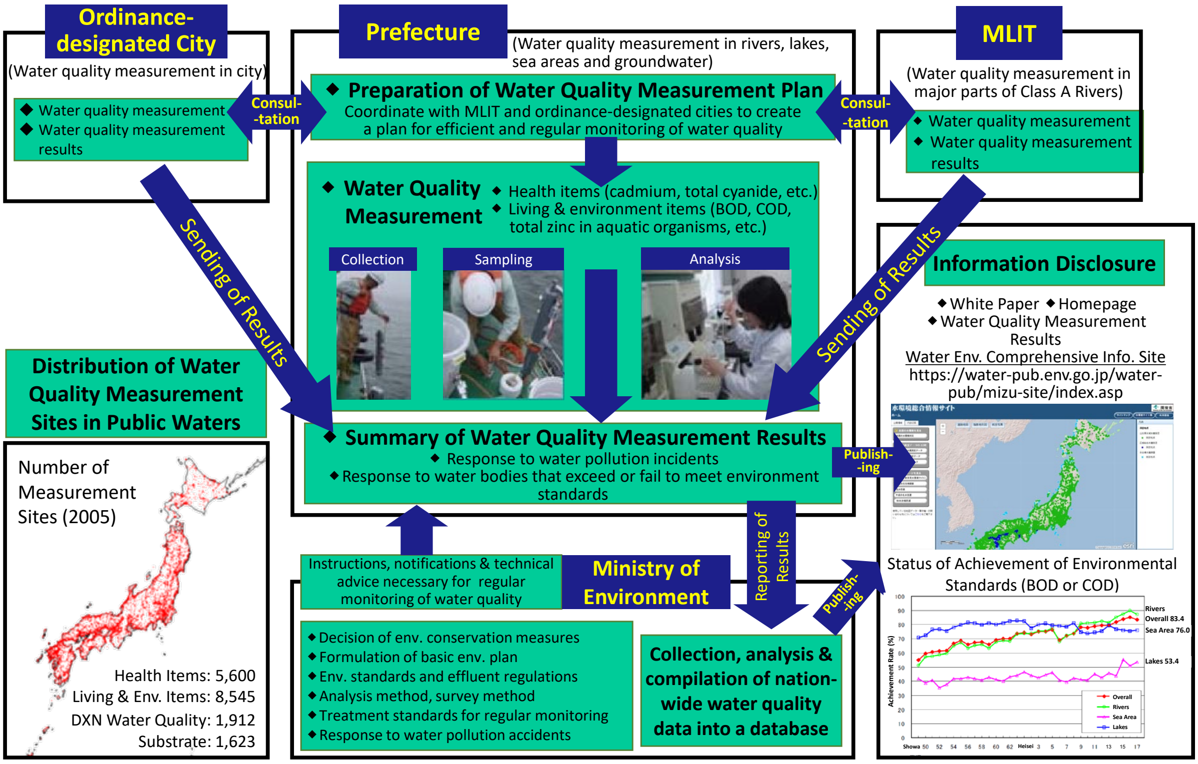
When wastewater from rural areas flows into channels, water quality declines. Water quality can be improved by domestic wastewater treatment using rural sewerage systems and on-site wastewater treatment systems called Johkasou, which treats both black and gray water at household level. In addition, agricultural 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

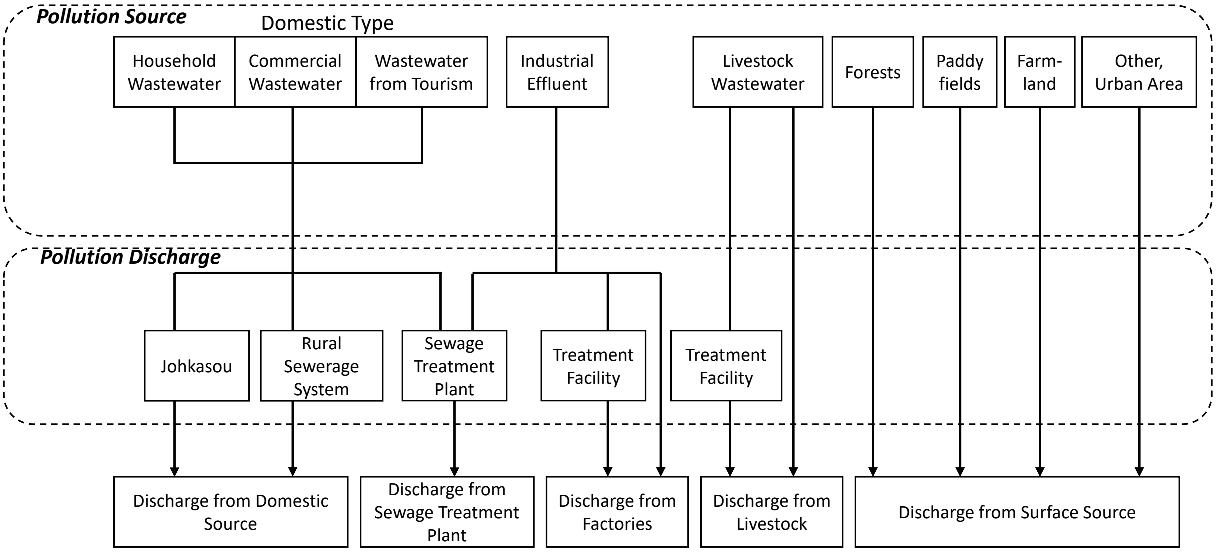
[8] The Ministry of Agriculture, Forestry and Fisheries (MAFF) has been implementing measures to help conserve agricultural land, water, and the environment since 2007.
[9] The person who supervises and manages the business (plant manager, etc.). A person must be appointed if the company has 21 or more 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

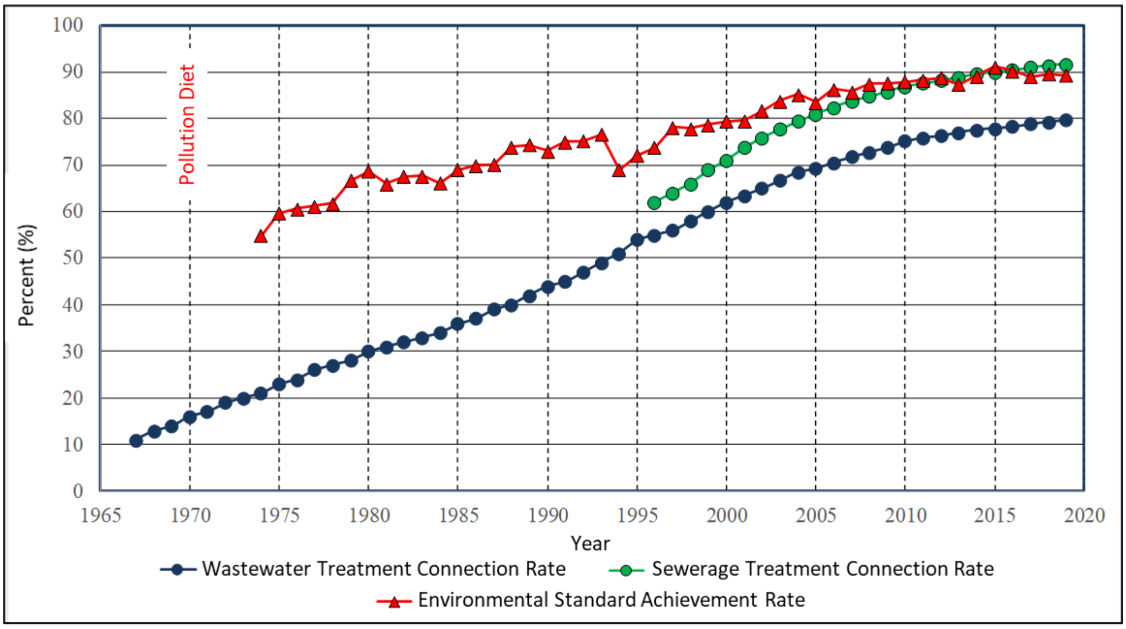
Figure 3.1 Sources of Pollution and Discharge Points

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

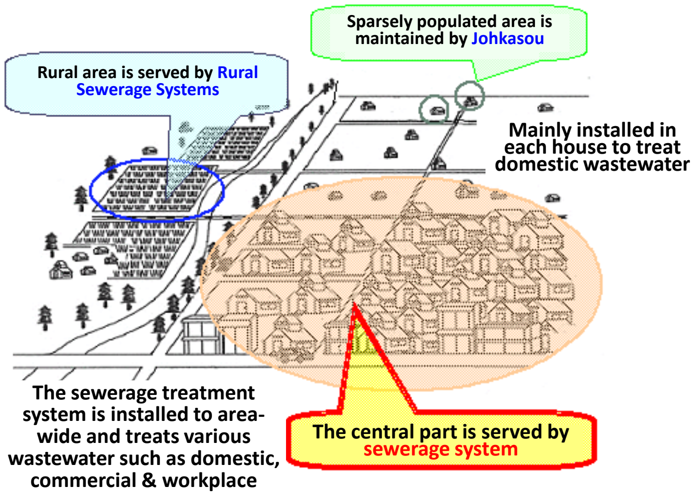
1) Comprehensive Basin-wide Plan of Sewerage Systems

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

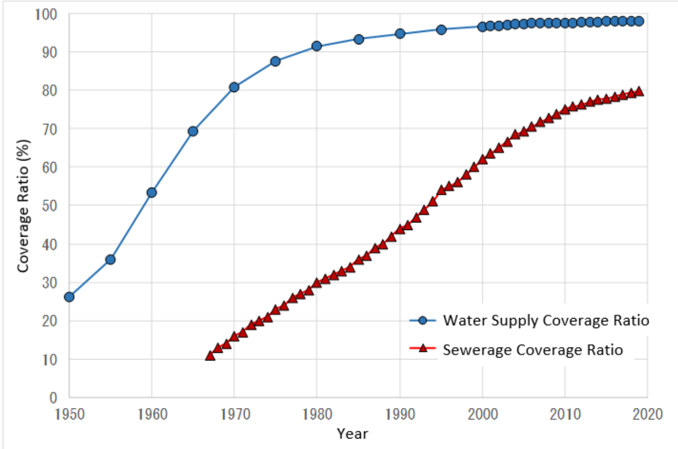
Table 3.1 Features of Typical Treatment Facilities

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.

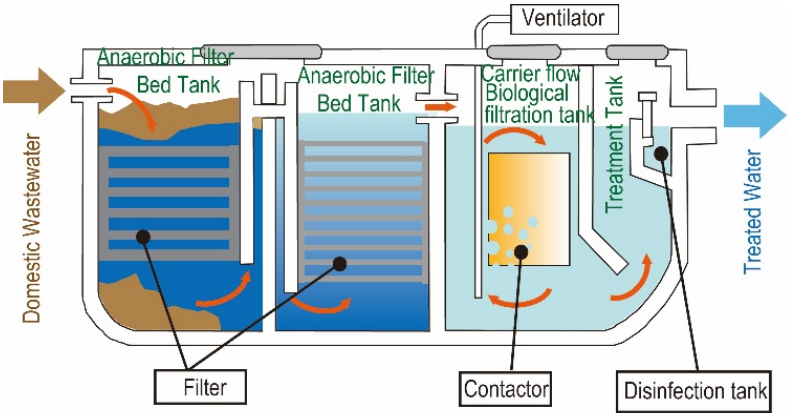
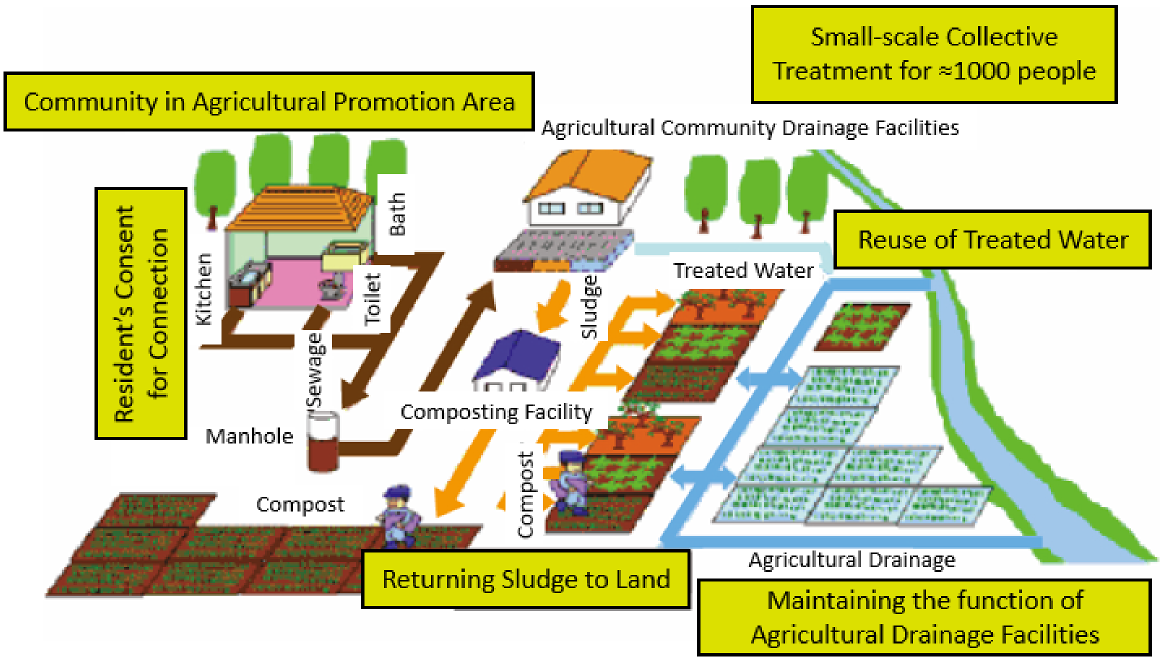


Figure 3.5 General Treatment Method in Johkasou

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

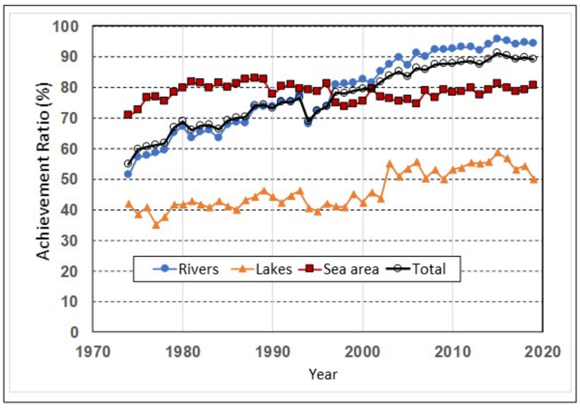
The Water Pollution Prevention Act requires sewage treatment plants to measure discharged water and record the results. For privately installed Johkasou, a designated inspection agency examines water quality once a year. The inspector gives the owner of the tank the inspection results with the classification 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

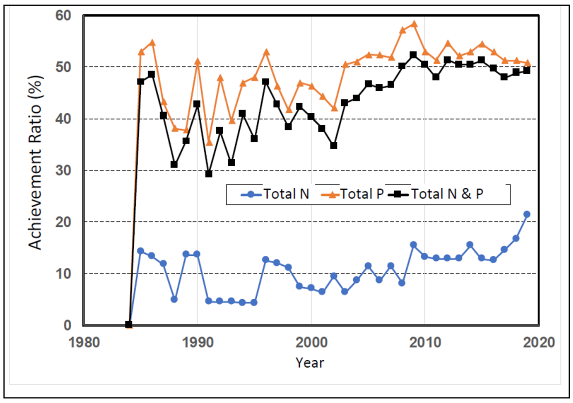
> It is difficult to improve the quality of closed water bodies, such as lakes, once it deteriorates. A long-term system should be established to regulate and improve the quality of inflowing water.

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.

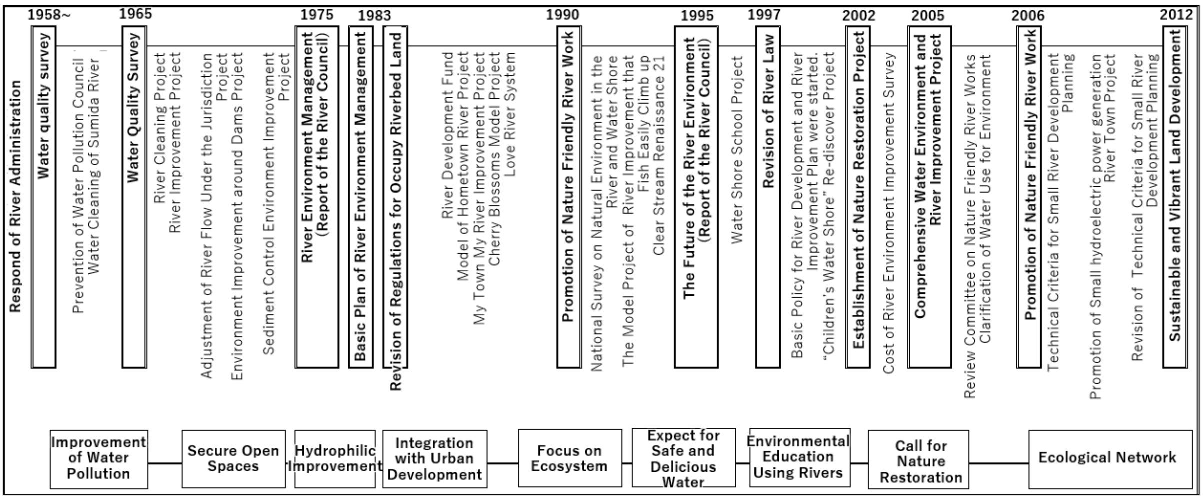
CHAPTER 5 RIVER ENVIRONMENTAL MANAGEMENT

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).

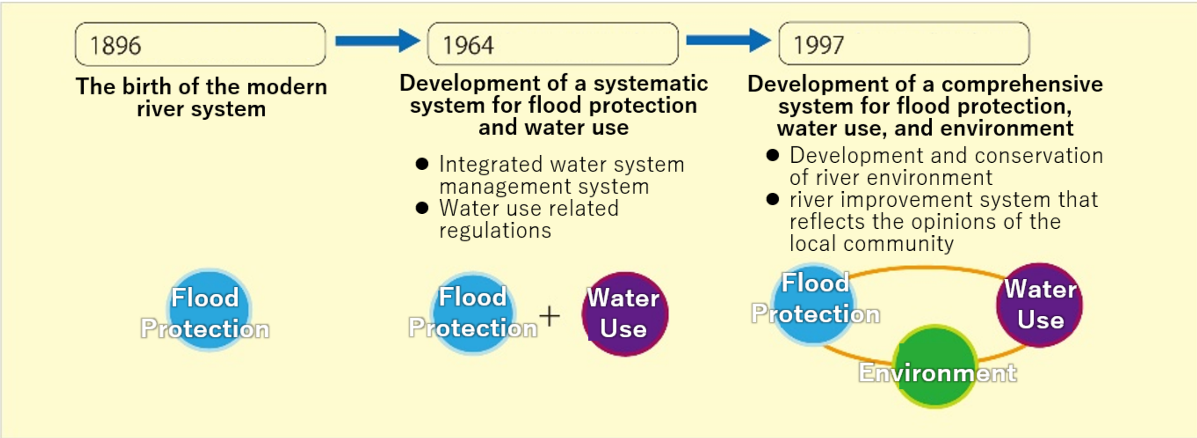


Source: Current status of efforts to develop and preserve the river environment, MLIT, April 13, 2007

Figure 5.1 History of Effort to Improve the River Environment

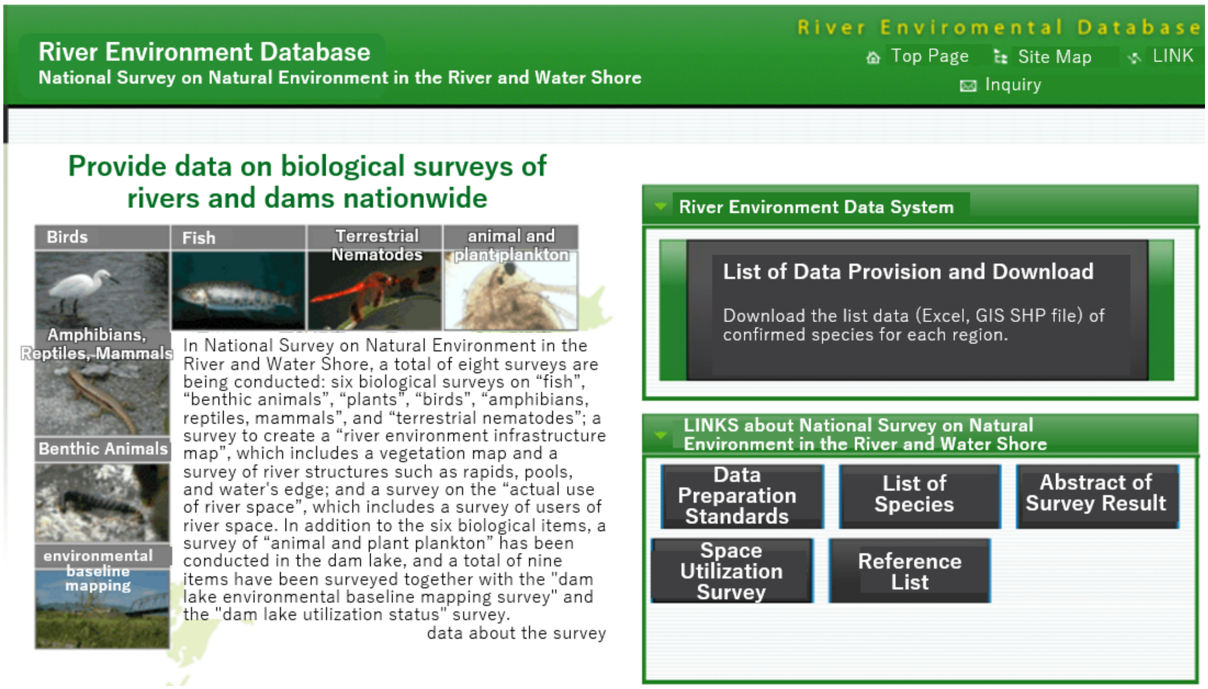
According to the 2002 Act for the Promotion of Nature Restoration, nature restoration involves the conservation, regeneration, creation, or maintenance of the natural environment through the participation of various local actors, including administrative agencies, local governments, non-profit organizations (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

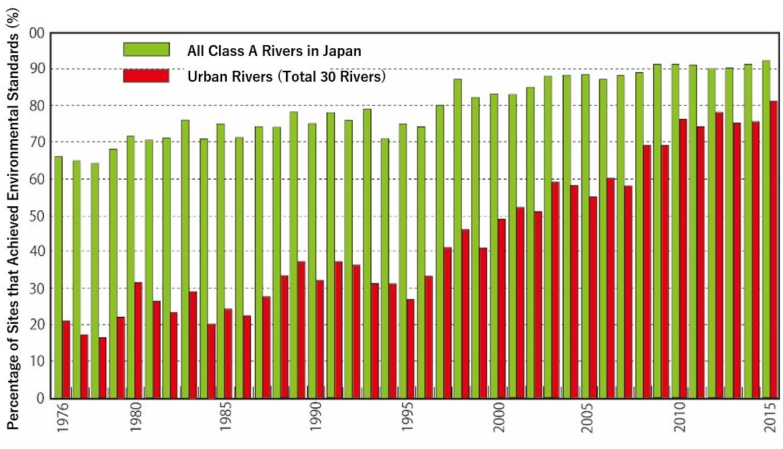
Various stakeholders and residents should be involved in improving the water environment.

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

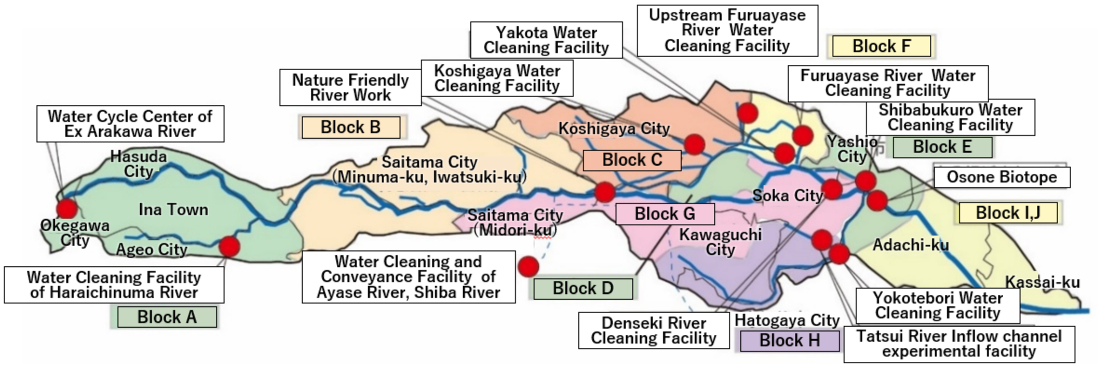
CCTV Camera Image
Yanaginomiya Area, Yashio City, Saitama

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

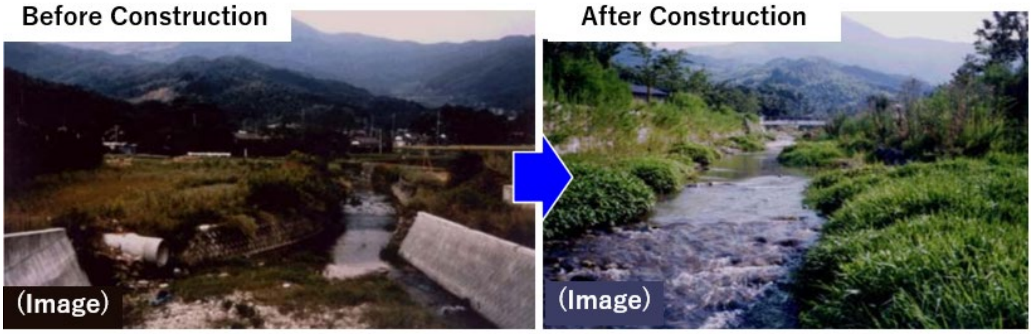
Figure 5.9 Examples of Collaboration and Education with Local Residents Along the Ayase River

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.

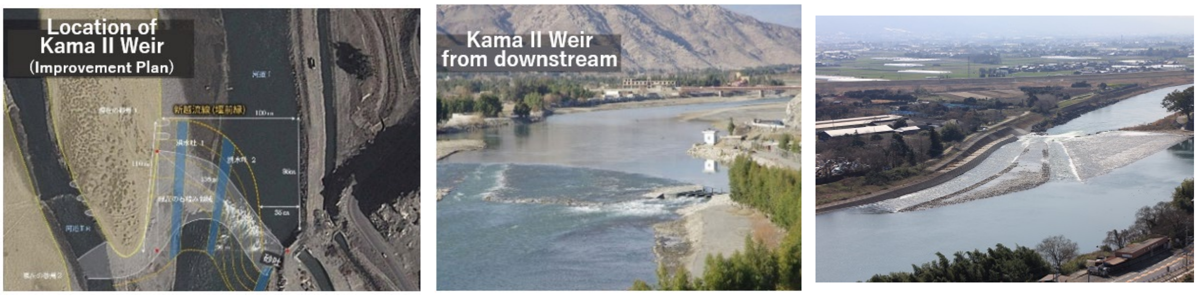
Source: Shinano River Downstream Office website

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

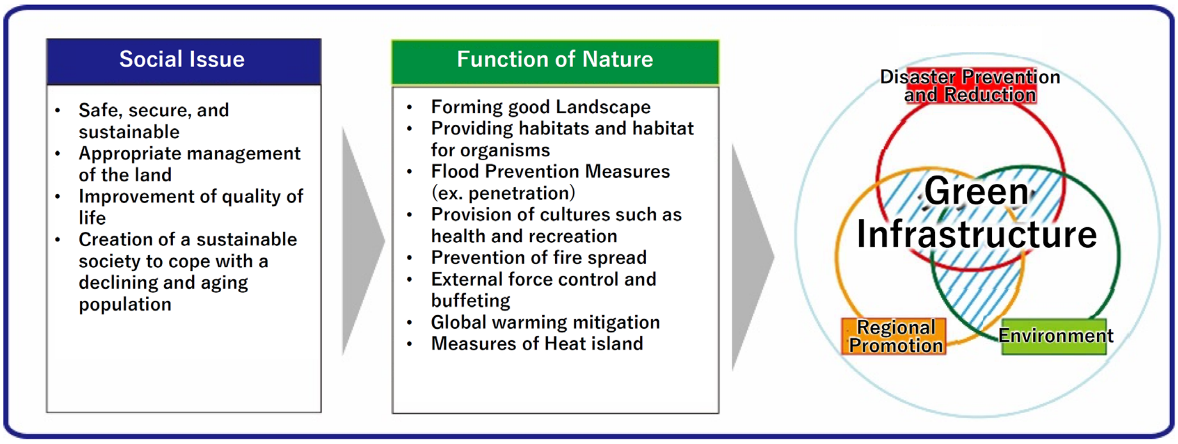
Figure 5.12 Conventional Weir

5.6 Green Infrastructure Initiatives

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

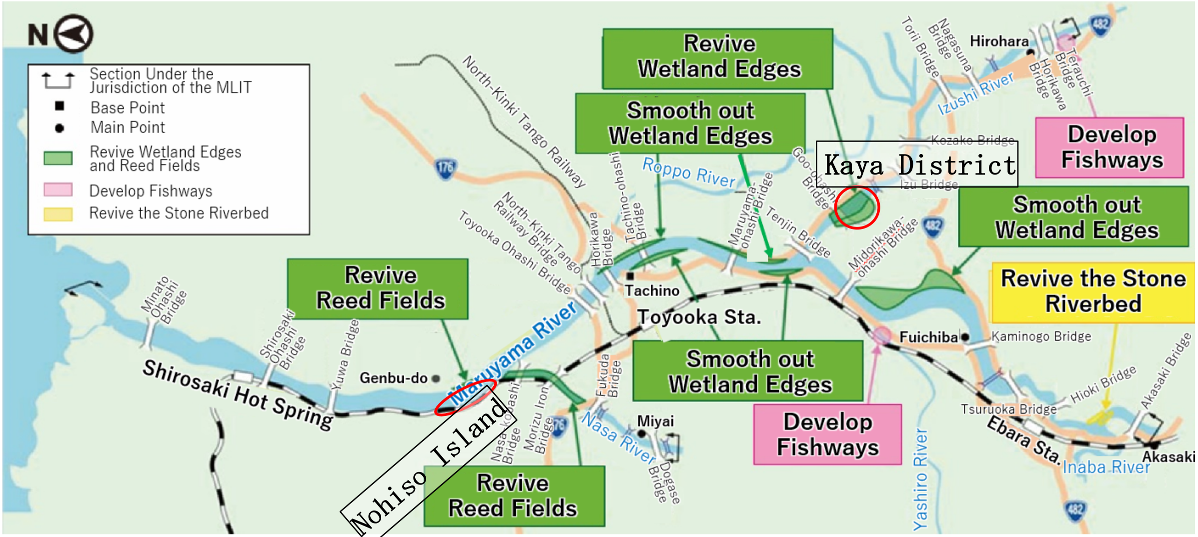
Japan used green infrastructure to protect tsunamis as recovery works from the Great East Japan Earthquake in 2011. The government organizations developed tsunami barriers with an afforestation program. The term "green infrastructure" was used in the National Land Formation Plan in 2015, which utilizes 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

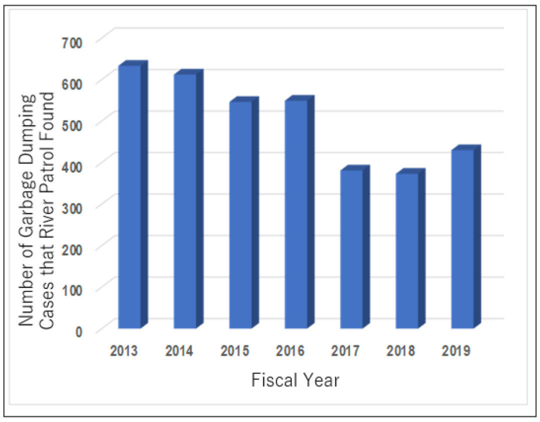
Source: MLIT Kinki Regional Development Bureau Toyooka River National Highway Office Website

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

THEME 5 URBAN WATER MANAGEMENT: INTEGRATING APPROACHES TO RESOLVE COMPLEX ISSUES

ABSTRACT

Population concentration in urban areas, expansion of urban areas, and growth in socioeconomic activities lead to a deteriorating water cycle that affects the water environment. The ground surfaces covered with asphalt and concrete reduce the water retention capacity and infiltration into the ground. The accumulation of assets and buildings in urban areas has led to increased damage from floods and droughts. Furthermore, the negative effect of climate change on rainfall patterns has increased the severity of floods and droughts.

Structural measures alone are not sufficient to resolve these complicated issues, and cooperation from multiple areas is necessary. Thus, local governments should formulate urban planning considering disaster risks and enhance soft measures, such as regulating development activities, managing water demand, recycling water, and improving the response to disasters. Additionally, green infrastructure may produce multiple benefits, including protecting against floods, improving the environment, and creating habits. Furthermore, problems regarding the urban poor in river areas may be resolved by jointly implementing river works and housing programs. These measures can be implemented through collaborative governance with diverse organizations. While Japan has continued these efforts, it is still struggling to resolve the complicated issues brought forth by climate change.

CHAPTER 1 INTRODUCTION

Flood damage, tight water supply, and environment deterioration exacerbated by urbanization may be resolved by strengthening governance among various related organizations and stakeholders and by implementing hard and soft measures.

Rapid population growth and economic activities may cause water-related problems in urban areas. Existing water facilities may be unable to fully supply the increased water demand, resulting in low-quality water. Land subsidence incurred by over-extraction of groundwater may also worsen flooding and inundation damage (Theme 7: Groundwater Management). The expansion of ground surfaces covered by asphalt and concrete may increase the runoff, resulting in increased flood damage. Additionally, wastewater deteriorates the water quality. However, it may be challenging to achieve the required coordination among ministries, government agencies, and local governments involved in resolving these issues. This theme describes the approaches of collaborative measures by multiple organizations in Japan.

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

Relationships between Urban Water Management and the SDGs:

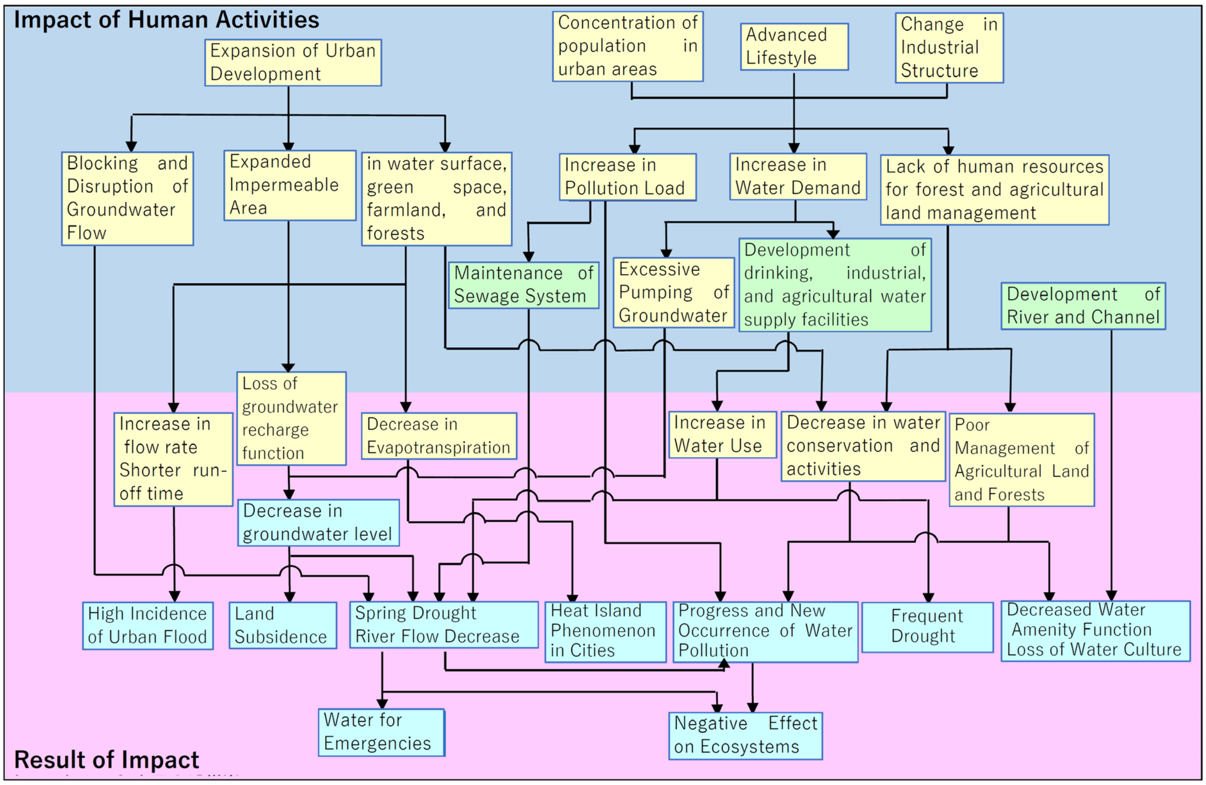
(1) Implementation of the drought and flood protection measures in urban water management is related to the following goals:

SDG6 “Water and Sanitation”: 6.a “Expand international cooperation and capacity-building support in water- and sanitation-related activities and programmes”
SDG11 “Sustainable Cities and Communities”: 11.5 “Significantly reduce the number of deaths and the number of people affected by disasters, including water-related disasters”
SDG13 “Climate Action”: 13.1 “Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters”
SDG17 “Partnership”: 17.17 “Encourage and promote effective public, public-private, and civil society partnerships, building on the experience and resourcing strategies of partnerships”

CHAPTER 2 WATER CYCLE IN URBAN AREAS

Urbanization causes various adverse effects on the water cycle system in urban area, particularly water utilization, flood protection, and water environment. Rather than addressing each of these effects individually, a more comprehensive approach should be undertaken to restore the water cycle.

The state of the water cycle is influenced by climatic conditions, the natural characteristics of the basin (e.g., topographical and geological conditions), and various human activities in urban areas. Changes in land use, population influx into urban areas, and changes in industrial structure affect the quantity and quality of water in urban areas (Figure 2.1). Because issues related to water resources are interrelated, measures to address them should have multiple benefits. Table 2.1 and Figure 2.2 show how the measures are related to flood protection, water utilization, and environmental conservation. Urban development that combines the restoration of the water cycle with the development of urban areas is being carried out in Japan. As an example, Figure 2.3 shows the development of the Hachioji Minamino City.



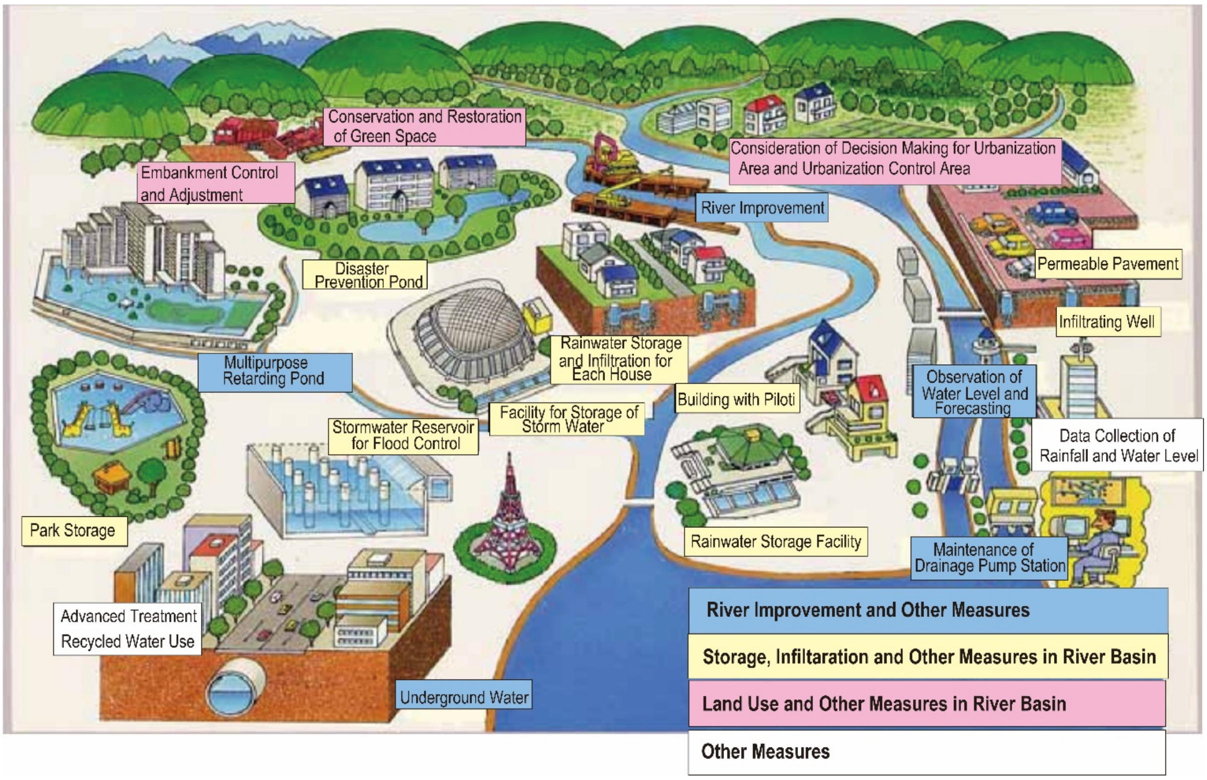
Source: "Toward the Creation of a Sound Water Cycle System." Liaison meeting of related ministries and agencies regarding the development of a healthy water environment, October 2003.

Figure 2.1 Impacts of Human Activities on the Water Cycle

Table 2.1 Measures Related to Water Utilization, Flood Protection, and Environmental Conservation in Urban Areas

Measures	Water Utilization	Flood Protection	Environmental Conservation	Remarks
1. Water Utilization				
1.1 Water fee system	○			Setting a higher fee for high volume users
1.2 Water-saving tap	○			Control of water use by each household.
1.3 Reduction of non-revenue water rate	○			
1.4 Rainwater harvesting (water use)	◎	○		It also reduces runoff during floods.
1.5 Recycled water use	○			
1.6 Sewerage high-treatment water use	◎		○	High-treated water is reused for environmental purposes.
1.7 Use of recovered water for industrial use	○			
1.8 Seawater desalination	○		△	Desalination plants return water with a high salt concentration to the sea
2. Flood Protection				
2.1 River improvement (Construction of levee, dredging of riverbed)		◎	○	Example is the super levees being built in Tokyo.
2.2 Retarding basin, multiple retarding basin		◎	○	It is used as a facility for other purposes.
2.3 Permeable pavement and permeable groundwater infiltration	○	◎		Contribution to groundwater conservation
2.4 Underground storage		◎		Energy is required for drainage.
2.5 Underground River		◎		
3. Water environment				
3.1 Nature-friendly River program		○	◎	
3.2 Sewerage system maintenance		◎	◎	Decrease in water quality during floods due to discharge of sewage and rainwater by same pipe.
4. Public awareness campaign	○	○	○	Link with all initiatives.

Note: ◎ Highly effective measure, ○ Effective measure, △ Low effect
Source: Preparation by Project Research Team

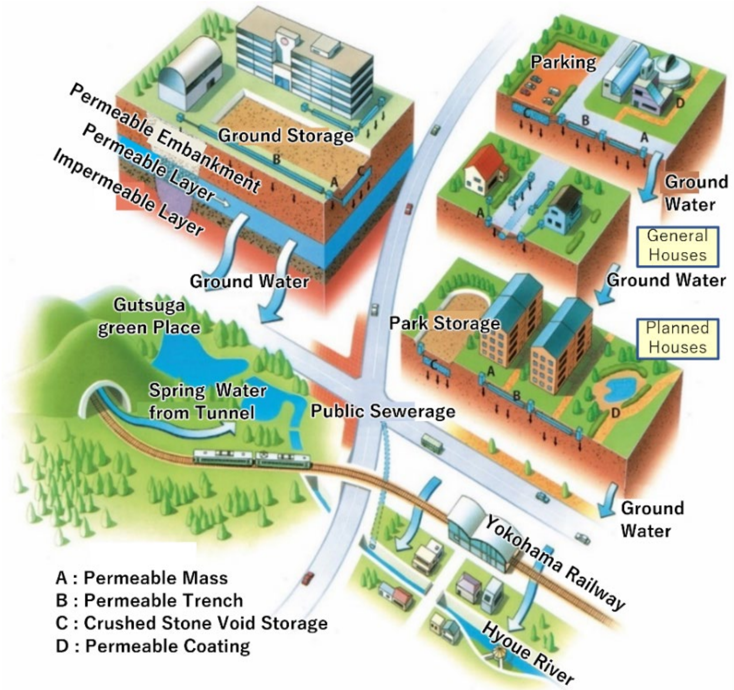


Source: MLIT Website

Figure 2.2 Image of Measures for Urban River Basin

Hachioji Minamino City

Hachioji Minamino City is minimizing the impact of development on groundwater and river flow, and maximizing the conservation of topography, flora, and fauna. One way to achieve this is by creating an "environmentally symbiotic city." The city restores and maintains a river system by installing rainwater storage facilities in schoolyards, adopting permeable pavements, and improving rainwater infiltration basins. The flow in the Hyoue River is restored and the volume of storm water runoff is reduced. The peak discharge during flood seasons in the Hyoue River reduced by 20–40% (maximum 50 m^3/s) and the discharge during drought seasons increased by 150% to 200%.



Source: UR x Green Infrastructure Case Studies UR Agency

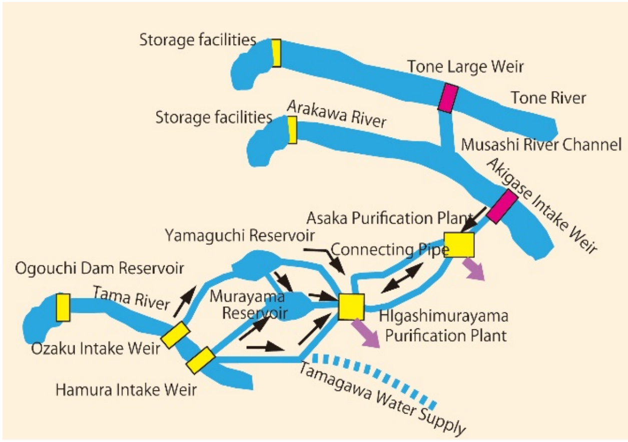
Figure 2.3 Hachioji Minamino City Water Cycle Regeneration System

CHAPTER 3 WATER UTILIZATION EFFORTS

To secure stable water supply, soft measures are implemented.

3.1 Managing Water Demand

Water resources were developed to secure a stable supply in the Tokyo metropolitan area. Governments constructed dams on the Tone, Arakawa, and Tama River systems to utilize multiple water sources efficiently (Figure 3.1) (Theme 1-1: Legislation and Organization, Chapter 2). The following initiatives are being implemented to manage water demand:

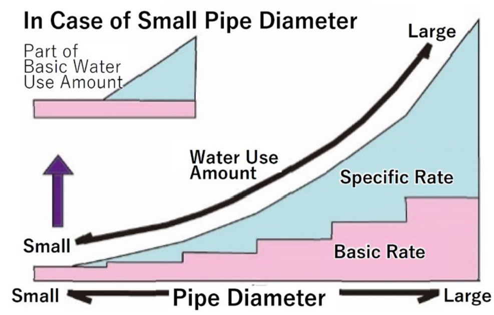


Source: Figure prepared by Tokyo Metropolitan Government Bureau of Waterworks with the addition of the Project Research Team

Figure 3.1 Wide-Area Water Resources Utilization

(1) Tariff System

The local government has introduced a gradual increase-type tariff system to encourage water users to reduce the amount of water used. There are two types of tariff system, one is unit rate increases depending on the amount of water used and the other is a two-part tariff system (Figure 3.2) comprising basic and specific rates. Basic service rates up to a certain amount are applied for low water usage from the public health perspective.

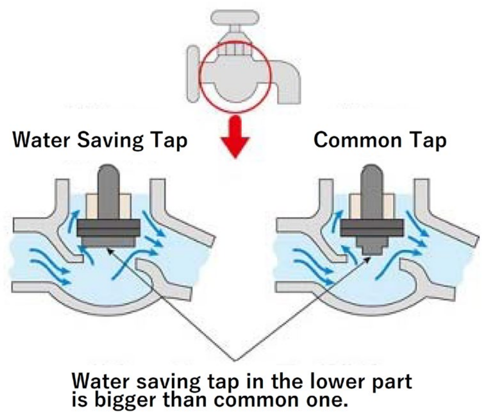


Source: Project Research Team

Figure 3.2 Two-part Tariff System

(2) Saving Water Use

The water discharge is reduced at large openings by installing water-saving taps (Figure 3.3). Various awareness-raising activities are being conducted to promote water conservation.



Source: Tokyo Metropolitan Government, Bureau of Waterworks

Figure 3.3 Water Saving Tap

i) Public Relations Activities: Kumamoto City established the "WakuWaku (Exciting) Water Saving Club" to promote water conservation through community collaboration. The mascot character "Sessui-chan" requests residents to save water (Figure 3.4).

ii) Water Day: August 1 was designated as Water Day to deepen the understanding of, and interest in, precious water resources and healthy water cycles. Local governments and related organizations collaborate to execute nationwide awareness campaigns.

iii) Water Saving Campaigns: Government organizations are conducting water-saving campaigns such as calling for water conservation on the radio and Internet.

iv) Mizu-iku (Water Education): Private companies host Mizu-iku, a program for the youth who would lead the next generation. The program encourages children to experience the wonders of nature, understand the importance of water and growing water, and then consider their role in water conservation.

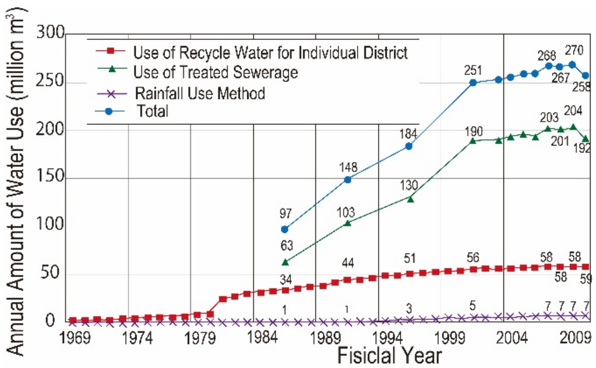
v) Ecolabeling System: The Japanese Environmental Association started an ecolabeling system in 1989. Ecolabeling is the only environmental label in Japan in accordance with ISO14024 Environmental labels and declarations. Water-saving equipment, such as water-saving toilets and taps, are certified through this system.

Source: Kumamoto City

Figure 3.4 Mascot for Water Saving

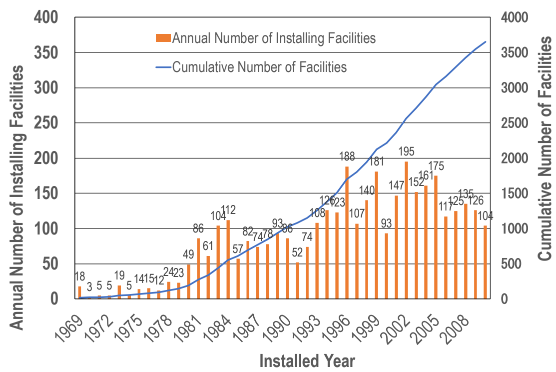
(3) Usage of Rain and Wastewater

Rainwater, recycled water, and treated sewage water were used in buildings and districts. The use of rainwater and recycled water in Japan began in the mid-1980s in areas where the water supply was limited. Figures 3.5 and 3.6 show the annual volume of water used and the number of facilities, respectively.



Note: MLIT Water Resources Department (end of 2010)
Totals may not match due to rounding.
Source : Water Resources in Japan (2013), MLIT

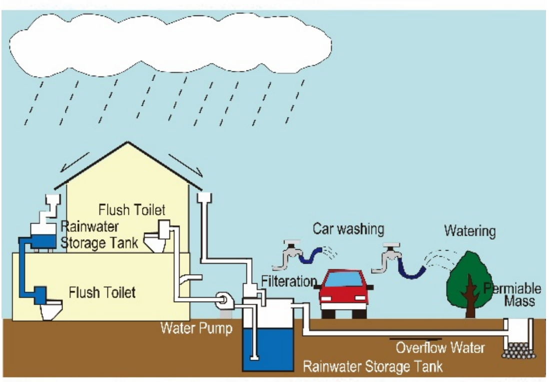
Figure 3.5 Trends in Rainwater and Recycled Water Use



Note MLIT Water Resources Department (end of 2010)

Figure 3.6 Changes in Rainwater and Recycled Water Use Facilities

1) Rainwater use: The use of rainwater promotes the effective use of water resources and contributes to controlling the outflow of rainwater into sewerage and rivers. The Act for the Promotion of Rainwater Use was enacted in 2014. Rainwater harvesting, in which rainwater is collected on the roofs of buildings and stored in tanks to be used for watering trees and flushing in toilets, is performed at individual, local, and national levels (Figure 3.7). The Ryogoku Kokugikan Sumo Stadium constructed in the 1980s has a rainwater tank that stores 1,000 m^3 of rainwater in the basement and is used for toilets, air conditioning, and sprinkling.

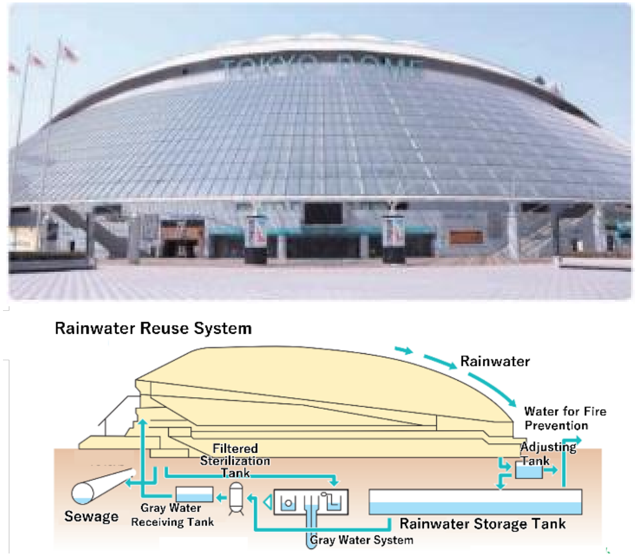


Source: Sumida Ward Website

Figure 3.7 Rainwater Reuse

Rainwater Use at Tokyo Dome

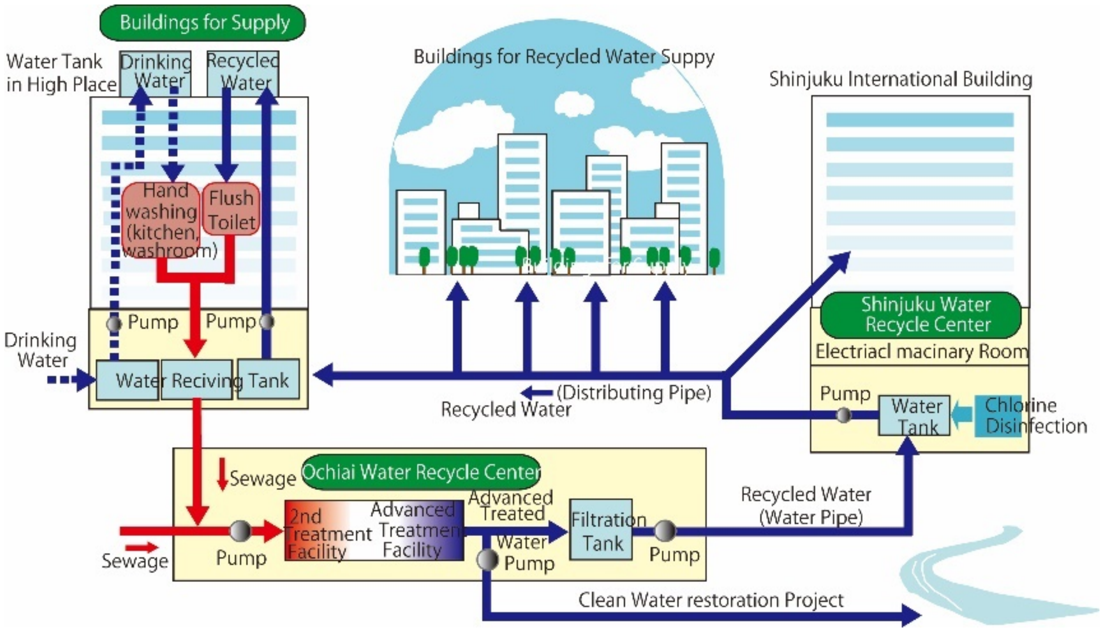
Tokyo Dome is an all-weather multipurpose stadium operating for professional baseball games, sports, and concerts since 1988. (Figure 3.8). The underground rainwater storage tank of 3,000 m^3 in the Dome stores the rainwater harvested on the roof and conveyed by the drainage system. This water is then utilized for flushing toilets and firefighting. Rainwater comprises approximately 30% of the recycled water in the Dome. The rainwater use has contributed to saving water on a large scale, including annual reduction of about 68,000 m^3 in 2007.



Source: Rainwater Use Case Studies, MLIT
Photograph and figures are provided by Tokyo Dome Corporation

Figure 3.8 Rainwater Use in Tokyo Dome

2) Recycled water: Wastewater treated with advanced treatment can be used for flushing toilets, washing cars, and cleaning drainage in buildings and areas. There are three circulation patterns: i) recycled water within the building, ii) regional circulation jointly operated by the building in small but cohesive areas, and iii) recycled water for business facilities and houses covering a large area (Figure 3.9).



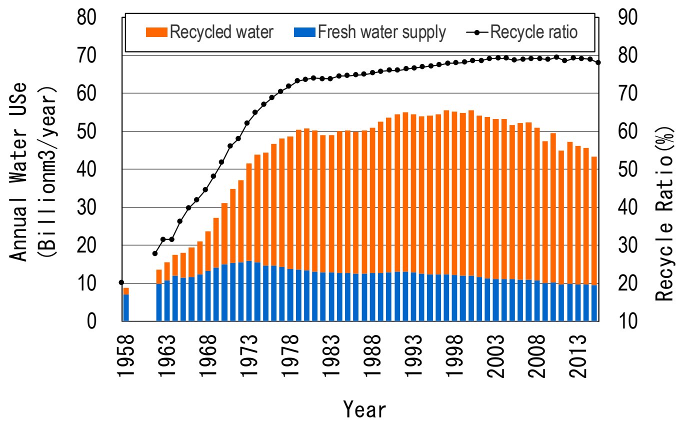
Source: Website of Tokyo Metropolitan Government Bureau of Sewerage

Figure 3.9 Recycled Water Supply System (Nishi-Shinjuku and Nakano-Sakaue Area)

3) Use of treated sewage water: Advanced treatment of sewage water allows it to be used in the same way as recycled water. The reuse ratio of treated sewage water was approximately 1.2% in fiscal year (FY) 2016 in Japan.

(4) Recycle of Industrial Water

Measures to control industrial water include 1) changing the water fee system, 2) increasing the recycling ratio, and 3) reusing wastewater. Until around 1980, the recycling ratio of industrial water increased to curb the water demand. The amount of recycled water exceeded that of the fresh water supply in 1970. In 2015, the recycling ratio was approximately 77.9% (Figure 3.10).



Note: Data of water use of business establishments with 30 or more employees excluding water used in public services
Source: Statistics from the Ministry of Economy, Trade and Industry

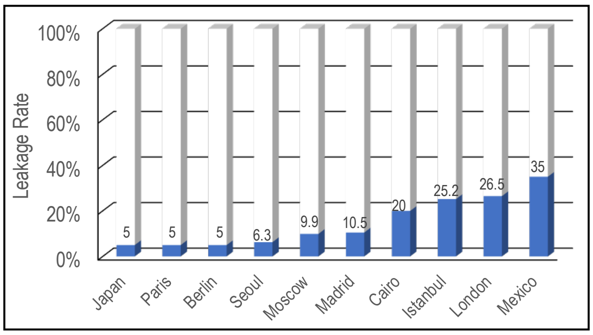
Figure 3.10 Changes in Industrial Water Usage

3.2 Improvement in Leakage in Water Supply

The effects of prevention of water leakage have similar impacts with the development of water sources. In some developing countries, the leakage rate in major cities is high. Figure 3.11 shows the leakage rates of major cities worldwide. Figure 3.12 shows the non-revenue water rate[1] in developing countries.

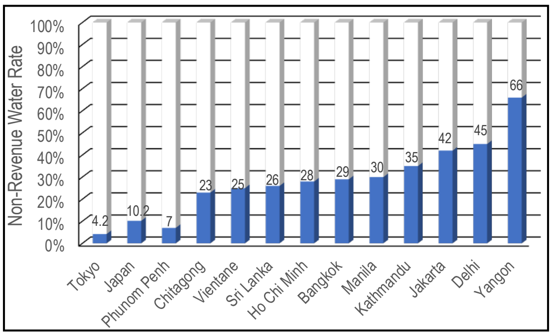
[1] Non-revenue water refers to water that cannot be collected due to leakage or theft from pipes, and since there is little data on only leakage in developing countries, the non-revenue water rate is shown here.

The leakage ratio in Japan was 26.8% in 1965 but improved to 7.2% in 2009. In Tokyo, the ratio improved from about 20–30% in the 1950s to 3% by 2008 (Figure 3.13). Leakage can be prevented by setting goals and formulating a comprehensive plan (Table 3.1).



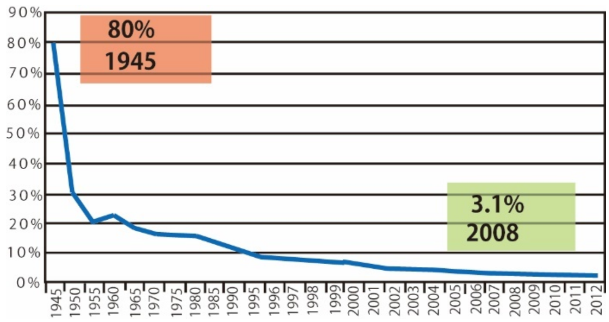
Source: Japan's Approach to Global Water Problems (2012), House of Representatives Research Office, Legislation and Survey No. 332
Statistics of Tokyo (2013), Tokyo Metropolitan Government Website

Figure 3.11 Leakage Rates of Major Cities in the World



Source: Tokyo, Japan: Water Research Center (Public Interest Incorporated Foundation), Water Services Hot News No. 543, December 16, 2016
Others: Research on International Comparison of Water Services, Japan Water Research Center, 2018

Figure 3.12 Comparison of Non-Revenue Water Ratio in Cities in Japan and Developing Countries



Source: Japan's Experience on Water Supply Projects, JICA

Figure 3.13 Changes in Water Leakage Ratio in Tokyo

Table 3.1 Leakage Prevention Measures

Measures	Item	Details
Basic Measures	Preparation	Establishment of construction system and maintenance of document and equipment
	Basic survey	Evaluation of the amount of water distributed and leaked, and water pressure
	Technology development	Improvement of pipes and equipment and development of methods to detect and measurement leaks
Symptomatic Measures	Flexible works	Immediate repair of leaks in ground
	Planned works	Detection and repair of leaks at an early stage
Protective Measures	Improvement of water distribution and water supply pipes	Replacement of pipes, maintenance of water supply pipes, prevention of pipe corrosion
	Water pressure adjustment	Maintenance of pipelines, establishment of block distribution system, measurements of water pressure
	Understanding the pipeline condition	Evaluation of pipelines through data collection and analysis

Source: Water Services Maintenance Guidelines, Japan Water Works Association 2006

3.3 Desalination

The desalination of seawater has become a technically and financially viable option to supplement conventional water resources in regions with scarce water resources. Approximately 20,000 desalination plants exist worldwide, with a total production capacity exceeding 100 million m^3/day. Approximately 7,000 plants are used for domestic water supply, with a total capacity of about 70 million m^3/day. There are 682 desalination plants in Japan, with a total capacity of 768,400 m^3/day (8.9 m^3/sec). A total of 463 plants (approximately 60%) were for industrial use, while 219 were for domestic use, mainly on small islands. The total production capacity of the latter plants was 285,600 m^3/day (3.3 m^3/sec). Table 3.2 shows large-scale seawater desalination plants in Japan. Table 3.3 shows the advantages and issues of desalination.

There are two key desalination methods: evaporation and membrane desalination. More plants used the membrane process than before because development of membrane technology is significant in (Table 3.4). In terms of cost, the construction cost of a facility with a capacity of 10,000 m^3/day or more was 100,000–200,000 Japanese yen/m^3/day. The water production cost was 100–150 Japanese yen/m^3.

Approximately 40–45% of the water taken from the sea is processed to freshwater, and the remaining 55–60% is left as concentrated saltwater and returned to the sea. Water quality standards were determined to secure evaporation residue[2] of 500 mg/L or less based on the guidelines of the World Health Organization (WHO).

Table 3.2 Large-scale Seawater Desalination Plants in Japan

Facility	Operation Start	Use	System	Production Capacity	Construction Cost
Chatan Water Treatment Administration Office, Okinawa	April 1997	Water Supply	Reverse Osmosis	40,000 m^3 /day	34.7 billion yen
Uminonakamichi Nata Sea Water Desalination Center, Fukuoka	September 2005	Water Supply	Reverse Osmosis	50,000 m^3 /day	40.8 billion yen

Source: Project Research Team

Table 3.3 Advantages and Issues of Desalination

Advantages	Issues
• Issues related to water rights are unlikely to occur. The period from planning to completion is short. • Water can be secured, regardless of drought and climate change. • Construction cost may be lower than that of conventional water supply facilities, in which freshwater is conveyed from distant dams or rivers.	• High cost for both construction and operation and maintenance. • High energy consumption. • Impact on the ecosystem due to the release of concentrated salt water.

Note: When comparing the construction costs, the desalination plant project cost includes only the construction of the plant, whereas the cost of the conventional water supply project includes the construction cost of the water source (e.g., dam), water supply facilities, water purification facilities, and water transmission facilities. If the costs of desalination plants and water purification facilities are simply compared, those of desalination plants are more expensive.
Source: Project Research Team

[2] Evaporation Residue: The total amount of suspended or dissolved material obtained as residue when water containing the material is dried by mean of evaporation. The main components of the evaporation residue in tap water are salts, such as calcium, magnesium, silica, sodium, and potassium, and organic matter. This value is determined to ensure taste since water with excessive values tastes bitter.

Table 3.4 Key Desalination Methods

Process	Method	Description	Application
Evaporation	Multi-stage flash distillation, Multiple effect distillation	Evaporate saline water to remove salt.	Almost limited to the Middle East, where energy cost is inexpensive.
Membrane	Reverse osmosis	Seawater and freshwater separated by semipermeable membrane, and freshwater moves to the seawater side (osmosis phenomenon). Reverse osmosis occurs by applying pressure that exceeds the osmotic pressure on the seawater. Water on the seawater side then moves to the freshwater side.	Highly energy-efficient and currently the most widespread method. Energy consumption has been reduced to less than one-third over the last 20 years.

Source: Project Research Team

CHAPTER 4 FLOOD PROTECTION EFFORTS

4.1 Implementation of Comprehensive Flood Protection

Urban flood damages increase due to the increase in flood discharge and the concentration of assets by urbanization. In addition to river improvement, basin-wide measures are necessary for flood protection, while cooperation among stakeholders is crucial to implement measures.

(1) Increase in Urban Flood Damages

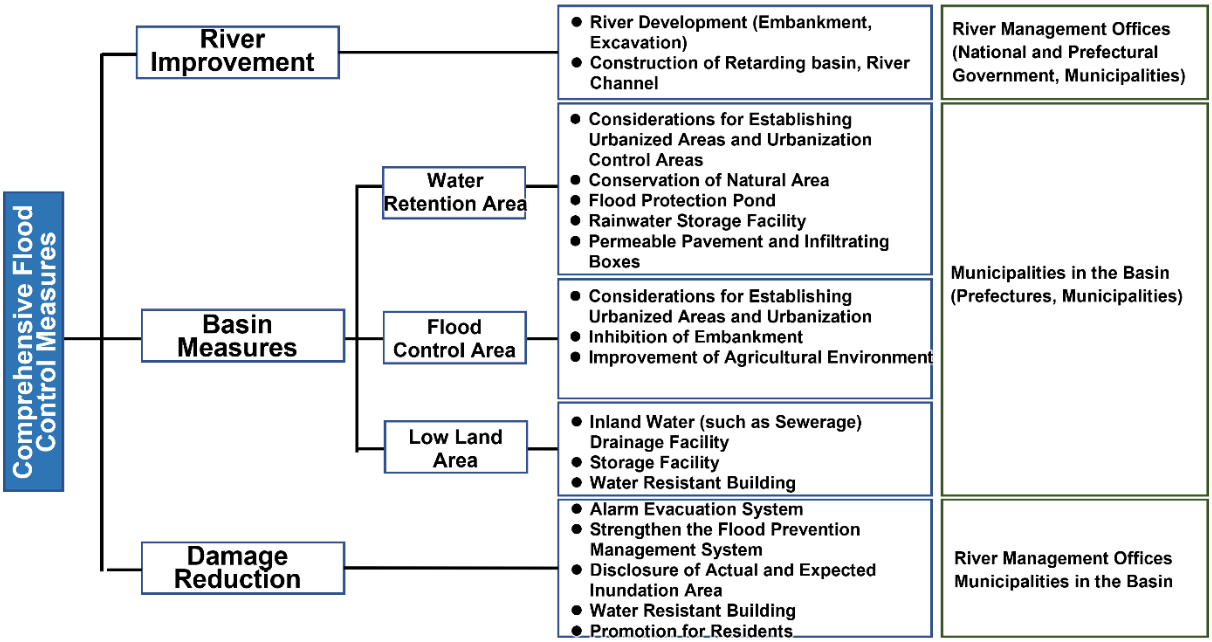
Governments should consider flood risks to promote urban development. However, urban planning proceeded without considering flood risks enough during high economic growth in Japan. Surface runoff increased because of urbanization, which deprived the runoff retarding function. Urbanization increases flood risk by concentrating on population and assets. Thus, urbanization has increased flood damage and made urban flooding a social problem. While population growth began to subside and urban development pressure decreased, the damage potential continued to increase and land use developed more intensively. Even currently, flooding occurs because of the small capacity of the drainage system. The total amount of flood damage in Tokyo over the past decade was approximately 17.6 billion Japanese yen due to floods from rivers and 42.9 billion Japanese yen due to floods from urban floods, corresponding to 71% of the total damage.

(2) Comprehensive Flood Protection Measures

Comprehensive flood protection measures address flooding throughout the basin. The government started the Promotion of Comprehensive Flood Protection Measures in 1980, targeting 17 urban rivers. The structure of this policy is illustrated in Figure 4.1. While conventional flood protection depends only on the improvement of rivers, comprehensive flood protection integrates measures for river improvement, basins, and flood damage reduction.

As the involvement of various agencies is essential, proper governance must be established. It is also crucial to coordinate the development of flood protection measures with basin development and land use planning. A basin countermeasure council was established to coordinate the related organizations. The council consists of the Regional Bureau of the MLIT, prefectural and municipal departments overseeing rivers, and other related departments, such as urban housing and land.

The council discusses specific measures for basin planning and formulates the river basin development plan. It divides responsibilities by dividing the flood discharge into the river portion to be handled by river management offices (RMOs) and the basin portion by various parties managing sewerage, land use, stormwater detention ponds, and permeable pavements. The Tokyo Metropolitan Government established its own council chaired by the Director of Urban Infrastructure Development, comprising the relevant bureaus and municipalities of Tokyo.



Source: Materials for Committee for Program Evaluation of Comprehensive Flood Protection Measures, MLIT, 28 August 2003

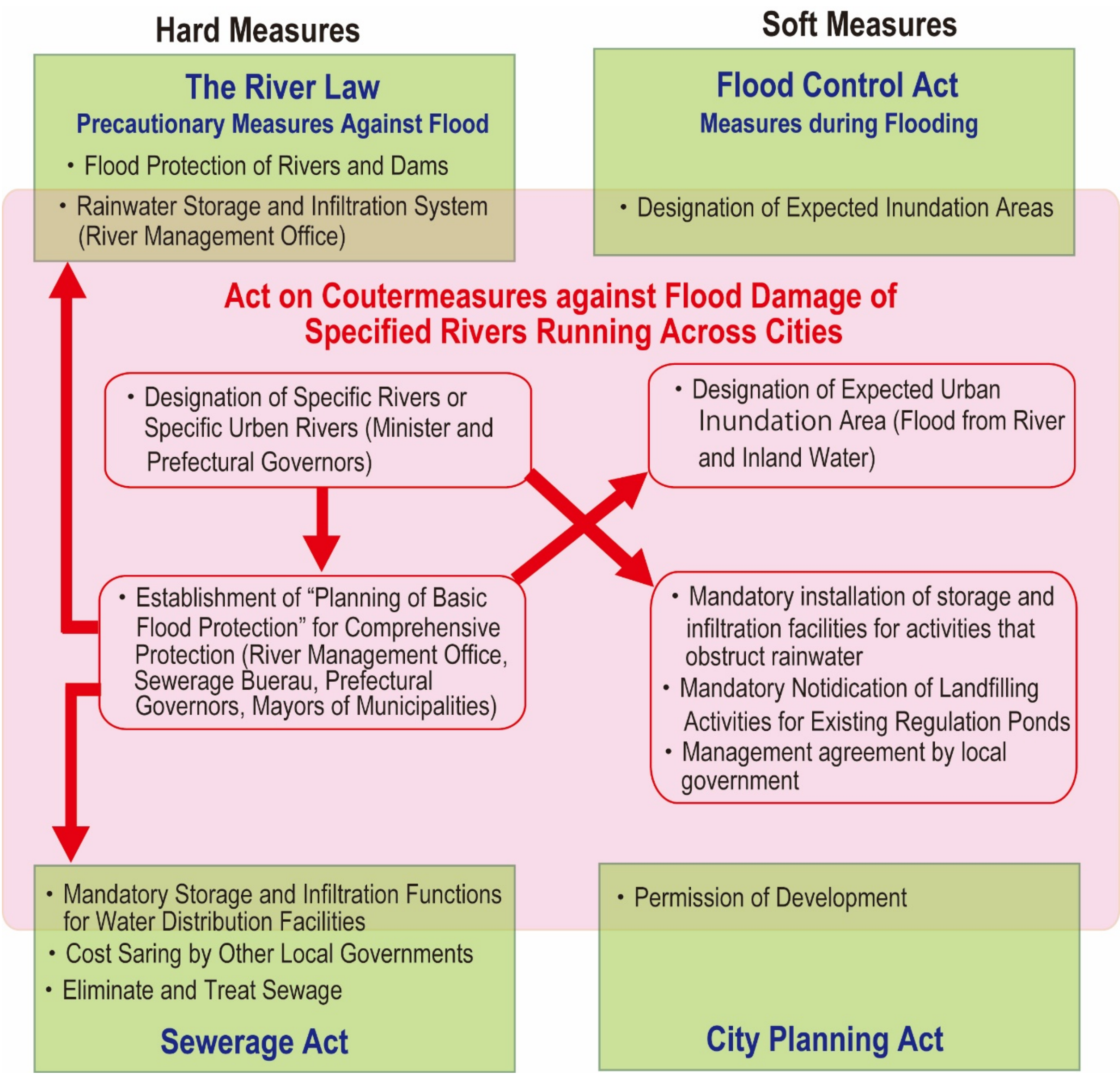
Figure 4.1 Comprehensive Flood Protection Measures

(3) Further Measures: The Act on Countermeasures against Flood Damage of Specified Rivers Running Across Cities in 2003

Although comprehensive flood protection measures had been implemented, the remaining issues still need to be resolved. The Act on Countermeasures against Flood Damage of Specified Rivers Running across Cities in 2003 aims at strengthening measures as follows:

1) Inclusion of Sewerage Bureau in the related organization,
2) Legally binding basin measures, such as maintaining rainwater storage facilities and acquiring permission to impede rainwater infiltration
3) RMOs can develop rainwater storage facilities and infiltration facilities in urban area, and
4) Expansion of regulations by ordinance.

Figure 4.2 shows the relationship between the Act and other relevant laws. The RMOs, Sewerage Bureaus, and local governments in the river basin jointly formulated an integrated river basin flood protection plan for the urban rivers designated by the Act. These measures included implementing river improvements, constructing sewage systems, improving rainwater storage, enhancing and infiltration facilities.



Source: FY2009 Policy Review results (evaluation report): Comprehensive flood countermeasures – Verification of the Implementation Status of the Act on Countermeasures against Flood Damage of Specified Rivers Running across Cities, MLIT (March 2010)

Figure 4.2 Relationship between the Act on Countermeasures against Flood Damage of Specified Rivers Running Across Cities and Other Relevant Laws

(4) Sewerage System

The Social Infrastructure Development Council reported on the medium-term objectives in 2007 to correspond to rainfall once every 10 years in important districts. The government implemented the following measures: 1) development of rainwater drainage, pumping stations, and rainwater storage and 2) development of inundation maps for preparing evacuation.

The Act on the Promotion of Rainwater Usage, enacted in 2014, stipulates that rainwater outflow is controlled by rainwater storage. The Sewerage Act, revised in 2015, stipulated the establishment of the Flood Damage Protection Area. Local governments designate areas where flood protection measures should be implemented through public-private partnerships (PPPs) in conjunction with urban redevelopment. The government can provide funds to the private sector to help construct rainwater storage facilities. Local governments can require the private sector to install rainwater storage and infiltration facilities and manage facilities installed by the private sector based on agreements.

In 2018, only 59% of sewerage systems in the Tokyo metropolitan area could treat rainfall events that occur once every five years. The metropolitan government is making efforts to respond to the rainfall that occurs once every 10 years. Furthermore, the government is developing sewerage systems, providing flood information, publicizing flood damage protection area maps, establishing evacuation and disaster prevention systems, and implementing public relations activities and warning issuances.

4.2 River Improvement in Urban Areas

> Coordination of the river improvement and the urban projects can protect against flood and improve the water environment.

The river improvement plan should integrate river and town spaces to improve the environment.

1) Shinano River: Gentle-slope levees with a gradient of 1:5 were constructed in Niigata City. In addition to disaster prevention, they are utilized as places for relaxation. Known as "Yasuragi-tsutsumi, they constitute a valuable waterfront space (Figure 4.3).

2) Motomachi visitor-oriented embankment: Riverside green spaces were created as part of the land readjustment project for post-World War II (WWII) reconstruction. Considering the landscape of the Ota River running through Hiroshima City (Section 5.4), they have become symbols of Hiroshima City as an attractive waterfront space (Figure 4.4).

Source: MLIT Shinano River Downstream Office Website

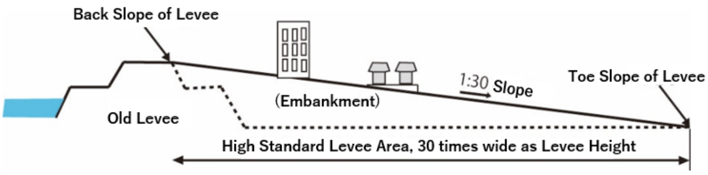
Figure 4.3 Yasuragi-tsutsumi in the Shinano River

Source: MLIT Website

Figure 4.4 Visitor-oriented Embankment at Moto Town in the Oota River

(1) High Standard Levee (Super Levee)

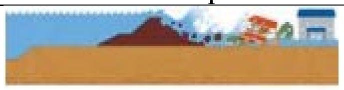
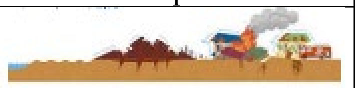
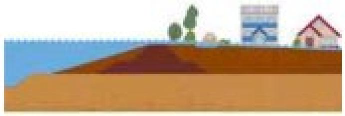
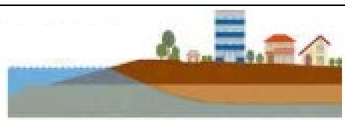
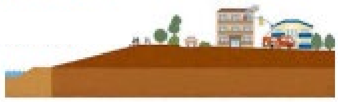
There is a risk of catastrophic damage caused by levee failures in low-lying areas, where the population and assets are densely concentrated. The national government has constructed wide and gentle slope levees, called high standard levees or super levees since 1987, to improve flood protection in large rivers. Figure 4.5 shows the concept of a high standard levee and Figure 4.6 shows their effects. The project called Heart Island SHINDEN is an example of integrated urban development



Source: Current Status and Issues of Development of High Standard Levees, Nobuhiro Yamashita, Research and Legislative Reference Bureau, National Diet Library, Reference No.831 (April)

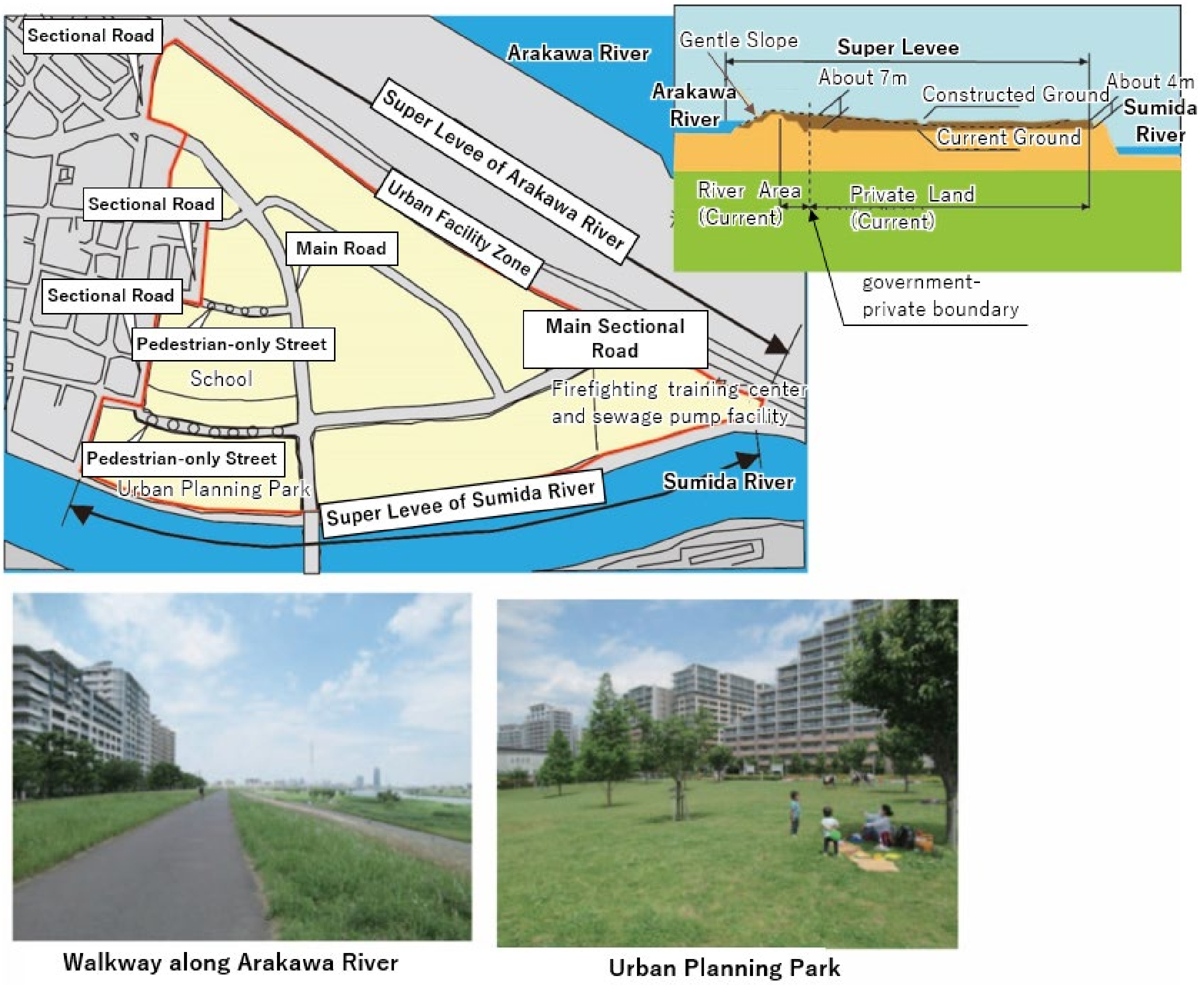
Figure 4.5 High Standard Levee Concept Diagram

utilizing water and greenery applied to a super levee. It was constructed on the land of 20.0 ha surrounded by the Arakawa and Sumida Rivers in Tokyo. (Figure 4.7).

Type	Overtop	Infiltration	Earthquake
Normal			
High standard			
	Even if water overflows, it will flow gently over the levee and prevent it from collapsing.	Even if the water infiltrates into levee, the wide levee prevents its collapse	To strengthen the ground and avoid damage with liquefaction by earthquake.

Source: MLIT Website

Figure 4.6 Effects of a High Standard Levee



Source: UR × Green Infrastructure Case Studies prepared by the UR Agency with the addition of the Project Research Team.

Figure 4.7 Heart Island SHINDEN: Urban Development Utilizing Water and Greenery

4.3 Retarding Basin, Regulation Ponds, and Underground Diversion Tunnel

Storing flood water in facilities can effectively decrease flood damage. The sites can be used for multiple purposes for ordinary times.

Retarding basins and regulation ponds store a portion of the floodwater. As land acquisition is difficult in urban areas, sites should be effectively utilized.

(1) Myoshoji River No. 1 Regulation Pond (Shinjuku and Nakano Wards, Tokyo)

Source: Myoshoji River No. 1 Regulating Pond pamphlet, Tokyo Metropolitan Government

Figure 4.8 Myoshoji River No.1 Regulation Pond

Housing complexes were developed with flood regulation ponds and parks as integrated joint projects to effectively utilize valuable spaces and reduce costs. The floor area ratio regulation was relaxed to lower the development cost. High-rise residential buildings located above the regulation ponds were constructed as piloti-type buildings (Figure 4.8). The regulation pond area is normally used for sports and recreation facilities, such as roller-skating rinks and tennis courts (Table 4.1). The park was constructed by the Housing and Urban Development Corporation (current Urban Renaissance [UR] agency) and managed by the Shinjuku and Nakano wards.

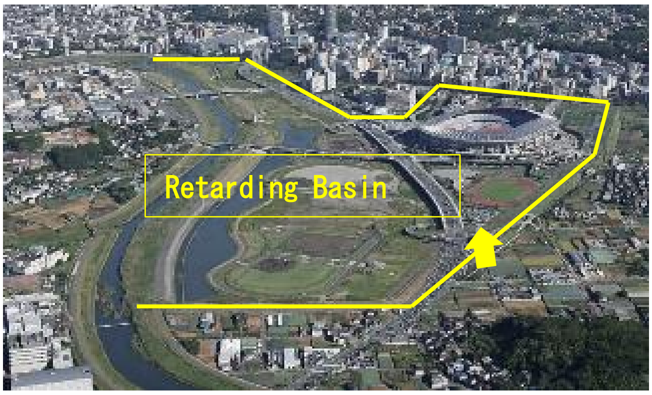
Table 4.1 Implementation Allocation of Myoshoji River No. 1 Regulation Pond

Items		Tokyo Metropolitan Government	Shinjuku / Nakano Wards	UR Agency
Land Use	Land Ownership	-	50%	50%
	Land Use	Using entire area as regulation pond	2/3 of the total area is used as a park	1/3 of the total area used as housing
	Land Acquisition Cost Allocation	42%	33%	25%
Implementation	Allocation	Construction of regulation pond, riverbank protection, outlet, inlet, management passage	Park maintenance	Construction of rental housing (piloti-type buildings)
Operation and Maintenance		Removal of sediment from riverbanks and regulation pond due to flooding	Park Maintenance	Maintenance of residential area

Source: Consideration of the establishment of a framework for river development that contributes to regional revitalization Morikawa Yoichi, et al. / Riverfront Research Institute, 2010 Research Report

(2) Tsurumi River Multipurpose Retarding Basin (Kohoku Ward, Yokohama City)

Nissan Stadium, where the 2008 Soccer World Cup final was held, is located in the Tsurumi River multipurpose retarding basin (Figure 4.9). The lower parts of the stadium were built as pilotis, and surrounding areas are used as retarding basins.



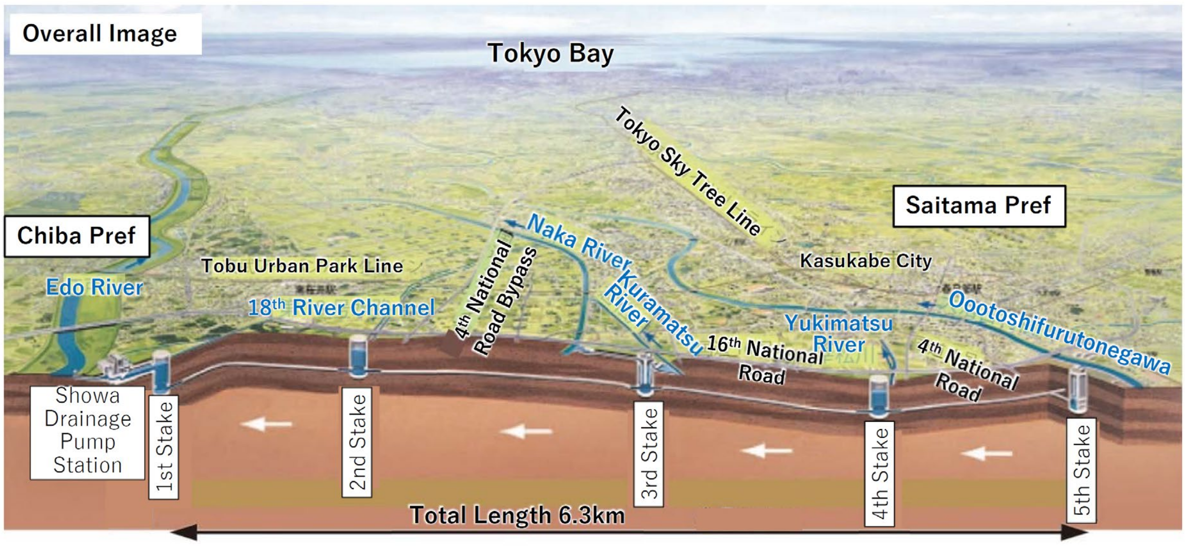
Source: Tsurumi River Multipurpose Retarding Basin Pamphlet (edited), MLIT with addition by Project Research Team

The photo is the view from the direction of the arrow on the picture provided on the left side.
Source: MLIT Keihin River Office Facebook

Figure 4.9 Tsurumi River Multipurpose Retarding Basin

(5) Underground Diversion Tunnel

Underground diversion tunnels are constructed in large cities, where land acquisition is difficult. The metropolitan area of the outer underground diversion tunnel (Figure 4.10) is one of the world's largest underground floodways, built 50 m below the ground surface. The tunnel reduced the number and area of inundated houses. The river basins of the Nakagawa and Ayasegawa rivers are surrounded by large rivers such as the Tone, Edogawa, and Arakawa Rivers. The small river gradient makes it difficult for water to flow into the sea in a short time, and the water level does not decrease easily during flooding.



Source: MLIT Edogawa River Management Office Website

Figure 4.10 Overall Image of the Metropolitan Area Outer Discharge Tunnel

CHAPTER 5 IMPROVING WATER ENVIRONMENT

Improving the water environment requires an approach from multiple perspectives, including water quality, discharge, ecosystem, and the use of waterfront spaces.

5.1 Development of Green Infrastructure

Developing green infrastructure can achieve various effects, such as disaster management, improvement of living and waterfront environments, conservation of ecosystems, promotion of regional development, and mitigation of climate change.

Japan has promoted green infrastructure or nature based solutions, which uses natural functions for disaster risk management. Green infrastructure can resolve water related issues in urban areas also (Theme 4: Water Pollution and Environmental Management, Section 5.4).

(1) Umeda River: Umeda River is a tributary of the Tsurumi River in Yokohama City. Works restored continuity between the forest on the slope and the river (Figure 5.1). The right bank was excavated to secure the flood flow capacity. The excavation was conducted along the contour lines of the topography. Consequently, the width and slope of the riverbank vary among places. Gabions covered with soil were placed as revetments on the hillside slope to recover vegetation. The waterfront was developed to provide a safe place for children to approach and play (Figure 5.2).

Before construction: plank hurdle revetment

Renovation: gabion revetment on right bank

Half year after construction: vegetation recovered on the gabions covered with soils

Thirteen years after construction: the natural connection between slope and river is maintained.

Note: The yellow oval lines show the construction area of the gabion revetment.
Photograph: provided by Yoshimura Shinich (Yoshimura Shinich Watershed Planning Offfice)

Source: Nature-friendly River Works Reference Book, Riverfront Research Center

Figure 5.1 Example of Nature-friendly River Works

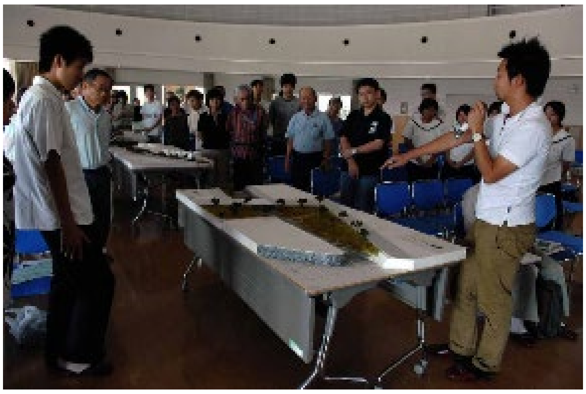
(2) Kamisaigo River: Fukutsu City, in Fukuoka Prefecture, restored the Kamisaigo River as a nature-friendly river. The river is a typical urban river with concrete revetments (Figure 5.3), scarce living creatures, and poor accessibility. The connection between the river and community was weak. Local citizens and Kyushu University discussed the river plan, tree-planting, and management system (Figure 5.3). At present, children play in rivers and people walk around on the riverfront. The local community cleans the river and cuts grasses. The river is also used in environmental education for elementary school children (Figure 5.3). Environmental improvement work is underway to create nature-friendly rivers by citizens themselves.

Source: Yokohama City Road Burau River Department

Figure 5.2 Waterfront Environment Established by the Project for Waterfront Schools for Fun

Pre-renovation

Post-renovation



Planning with thorough citizen participation

Frequently used for environmental studies by children

Photograph: Provided by Yoshimura Shinich (Yoshimura Shinich Watershed Planning Office), Hayashi Hironori (Kyusyu University)

Source: River Law Amendment 20 Years Nature-friendly River Management Promotion Committee, 1st Pamphlet: Specific Examples of Nature-friendly River Management (No. 1), MLIT

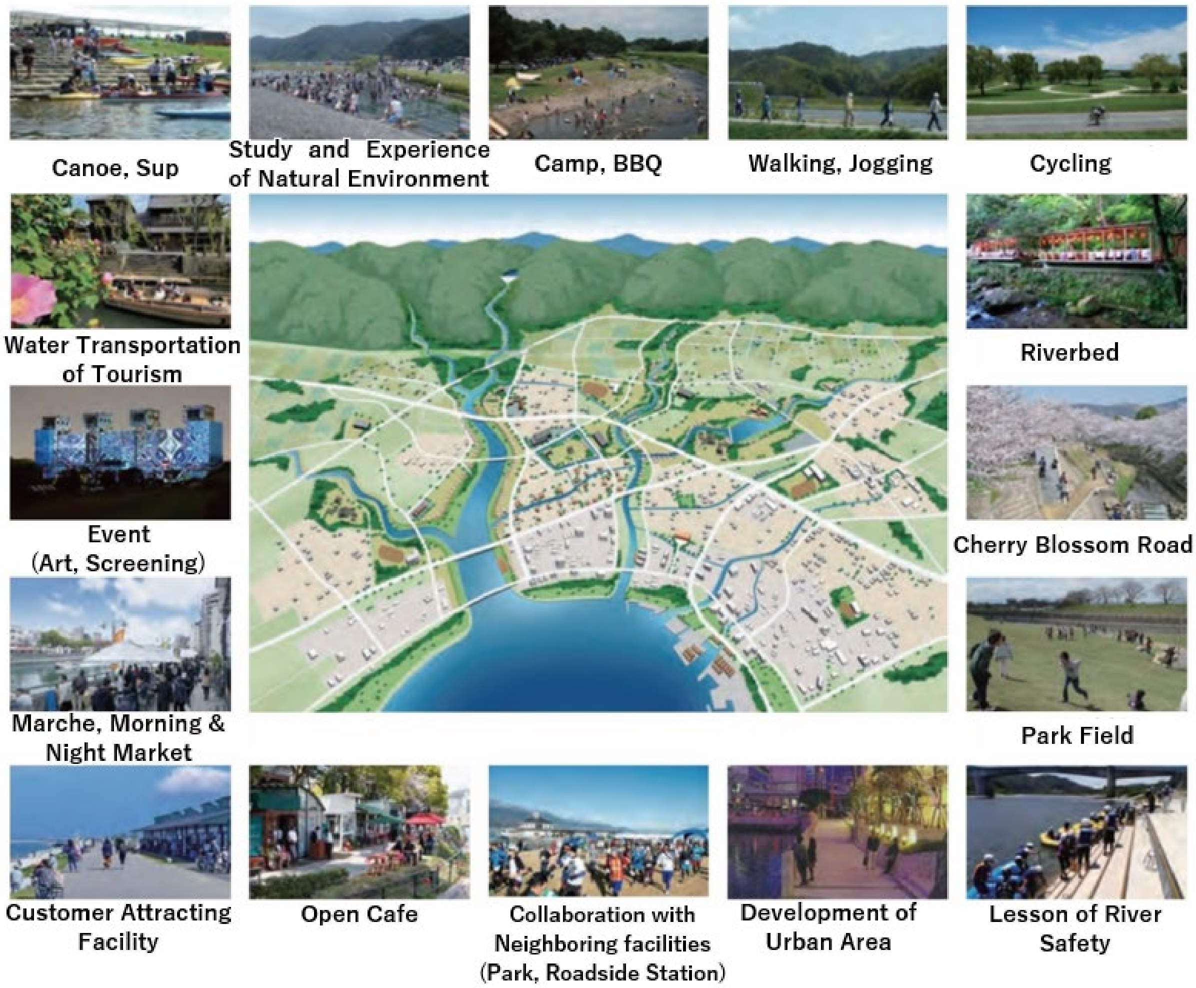
Figure 5.3 River Restoration Works of the Kamisaigo River, Fukuoka Prefecture

5.2 Improving Waterfront

Improving the waterfront environment can attract tourists, thereby leading to regional revitalization.

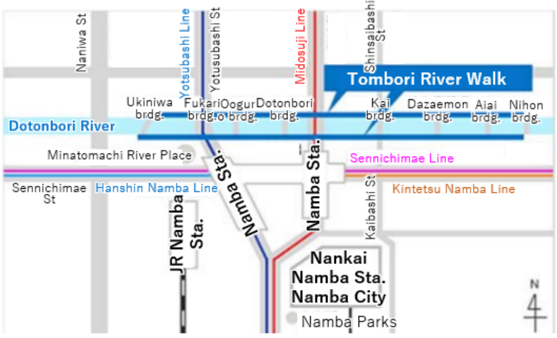
New values may be created by uniting the "river" and "town." Specifically, river spaces may be used for regional revitalization and tourism promotion by utilizing the resources and creative "wisdom" of the region. To this end, municipalities, private businesses, residents, and RMOs should collaborate with a developmental approach. Kawamachi Zukuri (River-Town Planning) aims to revitalize the community and improve the local brand (Figure 5.4).

In Dotonbori River located in Osaka downtown, a promenade was built, which was called "Tombori River Walk." (Figure 5.5). In addition to water purification, local organizations participated in this River-Town Planning project. Since its opening in 2013, it has been crowded with tourists.



Source: Guide for Formulating a River-Town Development Plan, 1st Edition, MLIT, March 2020

Figure 5.4 Possible Developmental Sceneries Achieved through River-Town Planning



Location Map **Night View of Dotonbori River**

Source: MLIT Website (Photograph: Riverfront Research Center)

Figure 5.5 Example of River-Town Planning along the Dotonbori River

5.3 Sewerage Improvement

Sewerage systems play an important role in forming healthy water cycles in urban areas.

Sewerage systems collect, treat, and discharge rainwater and sewage (Theme 4: Water Pollution and Environmental Management). Sewerage systems in Japan aim to 1) prevent inundation damage, 2) eliminate sewage and secure public health, and 3) preserve the quality of water in rivers and seas. As residents have more opportunities to encounter waterfronts, they have more interest in surrounding water areas such as rivers and canals, and want a rich water environment.

Local governments are improving the combined systems to drain sewage and rainwater in the same pipes. The inflow to the sewage treatment plant exceeded the treatment capacity of the plant during heavy rainfall events. The excess inflow is discharged directly into the rivers without being treated.

5.4 Response to the Urban Poor in the River Area

The living conditions of urban poor in the river areas could be improved by promoting relocation to affordable housing with flood protection works.

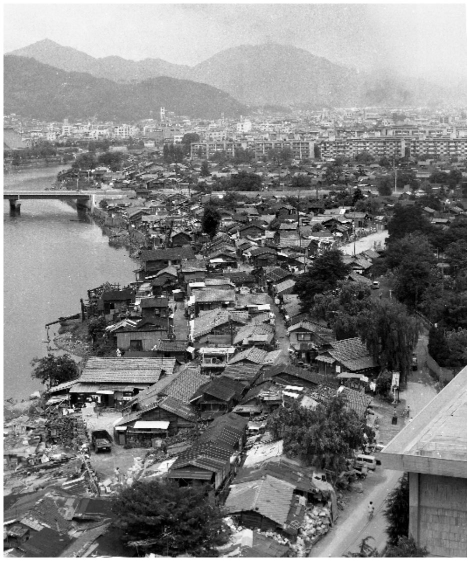
Urban poverty is increasing in cities in developing countries. The population in rural areas has moved to large cities to seek employment. Insufficient houses in urban areas have led people to build huts on river areas, slopes, and public land unsuitable for habitation.

Following the end of WWII in 1945, many people lived on the riverside in Japan. In Hiroshima City, the people comprising war victims and repatriates lived in a place known as Atomic Bomb Slums, located along the mainstream of the Ota River. (Figure 5.6). More than 4,500 high-rise housing units (up to 20 floors) have been constructed, including improved housing,[3] to accommodate residents. Parks and riverside green spaces have been secured, and infrastructure facilities such as shopping centers,

[3] Improved Housing: Rental housing constructed under Residential Areas Improvement Act, 1960. In densely populated areas, the MLIT designated the removal of poor or dangerous housing at high risk of impact from disaster-related damage, or inaccessible for fire trucks in the event of fire. These rental houses were built for residents who would otherwise lose their living space because of this removal.

elementary schools, and meeting areas have been established. The land has been developed into Hiroshima City Central Park and Ohta-Motomachi embankment (Figure 4.4).

In recent years, vagrants (homeless) have temporarily settled in the water channel area of rivers (Figure 5.7). In the Arakawa River, the RMO has been conducting joint patrols with police, relevant municipalities, and welfare departments.



Source: "Motomachi Aioi Street as seen from Rooftop of the Chamber of Commerce" Photo in Bulletin of the Hirosima City Archives, No.30,1
Photographer: Research Group of Community Structure/Provider: the Hirosima City Archives

Figure 5.6 Atomic Bomb Slum in Hiroshima

Joint Patrol Before and After Guidance to the Homeless

Source: Efforts to respond to homelessness in the lower Arakawa River, Arakawa River Office, Onagi River Sub-branch, Ooyama Takeshi, MLIT.

Figure 5.7 Measures to Address the Homeless in the Arakawa River

CHAPTER 6 LESSONS LEARNED

(1) **To ensure coexistence with the environment and resolve various urban related issues, the water cycle should be restored.** The concentration of urban population, expansion of urban areas, and increase in socioeconomic activities have caused deterioration of the water cycle in urban areas. These affect various areas in terms of the quality and quantity of water, the riparian environment, and groundwater. Organizations were concerned about the need to collaborate to restore the water cycle.

(2) **To cope with water demand due to the influx of the population into urban areas, water demand management and water recycling should be promoted.** Water demand could be managed by tariff systems and other software measures. The reduction of water leakage and use of rainwater and recycled water should be promoted. A review of the production process and recycling water is also required for industrial water supply.

(3) **To mitigate the flood damage in urban areas, comprehensive measures should be taken.** Urbanization caused a decline in water retention capacity and an increase in peak flood discharge. Flood risk is increased by climate change. Thus, integrated approaches to improve river facilities, river basins, and flood damage mitigation should be undertaken. Cooperation among related organizations should also be consolidated.

(4) **To conduct efficient development, the private sector's expertise should be utilized.** For example, parks and piloti-type housing complexes were developed above regulation ponds to store floodwaters in Tokyo. The government organizations provided incentives to the private sector. This has enabled the effective use of expensive land in urban areas.

(5) **To improve the water environment, multiple approaches should be taken in terms of water quality, discharge, ecosystems, and recreation.** A decline in water quality during high economic growth in Japan has resulted in ecosystem deterioration, and residents have avoided access to rivers. Various efforts to improve the water environment have been implemented to integrate "river space" and "town space," improve the waterfront environment, and conserve the ecosystem. Flood protection facilities have also contributed to urban development by providing recreational functions. Involving the local community and private organizations in implementing these initiatives was necessary. This collaboration led to the creation of a good space uniting the "river" and "town," which promoted tourism and rejuvenated the area.

(6) **Developing green infrastructure can achieve multiple benefits**. Flood protection works contribute to achieving various objectives using natural functions. These objectives include disaster management, improvement of the living environment and waterfront, conservation of ecosystems, promotion of regional development, and mitigation of climate change.

(7) **To improve issues of the urban poor in rivers public housing should be provided with river improvement works.** There were many slum areas along rivers in urban areas in Japan during post-WWII periods. Japan resolved these problems by providing affordable public housing for the urban poor with implementing flood protection works.

THEME 6 RIVER MANAGEMENT: MANAGING LAND AND WATER SUSTAINABILITY

ABSTRACT

Legal systems and organizations are necessary to manage river areas and water in an appropriate manner. In Japan, the River Management Office (RMO)[1] permits using rivers in a way that promotes public welfare and interest. Permitted river uses include the occupation of flowing water and land, collection of riverine products such as gravel, the reconstruction and construction of structures such as bridges and weirs, the harvest and transportation of timber, and passage through navigation locks. The river offices on the site conduct river management; the Minister of Land, Infrastructure, Transport and Tourism administers the major rivers of class A rivers, and the prefectural governor administers class B rivers. Penalties are imposed for illegal river use.

For rivers and river structures, the RMO should establish a system to maintain facilities in sound condition. The system should include the inspection of facilities, weeding and removal of obstacles in the river area, and the investigation of the gate condition. If any issues are observed with the river facilities, necessary measures should be adopted to rectify them.

When a flood is expected to occur, the RMO should adopt a precautionary approach, and patrol the river, check facilities, and operate the dam and gate. In collaboration with the Meteorological Agency, the RMO should announce flood forecasts and convey flood information to relevant organizations; the RMO should also support flood-fighting teams via organizing volunteers from the community.

[1] Rivers are for public use and river administrators are the authorities that have the power and are obliged to manage the rivers. River administrators are explained in detail in “Theme 6: River Management.”

CHAPTER 1 INTRODUCTION

The RMO should establish organizations and processes of managing land and water associated with river systems according to the legal systems.

The land and water associated with riverine ecosystems cannot be managed properly if the river area and management body are not clearly defined. These ecosystems are exposed to a number of potential issues. Excessive gravel mining from a river may damage structures such as levees and bridges. Structures and bridges in rivers may impede flood flows and increase flood damage. The discharge of harmful substances may disrupt the ecosystem and negatively impact water supply. Along with cities in developing countries, Japan once faced similar issues, such as building houses in riverine areas and occupying river channels (Theme 5: Urban Water Management); even in present day Japan, problems such as the mooring of boats in rivers still occur.

Legal systems, organizations, and processes need to manage land and water. The following chapters describe how river management systems have been developed for flood protection, water use, and the management of environmental issues. They explain how to ensure safety when constructing structures such as bridges and weirs, how to prevent and manage excessive gravel mining, and how to manage river facilities.

River management systems and policies differ depending on the topographic and historical context. In Japan, the risk of flooding is high because localized torrential downpours are likely to occur owing to weather fronts and typhoons. Two-thirds of the land is mountainous; as such, there are many rivers with steep gradients. Riverside areas have been used as paddy fields to produce the staple crop, rice. Populations have increased, particularly in the alluvial plains where floodplains formerly developed. Urbanization was promoted by inland water transportation which supported the movement of goods. The construction of levees to protect agricultural and residential areas became a basic flood protection policy. However, the occurrence of severe floods could not be eliminated and flood protection consistently remained a key issue in river management. Climate change has also increased the frequency of flood disasters.

Occasionally, water conflicts occurred prior to modernization, along with the development of new paddy fields. Japan developed common-use facilities such as small reservoirs and irrigation canals, and formed customary water use practices. The river-management system was first legislated after the Meiji Restoration with customary practices as the prototype in the background. This has been revised appropriately according to the needs of the present time (Theme 1-2: Water Rights).

Houses Built along River Course

The images below showcase examples of houses that were built along the river course, obstructing flood flow. Historically, municipalities permitted these constructions without considering disaster risks. Once houses were built, relocation was often difficult. Therefore, it is necessary to manage river spaces appropriately.


Source: Project Research Team

Water resource management and the Sustainable Development Goals (SDGs) are closely related. The relationship between river management, technology, and the SDGs is shown in the following box.

Relationships between River Management and the SDGs:

(1) Early response to problems in river structures through river management, such as regular patrols to ensure the proper function of river structures and mitigate flood disasters.

(2) Reduce the number of flood victims by collaborating with organizations (flood fighting groups)

SDG 11 “Sustainable Cities and Communities”: 11.5 “Significantly reduce the number of deaths and victims due to flood disasters”

SDG 13 “Climate Action”: 13.1 “Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters”

(3) Partner with organizations that have been established for river maintenance and emergency responses.

SDG 17 “Partnerships for the Goals”: 17.7 “Encourage and promote effective partnerships among public, public-private and civil society”

(4) Government is collaborating with private groups relating to river management such as environmental and disaster prevention education groups and riverine ecosystem researchers.

SDG 4 “Quality Education”: 4.7 “All learners acquire the knowledge and skills needed to promote sustainable development.”

SDG 6 “Clean Water and Sanitation”: 6.6 “Protect and restore the river ecosystems.”

CHAPTER 2 PURPOSE OF RIVER MANAGEMENT AND MANAGEMENT BODY

2.1 Purpose and Administration

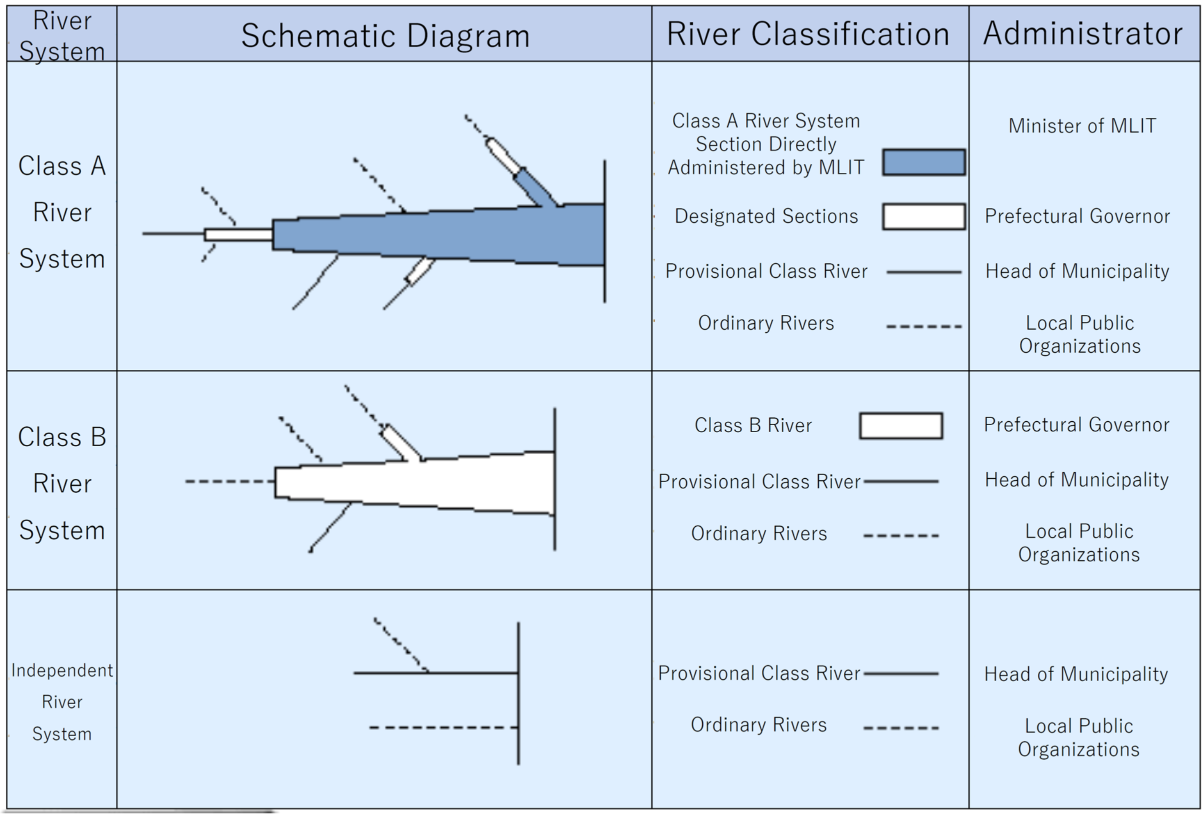
Japan manages rivers from the flood protection, river utility, and ecosystem perspectives.

There are three key purposes of river management in Japan: 1) to prevent disasters caused by floods, tsunamis, storm surges, and other disaster incidents; 2) to properly utilize rivers and maintain the function of streamflow; and 3) to plan the development and conservation of riverine ecosystems. The term "river use" includes the use of the streamflow, along with the riverine land and its products such as gravel and timber. Streamflow is recognized to carry out ten key functions: 1) inland navigation; 2) fisheries; 3) tourism; 4) water purification; 5) salinity intrusion control; 6) prevention of river-mouth clogging; 7) protection of facilities; 8) groundwater conservation; 9) animal and plant protection; and 10) water supply. The River Law applies to the natural environment and the relationship between people and rivers. Owing to the unique natural conditions, flood protection has consistently been the main subject of river management. Preservation of the river environment is highlighted along with the loss of nature caused by urbanization.

Rivers are classified into Classes A and B[2] (Figure 2.1) (Theme 1-1: Legislation and Organization). The Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) manages Class A river systems that are important from the national land conservation and economy perspectives; there are 109 Class A rivers, most of which flow across multiple prefectures. The ministry manages conflicting interests between upstream and downstream prefectures within the same river system or between prefectures on the left and right of the river bank. For example, upstream river improvement works for flood protection should be systematically implemented such that it does not adversely affect the downstream reaches. Conflicts between water source and water consumption areas should be prevented. The prefectural governments manage Class B rivers. Prefectural governments also share in the responsibility of river management works through the department supervising works at the local office; municipalities manage other rivers (Figure 2.2).

The total river length of Class A and B rivers and Class Provisional rivers is 144 000 km. Class A rivers comprise approximately 61% of the total. In contrast, Class B and Class Provisional rivers comprise approximately 25% and 14%, respectively. The Japanese government subsidizes projects in Class B, although this does not include maintenance works.

[2] The River Law defines the rivers as Classes A and B. Class Provisional rivers are those to which the River Law may be partially applied. Class Ordinary rivers are those outside the River Law.



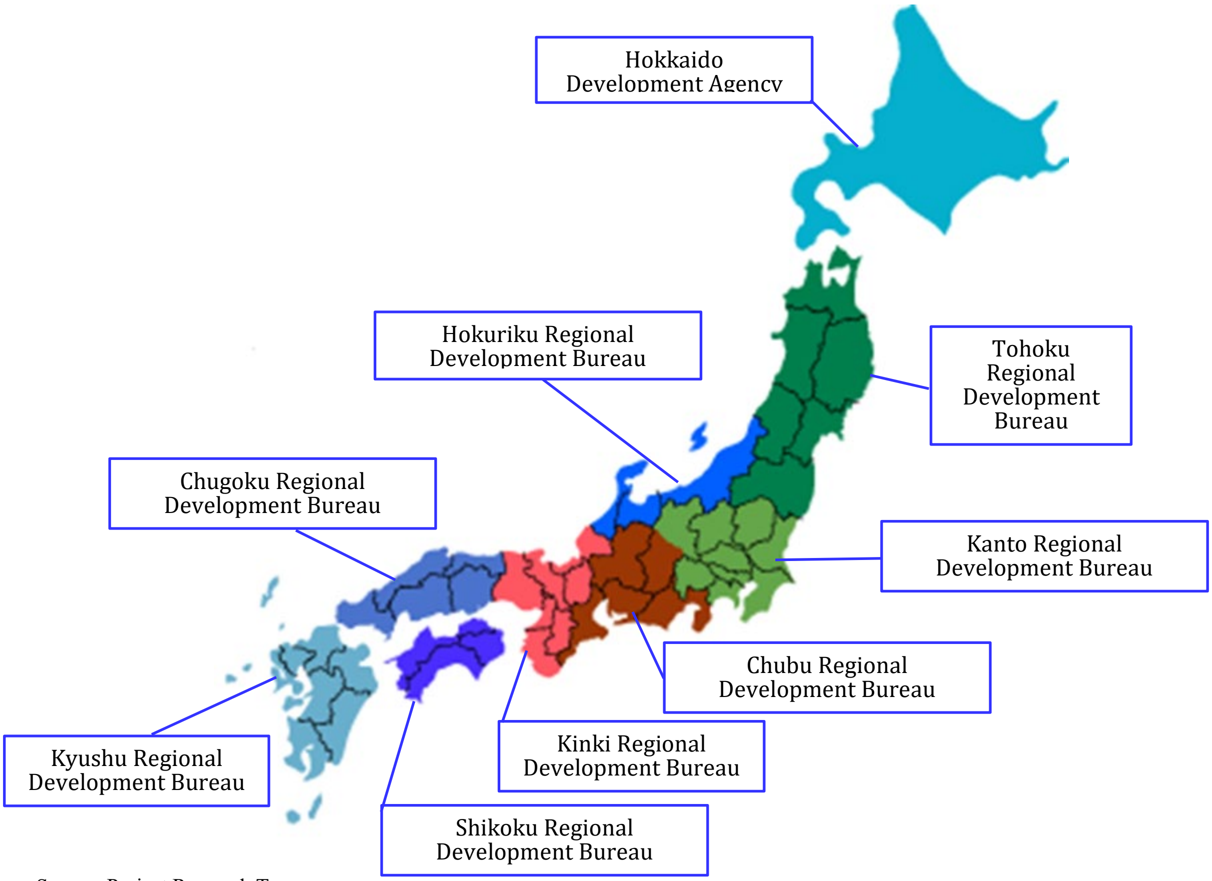
Source: Website of Yamato River Office, Kinki Regional Development Bureau, MLIT

Figure 2.1 Classification of Different River Systems and Corresponding Administrators

Water Use Conflicts on Dam Construction in the Ogouchi Dam Project

Under the former River Law, the Prefecture Governor had the authority to manage rivers. Therefore, it was difficult to resolve water conflicts between two prefectures. The Ogouchi Dam is a concrete gravity dam constructed by the Tokyo Metropolitan Government in 1957 on the Tama River. It supplies a maximum of 425 000 m^3 of water daily to the metropolitan area; this corresponds to 20% of the daily water supply in this area. In 1932, the metropolitan government announced the construction of the Ogouchi Dam. In the following year, a water union in the Kanagawa Prefecture that extracts water for irrigation purposes downstream, appealed to the prefecture for the suspension of the project; this caused disputes between the Tokyo Metropolitan Government and Kanagawa Prefecture. Construction was postponed for three years until the issue was resolved by increasing water abstraction of Kanagawa from the river as compensation from Tokyo.

The River Law was amended such that the national government now managed major rivers. According to this amended law, applicants for new water rights were required to build consensus in advance with existing water right holders.



Source: Project Research Team

Figure 2.2 Regional Development Bureaus Jurisdictions and the Hokkaido Development Agency

2.2 Regulations on River Use

> The RMO permits river usage that promotes public welfare and interest, on the premise that this use does not interfere with river management.

(1) River Areas

The river area spans the area in which: 1) streamflow is continuous; 2) river management facilities are situated; 3) the land to be managed integrates these areas. The river area spans to the feet of the urban side on the left and right levees (Figure 2.4). Within the river area, permission from the RMOs is required for actions, as described in Section (2). River-use regulation is applied to privately owned lands. For interior land, land use is regulated for river management as a conservation area, alongside areas that may be incorporated into the river area in future.

(2) Actions Requiring Permission

River users need to obtain permission from the RMO when conducting the following actions in the river area [6]; any action that is likely to impede proper river management is prohibited:

1) New acquisition, change, and renewal of water use (occupation of flowing water)

[6] As for aquatic products, inland waterways are effectively managed by the fisheries cooperative associations, which are obligated by the prefectural government to propagate aquatic products in accordance with the Fisheries Law.

2) Exclusive and continuous[7] use of the river area (occupation of land)
3) Collection of river products such as gravel and wood
4) Construction and reconstruction of river structures such as bridges and weirs
5) Excavation of land
6) Transport of timber and passage through navigation lock using the river channel and streamflow

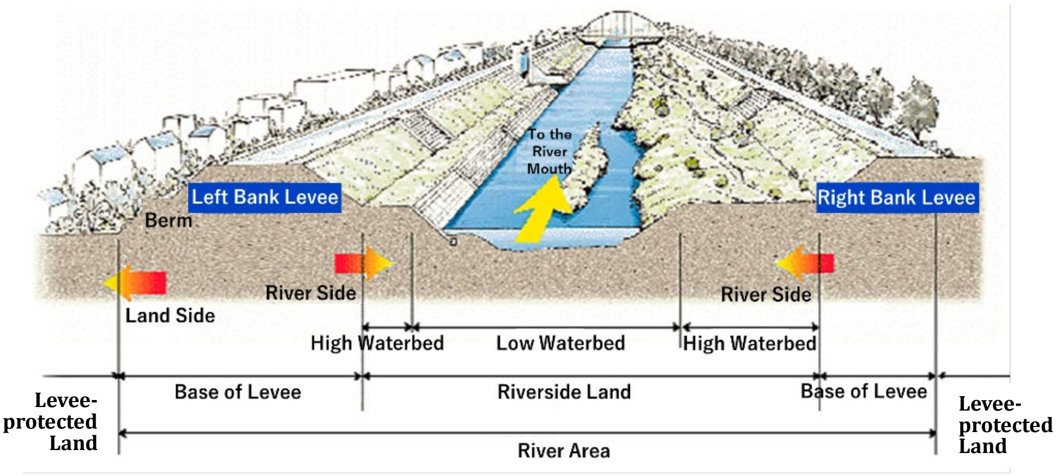
Water cannot be privately owned, although ownership of some land in the river area is permitted (Theme 1-2: Water Rights). Section 2.3 discusses the construction of new river structures.

(3) Occupation of Land in the River Area

An application is necessary to occupy land. The land includes infrastructure (e.g., roads, railways, water supply and sewerage pipes, electric power transmission lines, gas pipelines), public facilities (e.g., parks, green spaces, golf courses), and flood protection facilities. The permitting rules are amended according to changing social needs. In recent years, the river area has become open to the public under deregulation. This supports the activities of local governments and enterprises, such as open cafes and barbecue areas (Figure 2.3) (Theme 5: Urban Water Management).

Source: General Incorporated Foundation Consultants of Landscape

Figure 2.3 Opening of River Space (Kano River)



Source: MLIT Website

Figure 2.4 River Area

(4) Products in River

Gravel is a typical product collected from rivers. During high economic growth from the mid-1950s to mid-1970s, the increasing demand for river aggregates as construction materials was lowering the

[7] In general, the period of permission is within ten years. For applications from non-profit enthusiast groups (e.g. glider training grounds, motocross fields, or radio-controlled airplane gliding fields), the period is limited to five years. If the land is to be used continuously, the application should be resubmitted before the expiration date.

riverbed in many rivers. In 1968, the RMO established an approval standard for gravel mining. To maintain the river cross-section required to transport floodwaters and the reservoir capacity of dams, they established a system to grant permits for gravel mining in 1975. Every few years, the river offices of the MLIT formulate the "Control and Regulation Plan of Gravel Mining" to recruit enterprises to remove gravel deposits from river channels and dam reservoirs (Figure 2.5). The Gravel Mining Act stipulates that gravel mining companies (including hill-sands and sea gravels) should register with the Prefectural Governor. The Ministry of Economy, Trade and Industry (METI) is responsible for administering the Act.

(5) Penalty and Enforcement

Fines are imposed on illegal river use, and an RMO can remove illegal occupants. Some or all of the costs may be covered by taxes when the offender cannot be identified. A typical example of enforcement is with "Countermeasures against Illegal Mooring Ships." The Civil Code was amended in 1995, simplifying the administrative execution system to remove ships and mooring facilities that hindered river management (Figure 2.6). Although the situation has improved significantly, the issue still remains unresolved.

Source: ISHIGAMIJARI LLC.

Figure 2.5 Gravel Mining

Source: Keihin River Office, Kanto Regional Development Bureau, MLIT

Figure 2.6 Removal of Illegally Moored Vessels

2.3 Management of River Structures

> Common standards should be established to ensure safe river structures. The RMO should maintain river structures over the long-term; they should carry out patrols and periodic inspections at appropriate intervals, which should be followed-up by efficient maintenance works.

River structures are classified into two groups: (1) river management facilities constructed by the RMO; and (2) permitted structures, constructed by water users with permission from the RMO.

(1) River Management Facilities

River management facilities function to develop water resources, protect against floods, and improve the riverine environment, including dams, weirs, gates, levees, and bank protection (Figure 2.7). The Structural Standards describe the general standards for structures and the construction location of these facilities. For example, the Structural Standards provide guidance on the position of abutments, shape and depth of piers, span length, clearance below the girder bottom, and protection works. Technical criteria stipulate the planning and design methods. Consensus-building is required when constructing major river management facilities. The River Improvement Plan should describe the location and function of planned structures (Theme 2-2: River Basin Planning); it should also reflect the opinions of academic experts and residents through public hearings (Theme 1-3: Public Participation and Decision-Making Process).

Source: Fukushima Office of Rivers and National Highways, Tohoku Regional Development Bureau, MLIT

Figure 2.7 Green Belt as Riverine Buffer Zone (Agano River system, Arakawa River)

(2) Permitted Structures

To construct structures such as bridges and weirs, organizations must obtain permission from the RMO. They must examine the appropriateness of the structure, its purpose and technical matters, and the effects of the structure on flood protection, water use, and riverine ecology. The structures should comply with technical criteria and standards; in particular, the River Law includes “Special Provisions” for dams to meet strict requirements (Theme 8: Dam Management). The use of structures is restricted until they pass the inspection, and dam operation should follow the instructions of the RMO.

(3) Maintenance

The River Law stipulates that the RMO maintains structures in sound condition. The RMO is responsible for patrolling facilities, carrying out river functions (e.g., weeding, removal of obstacles), and operating gates at an appropriate time. Appropriate countermeasures should be implemented when malfunctions are identified. For efficient repairs, inspections on structures (e.g., dams, weirs, levees, water gates, and sluices) should be carried out at least once a year.

2.4 Disaster Management

During flooding, the RMO should prevent and mitigate damage by supporting disaster management organizations. In drought conditions, necessary mediations should be carried out through coordination with water users.

The RMO issues flood alerts and conducts disaster management activities such as patrols, the inspection of river channels and facilities, and the operation of dams and floodgates. The RMO provides public flood forecasts in cooperation with the Meteorological Agency. If the river water levels exceed dangerous thresholds, the RMO should notify relevant organizations. The RMO supports the activities of flood-fighting teams that are a community volunteer organization by carrying out tasks such as providing emergency information, accommodating the stock of equipment and materials, advising on disaster countermeasures, and dispatching liaison officers. During flooding, flood-fighting teams undertake urgent reinforcement of levees, provide warnings to residents, offer evacuation support, and operate the relevant facilities (Theme 1-3: Public Participation and Decision-Making Process, Chapter 4). The MLIT organizes the Technical Emergency Control Force and mobilizes various machinery for emergency operations, such as drainage pump vehicles, remote-controlled backhoes, satellite communications, and helicopters.

During a severe drought, the RMO should provide information to water users to promote coordination among concerned parties. If discussions for coordination become difficult, the RMO executes mediation and consultation (Theme 1-2: Water Rights).

2.5 Collaboration with Private Sector

It is a prerequisite for river management to collaborate with local communities.

Collaboration with local communities is necessary for river management to meet actual local conditions (Theme 1-3: Public Participation and Decision-Making Process). The RMO promotes collaboration with private organizations involved in river management activities such as river beautification (e.g., weeding, cleaning, extermination of alien species), river-environment and disaster-prevention education, and riverine ecosystem investigation and research (Figure 2.8). Such an organization may be designated as the “River Collaboration Organization,” and the RMO supports its activities by relaxing water usage regulations.

Source: MLIT

Figure 2.8 Activities of River Collaboration Organizations (Left: Cleaning Activity, Right: Fish Survey)

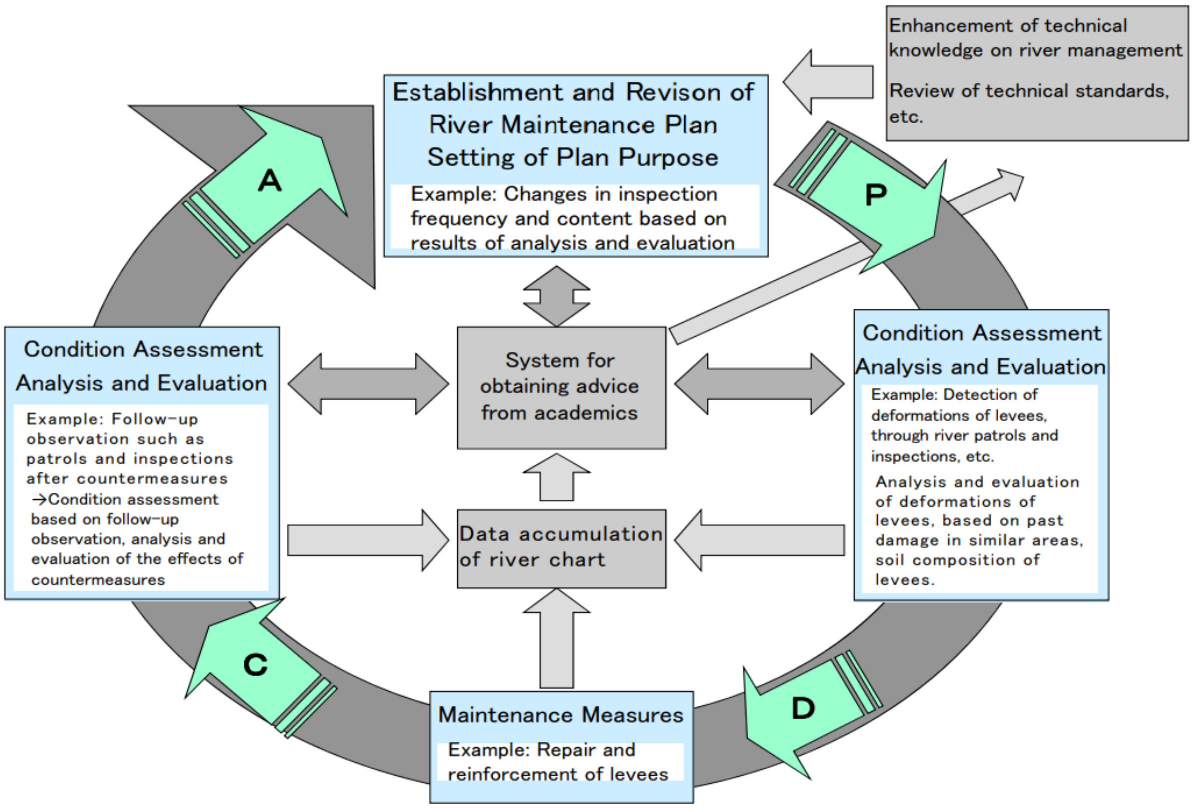
CHAPTER 3 NEW INITIATIVES

3.1 Extending Lifetime of River Management Facilities

The lifetime of river management facilities should be extended through efficient and effective maintenance. Laws and standards should be established to support long-term river management.

In Japan, river management facilities and permitted structures were constructed post-World War 2. The number of these facilities and structures increased during the high economic growth period, and declined from 1980 to the present. Hence, the maintenance of an increasing number of deteriorating facilities is becoming an issue.

The national government established a new policy to determine the extent of damage through inspections, replacing or renewing defects at the right time, preventing fatal damage in advance. In 2013, the government introduced an information system (RiMaDIS: River Management Data Intelligent System) using tablets to record inspection results in the database for a streamlined assessment of conditions. The PDCA (Plan, Do, Check, Action) cycle-management system maintains the river channel and facilities efficiently, and reduces total costs (Figure 3.1).



Source: MLIT Website

Figure 3.1 PDCA-type Maintenance and Management System

In 2012, a fatal accident occurred due to the collapse of the ceiling board of a highway tunnel; this accident inspired an increased interest in facility maintenance. In 2014, the Cabinet formulated the "Basic Plan for Extending Lifetime of Infrastructures" to improve the safety of public facilities and promote efficient maintenance. The plan presents new technological development through industry-university-government collaboration. New technologies were developed in accordance with this plan, including information and communication technology (ICT) (Theme 10: Development of Human Resources and Technology).

A basic plan seeks to increase the longevity of functional river facilities. The River Law states that facility owners have an obligation to maintain facilities, and established corresponding inspection standards. The government revised the technical criteria for River-Sabo Works to present methods to assess facility conditions. A qualification system was also established for private specialists to assist in maintenance work. The "River Facilities Supervision Service" for river maintenance engineers is being piloted as a qualification requirement to comprehensively evaluate inspection results.

3.2 Collaboration with Relevant Offices

Collaboration with relevant government offices is required to seek solutions to river management issues.

(1) Comprehensive Sediment Management Plan

For rivers with significant sediment discharge, the MLIT designates Sabo, sediment disaster management, areas to implement Sabo projects, such as the construction of Sabo dams (Figure 3.2), mountain slope works, channel works, and sand pockets, according to the Sabo Act (Figure 3.3). The prefectural government manages the Sabo area, and several activities are restricted within this area. For a large-scale project that the local governments are unable to implement due to financial limitations, the MLIT carries out the necessary construction work and facility management. In devastated forest areas, the Forestry Agency and local governments implement similar Sabo and afforestation projects.

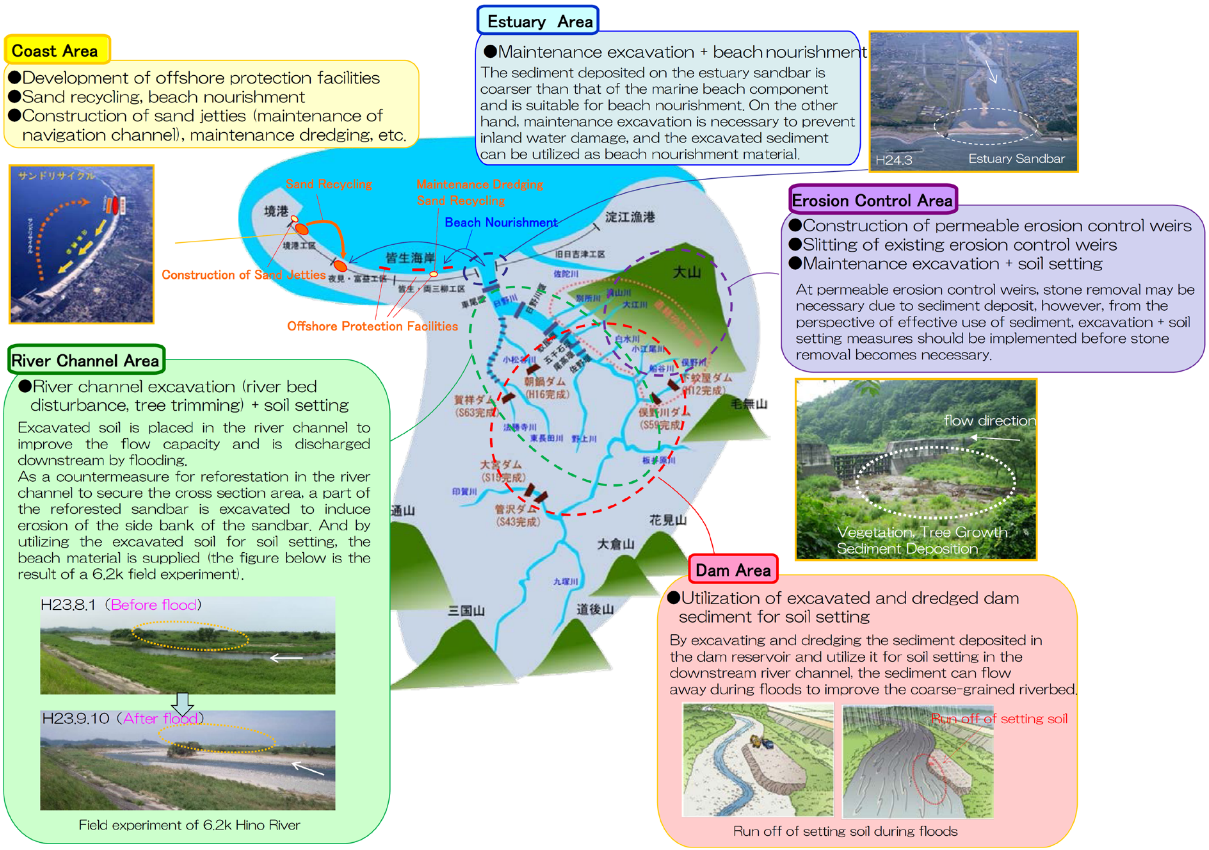
Source: Niko Sabo Office, Kanto Regional Development Bureau, MLIT

Figure 3.2 Sabo Dam

The government formulated a comprehensive sediment management plan by specifying measures to be carried out by relevant organizations responsible for Sabo areas, dams, rivers, and coasts in river systems. There are increasing concerns regarding sedimentation problems in dam reservoirs and impacts on the riverine ecosystem, including changes to aquatic habitat due to coarse-grained riverbed materials, the destabilization of river structures due to riverbed lowering, and coastal erosion. These problems are caused by an imbalance in sediment transport throughout rivers. Overall, sediment management is important, requiring the collaboration of organizations related to the sediment transport system, from the headwaters of the river to the coast.

(2) Mitigating Large-scale Flood Inundation

The Flood Control Act has been amended in response to frequent heavy rainfall disasters in recent years. Japan recognizes strengthening non-structural measures as a crucial measure of adapting to flood risks increased by climate change. The Council for Mitigating Large-scale Flood Inundation (comprised of the RMO and local government), was established in each river basin to collaborate on four key policies: 1) evacuation; 2) flood protection; 3) inundation control; and 4) information sharing. At annual meetings, members confirm the status of activities, and examine and improve on activities. One emergency measure is early evacuation based on observed data; the RBO (River Basin Organization) and local governments have installed low-cost water level gauges specialized for flood monitoring. Governments and local companies jointly completed the system by 2020, and installed approximately 9000 units nationwide.



Source: Chubu Regional Development Bureau, MLIT

Figure 3.3 Comprehensive Sediment Management Plan for Hino River Sabo and Forestation

CHAPTER 4 LESSONS LEARNED

(1) **The mechanisms of managing rivers need to be established.** In Japan, the RMO designates river areas that regulate various activities; organizations must obtain permission from the RMO to construct structures and conduct activities. As river water is a public good, water users require RMO permissions; the RMO formulated technical guidelines and standards detailing the permissions process. In Japan, when the prefectural government carried out river management, it was difficult to solve conflicts between upstream and downstream or left and right riverbanks. In response, the management responsibility was altered such that the national government manages major rivers, which is particularly useful for rivers flowing through multiple prefectures.

(2) **River management should adapt to changing social conditions.** As river management becomes more complex with societal development, management goals should be established flexibly. The unique natural conditions in Japan have meant flood protection has consistently been the main focus of river management. The country needs to adapt to effects caused by climate change. Also, sediment management, quality of structure, and leisure activities became more important issues. Restoration of nature requires a long time, and in the worst case, it may be irreversible

(3) **Systematic maintenance is required to ensure long-term quality of river structures.** Systematic maintenance is essentially required to ensure the quality of structures. Therefore, inspections, maintenance, and repairs must be continued at the operation and maintenance stages. These activities extend the longevity of river structures. The use of ICT may also prove to be effective for economic and efficient maintenance.

(4) **Climate change and environmental problems should be addressed through cooperation with communities and inter-governmental coordination.** The frequency and severity of large-scale floods and droughts are increasing worldwide due to climate change. These issues cannot be dealt with solely through using facilities, and river conservation cannot be conducted by the RMO alone. Cooperation with local communities and inter-governmental coordination are essential to cope with these issues; as such, a relevant mechanism should be established.

THEME 7 GROUNDWATER MANAGEMENT: SECURING ALTERNATIVE WATER SOURCES ALONG WITH REGULATIONS

ABSTRACT

Excessive groundwater extraction causes problems such as land subsidence, lowering of groundwater levels, and salinization. This results in additional issues such as damage to buildings, worsening flood inundation levels, and increased water intake. In Japan, land subsidence caused by excessive groundwater extraction worsened because of the increase in groundwater use for industrial purposes during the post-World War II reconstruction period and resulting high economic growth. Problems with groundwater pollution caused by factory wastewater infiltration have also emerged.

These difficulties can be solved by establishing a legal system to regulate groundwater extraction and secure alternative water sources. A monitoring system for land subsidence and groundwater contamination should also be established. A council of groundwater comprising stakeholders of the public and private sectors should be established to build a consensus on groundwater management policy, formulate a groundwater management plan, implement said plan, and monitor progress in groundwater conservation.

CHAPTER 1 INTRODUCTION

Excessive groundwater extraction causes problems such as land subsidence, abnormal lowering of groundwater levels and salinization. Once land subsidence and groundwater quality deterioration occur, it is difficult to reverse them. To ensure sustainable groundwater use, it is important to conserve groundwater by regulating its extraction and securing alternative water sources.

Continuous and excessive extraction of groundwater induces land subsidence, resulting in lower groundwater levels and salinization (Figure 1.1). Land subsidence is an irreversible phenomenon resulting from the consolidation of underground clay layers, which is caused by the drainage of the water contained within the layers. Underground infiltration of wastewater from factories pollutes the groundwater. Once these problems occur, the recovery process is long.

In Japan, land subsidence caused by excessive groundwater extraction has occurred for over a century. During post-World War II (WWII) reconstruction and the resulting period of high economic growth, the amount of groundwater extracted for industrial use increased, resulting in social issues. To mitigate groundwater problems, a legal system was established to conserve groundwater, and subsidence issues have slowed. This theme explains the various approaches to tackling land subsidence and groundwater pollution issues in Japan.

Source: Tokyo Metropolitan Government, Bureau of Environmental Website

Area below sea tide level near river mouth of Arakawa River (1981)

Source: JICA

Area below sea tide level surrounding Pluit pump station (Jakarta Indonesia)

Figure 1.1 Impact of Excessive Groundwater Extraction (Land Subsidence)

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

Relationships between Groundwater Management and the SDGs:

(1) Supply safe water by managing the quantity and quality of groundwater.

SDG 3 "Healthy lives and well-being for all":

3.3 "End the epidemics of water-borne diseases," 3.9 "Substantially reduce the number of deaths and illnesses from water and soil pollution and contamination"

SDG 6 "Availability and sustainable management of water and sanitation for all:"

6.3 "Improve water quality by reducing pollution," 6.4 "Ensure sustainable withdrawals and supply of freshwater," 6.5 "Integrated Water Resources Management"

(2) Groundwater is conserved through public-private partnerships (PPPs)

SDG 17 "Global partnership for Sustainable Development:"

17.17 "Encourage and promote effective public, public-private, and civil society partnerships, building"

CHAPTER 2 GROUNDWATER USE

2.1 Current Status of Groundwater Use in Japan

As groundwater is a vital component of a healthy water cycle system, proper management must be implemented through regulations and monitoring.

(1) Groundwater in the Water Cycle

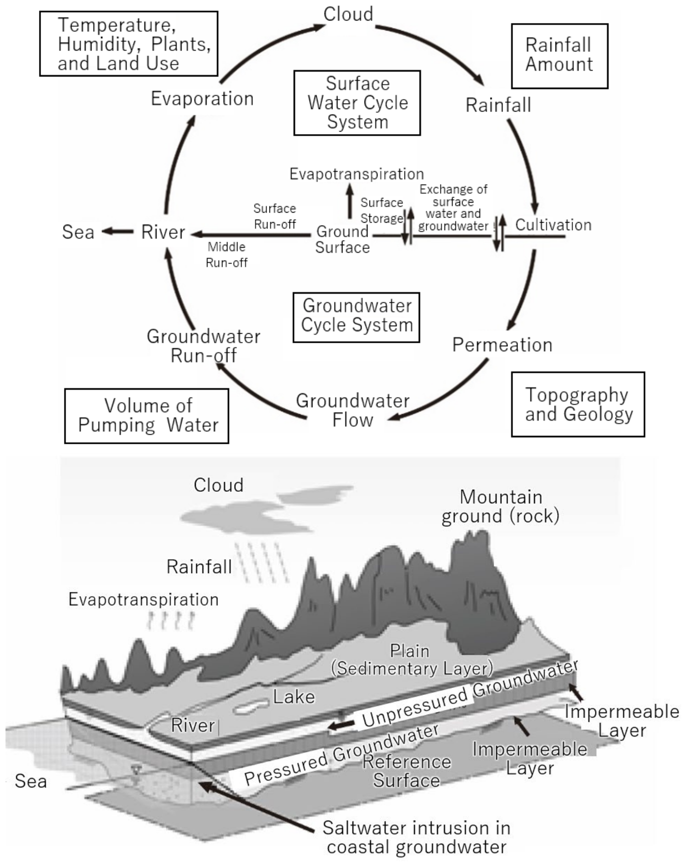
The source of groundwater is precipitation, and groundwater forms a water cycle with surface water. Direct runoff of precipitation into a river is divided into two routes: surface runoff directly flowing into a river and intermediate runoff via the shallow underground. Precipitation that does not flow directly into a river channel infiltrates underground. Groundwater flows extremely slowly compared to surface water. The global average detention time of groundwater is approximately 830 years (Table 2.1). After a long detention time, groundwater flows out to rivers and lakes as surface water.

The water cycle is influenced by atmospheric events and underground structures (Figure 2.1). Groundwater circulation is affected by geological and topographical conditions. The evaporation of surface water is affected by temperature, humidity, and vegetation. Human activities, such as groundwater extraction and land use, affect the water cycle.

Table 2.1 Water Storage and Detention Time on Earth

	Storage Capacity (km3)	Average Dwell Time
Seashore	134,929,000	3,200 years
Ice and Snow	24,230,000	9,600 years
Groundwater	10,100,000	830 years
Soil Moisture	25,000	0.3 years
Lake Water	219,000	a few to hundreds years
River Water	1,200	13 days
Water Vapor	13,000	10 days

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

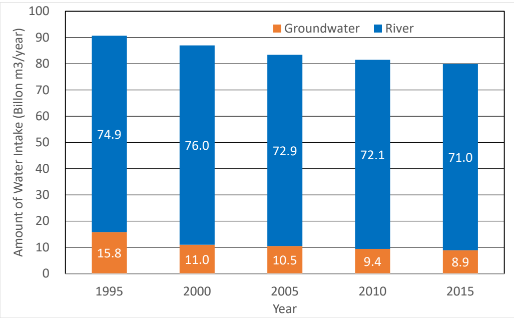


Source: Toward the Conservation and Sound Use of Groundwater, Advisory Group on Future Groundwater Use, March 2007, MLIT

Figure 2.1 Conceptual Diagram of the Water Cycle and Influential Factors

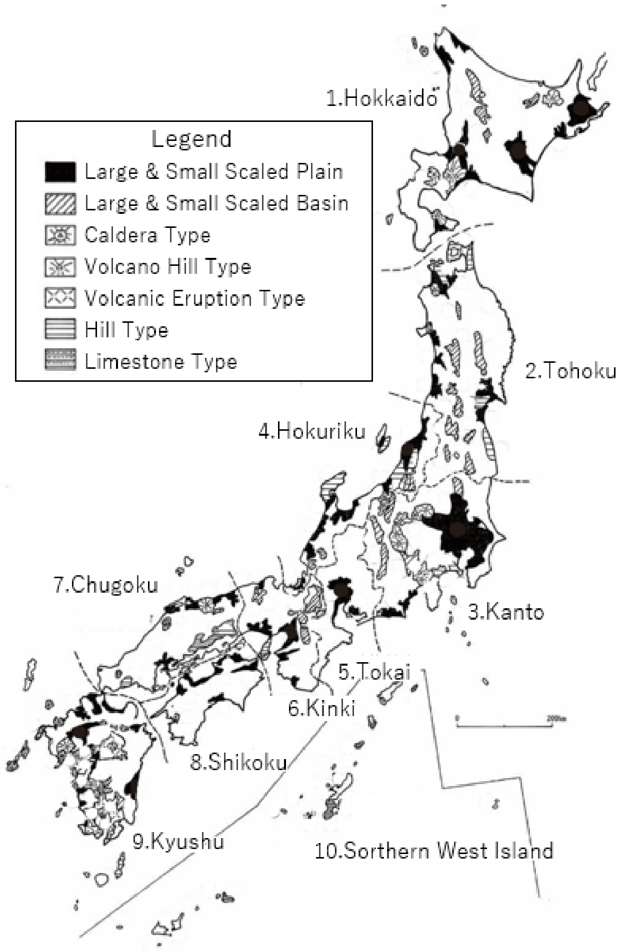
(2) Groundwater in Japan

Figure 2.2 shows the distribution of the groundwater basin formed by topography and geology in Japan. The basin can be classified into several types, including plains, basins, calderas, hills, and others. The annual amount of water used, including river water and groundwater, is shown in Figure 2.3. The total amount of water used has decreased annually. Specifically, the annual amount of groundwater use has decreased by 60% over the past 20 years.



Note: Agricultural Water–2005 data using 1995/10–1996/09 survey results, 2015 data using 2008 data.
Source: Japan's Water Resources, data from MLIT

Figure 2.3 Annual Water Use by Water Source in Japan



Source: Groundwater in Japan, Agricultural Groundwater Research Group (1986)

Figure 2.2 Groundwater Basin Types in Japan

2.2 Regulation and Measures of Groundwater Use by Legislation

Government organizations should establish legal systems to regulate groundwater extraction, secure alternative water sources and monitor groundwater extraction.

(1) Land Subsidence Problem

Groundwater was used as a common property of village communities in Japan until the Edo period (-1968). During the Meiji period (1868-1912), river water was mostly used for agricultural purposes and could not be used to meet new water demands. Urban water supplies increased with the modernization of Japanese society and depended on groundwater. Groundwater use was accelerated by digging deeper and larger wells via drilling mechanization. Governments did not regulate the use of groundwater by landowners. Since 1930, land subsidence

Source: National Ground Environment Information Directory, Ministry of the Environment

Figure 2.4 Subsidence of Bridges in Osaka City

of 15–17 cm per year has been observed locally in urban areas. This subsidence caused the tilting of buildings[1], road damage, settlements of bridge abutments that interrupted navigation in rivers (Figure 2.4), and aggravated flood damage. During the post-WWII reconstruction and resulting high economic growth period, the damages in Tokyo and Osaka caused by land subsidence and groundwater salinization were especially serious . Figure 2.5 shows examples of damage caused by land subsidence in the Tokyo urban area.

(2) Salinization

Salinization of groundwater is caused by seawater intrusion into an aquifer when the groundwater level is lowered below sea level owing to excessive water extraction. Since 1960, salinization issues have occurred in many places in coastal areas; one such example is Fuji City, Shizuoka Prefecture, where a paper industry was developed. The area's salinized groundwater is unsuitable for drinking and industrial water use. Salt damage to crops has also been observed.

The groundwater level must be maintained above the sea water level to prevent salinization through 1) restricting the amount of groundwater extraction, 2) facilitating artificial recharge of groundwater, 3) limiting the groundwater restriction zone to a coastal area and allowing saltwater intrusion in a limited zone, or 4) building impermeable walls to prevent saltwater intrusion.

(3) Legal Regulations against Land Subsidence

The Industrial Water Act of 1956 and the Act on Regulation of Groundwater Extraction for Buildings (the Building Water Act) of 1962 were enacted to restrict groundwater extraction rates. The Industrial Water Act intended to provide a stable supply of industrial water, but did not directly address the problem of groundwater extraction. In addition, it did not restrict groundwater use for purposes other than industrial water. The Building Water Act regulated the extraction of groundwater for water use only in buildings.

Rising of a Building in Urayasu City, Chiba Prefecture	Rising of a Well Pipe in Katsushika Ward, Tokyo	Uneven Ground in Tokorozawa City, Saitama Prefecture

Source: National Ground Environment Information Directory, Ministry of the Environment

Figure 2.5 Damage by Land Subsidence in Tokyo Urban Area

[1] Phenomena where bases of structures and buildings on the ground rise above the ground level due to lowering of ground level by excessive extraction of ground water, or liquefaction caused by earthquakes.

The ordinances of local governments were more effective in restricting groundwater extraction than national laws. In the 1970s, local governments established ordinances to regulate pollution prevention as well as groundwater extraction in areas that national acts could not cover. The ordinances covered groundwater extraction without limiting the purpose of water use, whereas the Industrial Water Act covered only industrial water use. The ordinances also did not require the alternative development of water sources besides groundwater.

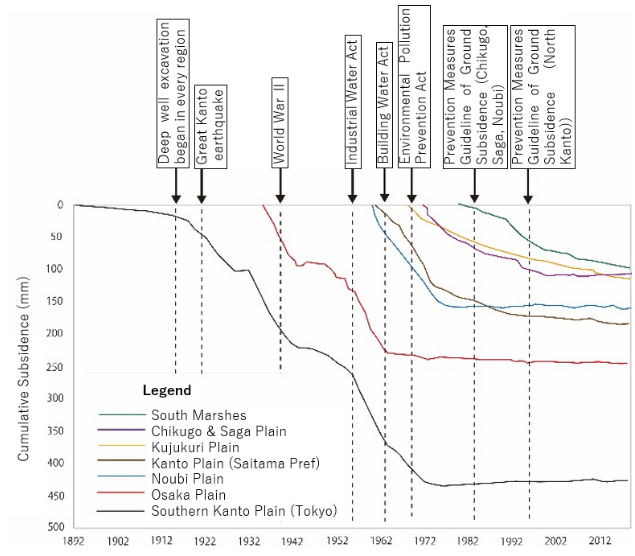
The Basic Environment Act, enacted in 1993, promotes comprehensive conservation measures for both groundwater quality and quantity. The Basic Act on the Water Cycle enacted in 2014 and the Basic Plan on the Water Cycle formulated in 2015 promotes "sustainable groundwater use and conservation " (Theme 1-1: Legislation and Organization, Section 2.6).

(4) Changing Water Sources for Industrial Water

As groundwater extraction for industrial water use was regulated by the Industrial Water Act through restricting the use of existing wells, the conversion of water sources from groundwater to surface water was also promoted. When local governments developed industrial water supply systems, industrial entities were instructed to abolish their wells. Subsidies by the national government were provided to avoid cost increases caused by the conversion of water sources. As the cost of groundwater extraction by industrial entities was 1–3 yen/m^3 , the tariff of industrial water use provided by local governments was set at 3.5 yen/m^3. In 2001, this tariff increased to 24.4 yen/m^3; however, it was still one-eighth of the unit cost of water supply of local governments (Theme 2-1: Management Planning).

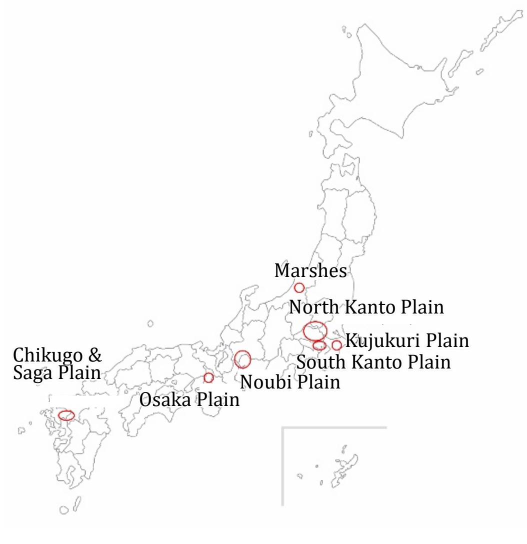
(5) Land Subsidence

As a result of the restriction of groundwater extraction by acts and ordinances, the amount of groundwater extraction decreased nationwide. The groundwater level recovered, and serious land subsidence was mitigated (Figures 2.6, 2.7). In 2019, although five locations showed land subsidence of more than 2 cm per year, the number and area of overall land subsidence incidents decreased.



Source: Overview of Land Subsidence in Japan in 2019, Ministry of the Environment, Water and Air Environment Bureau (2019 March)

Figure 2.6 Land Subsidence at Typical Points



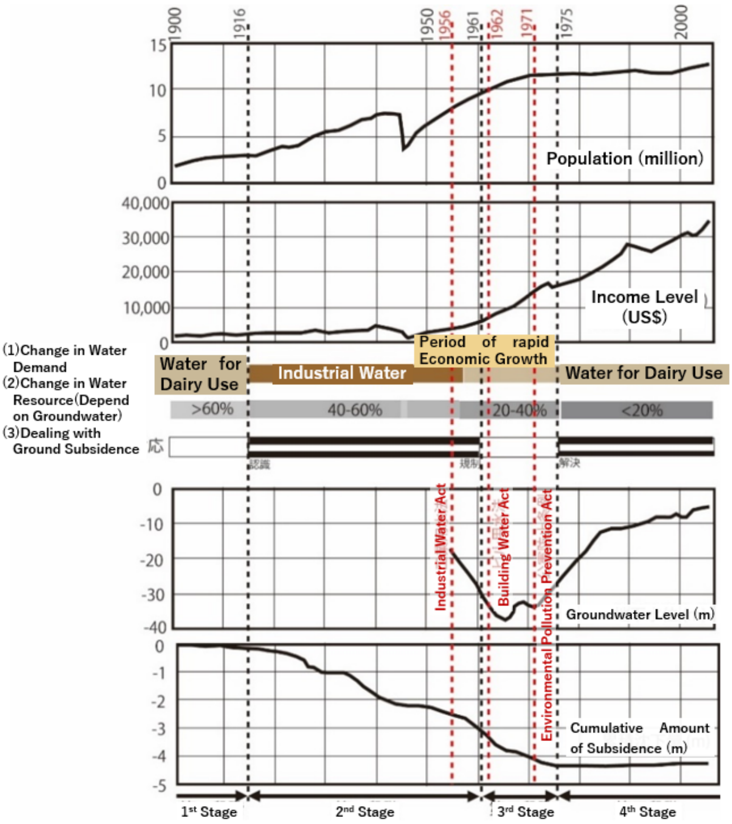
Source: created by Project Team

Figure 2.7 Location Map

(6) Regulation by Tokyo Metropolitan Government

Figure 2.8 presents the relationship between social and economic development, the groundwater level, and land subsidence in the Tokyo metropolitan area. The history of regulations is summarized below.

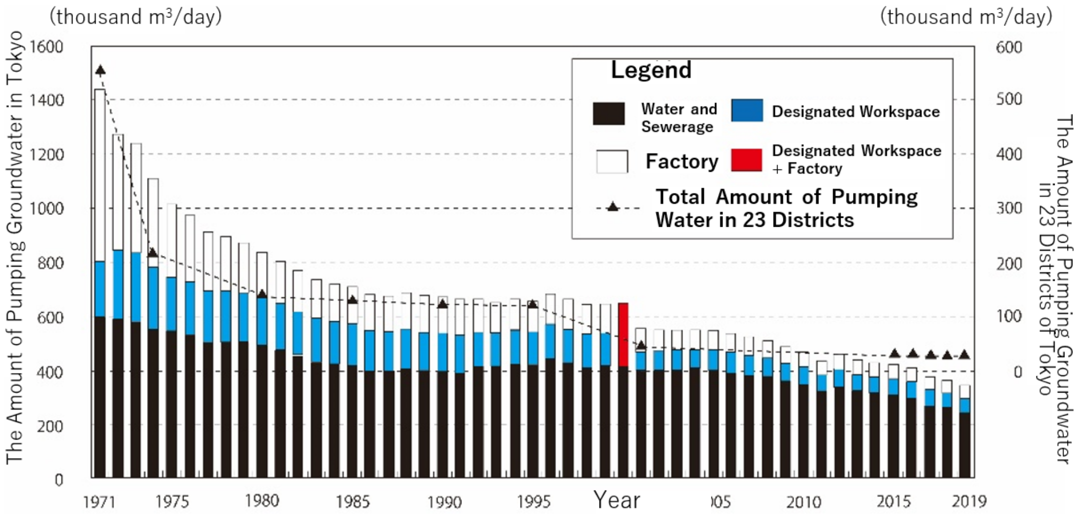
1) Stage 1 (1900-1916): Water use depended on groundwater by more than 60%, but land subsidence was not substantial.
2) Stage 2 (1916-1960): Land subsidence became substantial. No effective measures were implemented.
3) Stage 3 (1961-1974): Enacted regulations regarding groundwater extraction gradually recovered the groundwater level.
4) Stage 4 (1975–): The groundwater level continued to recover and land subsidence ceased.



Source: Urbanization and Land Subsidence in the Case of Tokyo: A Stage-by-Stage Approach Using Long-term Indicators, Tomoyo Toyoda & Shinji Kaneko, National Institutes for the Humanities, Institute for Global Environmental Studies

Figure 2.8 History of Land Subsidence in Tokyo

Land subsidence in Tokyo slowed because of the regulations of the Metropolitan Government based on the national laws. The regulation based on the Industrial Water Act covered eight wards, and that based on the Building Water Act covered twenty-three wards. The Pollution Prevention Ordinance of 1971, which covered almost the entire area of Tokyo, strictly restricted groundwater extraction rates and converted water sources using surface water. The ordnance requested industrial water users to rationalize their water use, including increasing recycled water usage (Figure 2.9). The amount of groundwater extracted, the groundwater level, and land subsidence were monitored. Recently, uplift pressure on facilities caused by the recovery of the groundwater level has also been highlighted. An uplift pressure acting on the bottom faces of structures that is larger than the pressure assumed by the structure design may cause a structure to float upward.

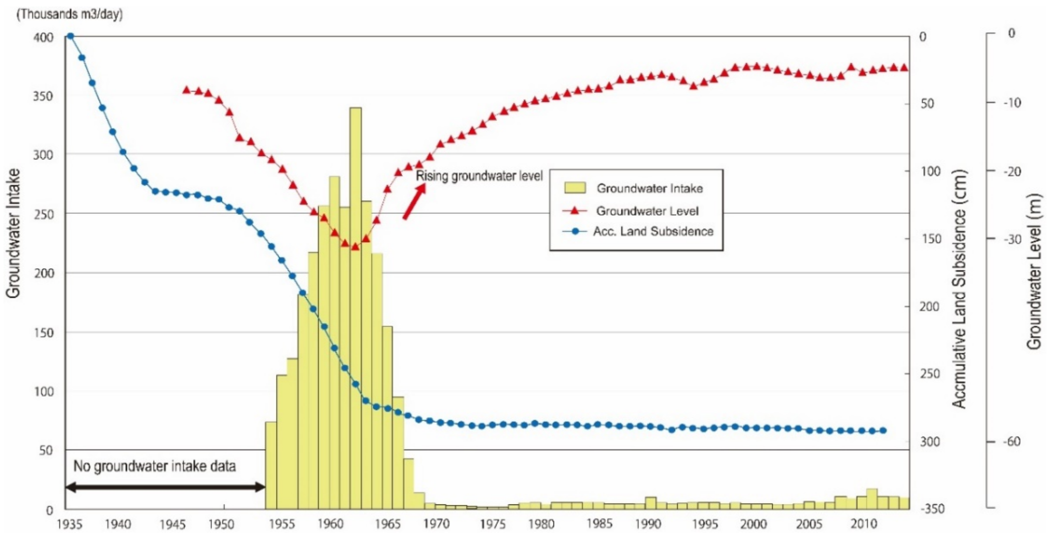


Note: Values from 1972 to 2000 denote the extraction volumes of wells subject to pollution control ordinance regulations (discharge c/a of 21 cm^2 or more) plus the estimated extraction volumes of wells of less than 21 cm^2
Source: Actual Conditions of Groundwater Extraction in Tokyo in 1989, Tokyo Metropolitan Government (March 2021)

Figure 2.9 Trends in Groundwater Extraction of 23 Wards in Tokyo

(7) Regulation in Osaka City

Similar to Tokyo, groundwater extraction rates in Osaka have been regulated and monitored. The Osaka city government allows extractions from layers only below–500-600 m. This makes groundwater use difficult (Figure 2.10).

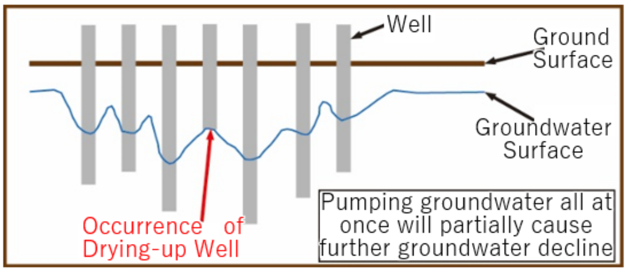


Note: Data on Groundwater Sampling - Port Observatory until 1965, Port Observation II since 1966
Source: "Report on the effective use of groundwater in consideration of the ground environment in the Osaka City area", Study Council on the Effective Use of Groundwater in Consideration of the Ground Environment in Osaka City Area (1991 February)

Figure 2.10 Groundwater Use and Land Subsidence in Osaka City

(8) Measures to counteract Drying of Wells in Snowfall Areas

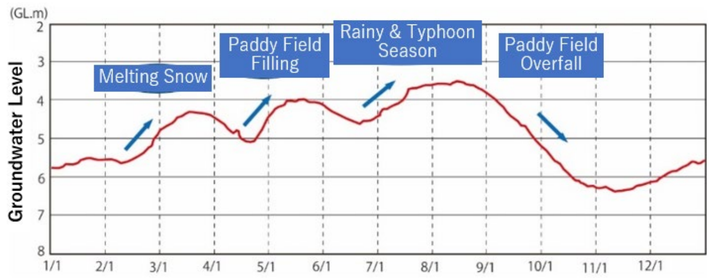
In snowfall areas, groundwater is often used to remove snow from roads to ensure traffic safety. Sometimes, wells dry because of the use of groundwater in the snowy season.



Source: Groundwater and Springs – Revitalization of Spring Water Culture, Ono City, Fukui Prefecture

Figure 2.11 Dried-up Well due in Snow Season

Substantial groundwater consumption for removing snow from December to February causes the drying of wells (Figure 2.11, Figure 2.12). Accordingly, in Ono City, Fukui Prefecture, around a thousand wells dried from 1975 to 1984 during the winter. Some wells were re-bored. Approximately 60% of households and business offices in the city have wells 5 to 10 m deep, and approximately 36% have wells deeper than 10 m. Once a low groundwater level is observed at the monitoring well, a warning is issued to request water saving (Figure 2.13).



Average groundwater level for Ono City from 2002 to 2011.
Source: Groundwater and Spring Water in "Echizen Ono, the Hometown of Yui" ~Revitalization of Spring Water Culture~ Ono City, Fukui Prefecture

Figure 2.12 Seasonal Changes in Groundwater Levels (Kasuga Park Observation Well)

Source: Ono City, Fukui Prefecture

Figure 2.13 Kasuga Park Observation Well

2.3 Groundwater Monitoring

In groundwater management, long-term monitoring of land subsidence and groundwater extraction by groundwater users is necessary to ensure effective regulation.

Groundwater monitoring includes the amount of water extracted, groundwater level, land subsidence, and water quality. This section explains the monitoring of groundwater extraction, whereas Section 3.2 explains the monitoring of groundwater quality. A registration system was introduced to prevent an abnormal lowering of the groundwater level, a depletion of groundwater, and land subsidence resulting from excessive groundwater extraction. The system requires the registration of pump facility users so that the supervising organization can monitor groundwater extraction and groundwater levels.

(1) Reporting Water Extraction

The ordinances by local governments require groundwater users to record their extraction volume and report it to the governors.

(2) Monitoring Land Subsidence

The guidelines of the Ministry of Environment (MOE) specify monitoring and survey items, which are useful in analyzing the mechanism of land subsidence and assisting in determining preventive measures.

1) Monitoring Items

(a) **Ground Level:** Long-term monitoring of ground levels at the same points is important in obtaining key information for predicting land subsidence. Detailed monitoring of a wide area is required, especially in areas with substantial ongoing land subsidence. The standard frequency of observations is once per year. The observation dates are fixed annually. Seasonal observations are required in areas where seasonal land subsidence has occurred.

(b) **Groundwater Level:** Continuous observations using an automatic water-level recorder are required. If continuous observations are not feasible, a monthly observation is accepted. The observation points must cover the area of ongoing land subsidence, area of future potential land subsidence in the future, and area where land subsidence is not allowed.

(c) **Land Subsidence:** Observation wells must be installed to monitor the settlement of each geological layer. The monitoring area must cover a wide area to fully detail the regional features of the land subsidence. The geological distribution of clay layers must be considered. Automatic monitoring equipment is used to ensure continuous measurements.

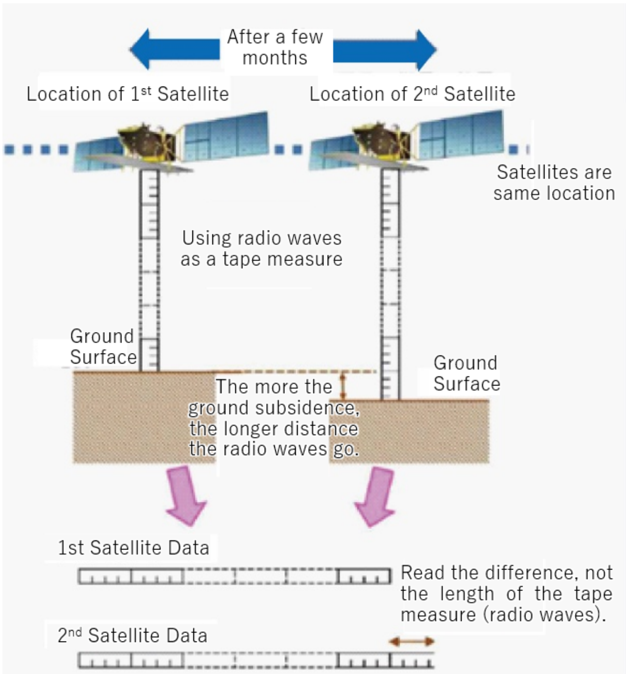
2) Survey Items

(a) **Geology:** Borehole surveys and soil tests are conducted in the land subsidence area to determine the geological strata that cause subsidence.

(b) **Amount of water extraction:** Survey amount of groundwater extraction for each prescribed purpose (industry, domestic use, irrigation, building, hot spring) through records of water users or questionnaires to users. The depth and geological layers of groundwater extraction are surveyed.

(3) Monitoring by Satellite Data

Monitoring land subsidence through leveling surveys requires considerable cost, effort, and time. The utilization of satellite data is expected to enable more efficient observations. The MOE published the "Manual for Utilization of



Source: Manual for the Use of Satellite Observation for Land Subsidence, Ministry of the Environment

Figure 2.14 Land Subsidence Monitoring by SAR Satellite

Satellites in Land Subsidence Observation" (in March 2017) using the satellite data of the Advanced Land Observing Satellite-2 "Daichi-2" (ALOS-2) to provide an easier monitoring system for local governments (Figure 2.14).

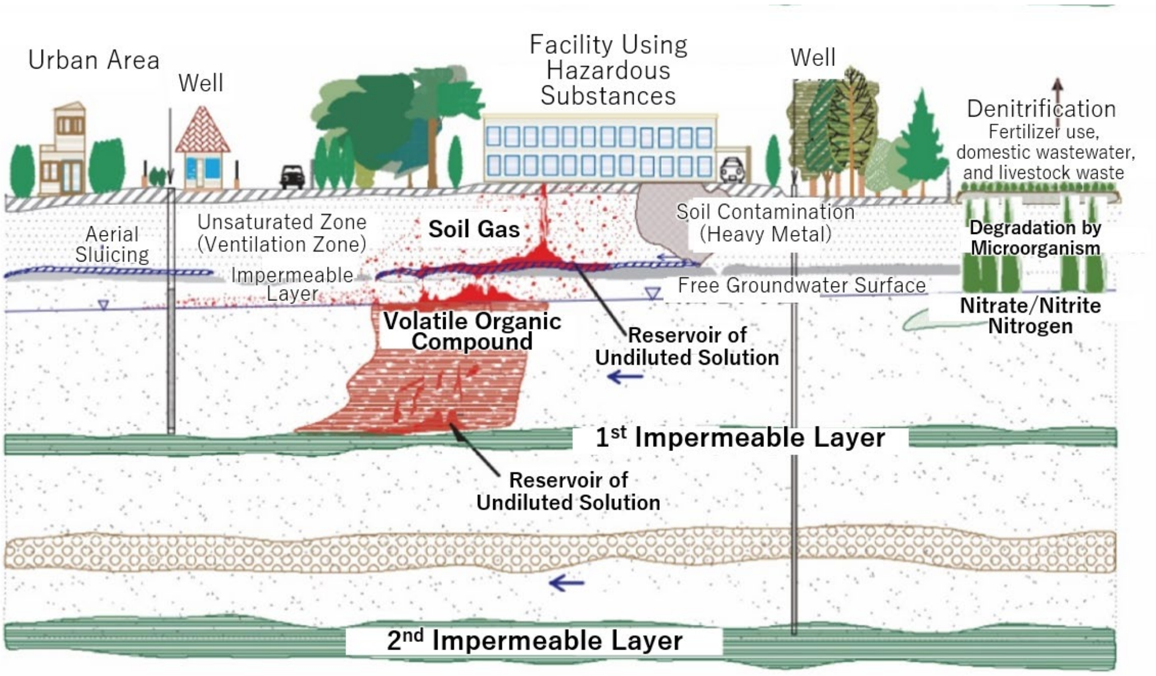
CHAPTER 3 WATER QUALITY MANAGEMENT

Once groundwater is contaminated, restoring water quality is difficult. Preventive measures against groundwater contamination and for spreading the contamination to decrease pollutant potency are the most important.

In Japan, the standards for environmental conservation include both the surface water as well as the groundwater. Local governments established regulations regarding the monitoring of groundwater quality and the process of remedial measures needed to improve the water quality.

3.1 Groundwater Contamination Mechanism

Monitoring and early warning measures are important in preventing contamination from pollutants infiltrating underground , including volatile organic compounds (VOCs), harmful heavy metals, and nitrate-nitrogen. Measures differ according to the pollutant. Because VOCs as well as nitrate- and nitrite-nitrogen are difficult to decompose and are not easily adsorbed in the soil, contamination is likely to spread into wider areas through the groundwater flow. VOCs may accumulate in soil in undiluted conditions and sometimes infiltrate deeper underground areas according to the geological conditions. Because heavy metals are generally easily adsorbed in soil, contamination is unlikely to spread deeper underground. Figure 3.1 illustrates an image of groundwater contamination, and Table 3.1 explains the nature and cause of the pollutants.



Source: To Clean Up Groundwater, Ministry of the Environment (2004)

Figure 3.1 Depiction of Groundwater Contamination

Table 3.1 Nature, Causes and Characteristics of Pollutants

Pollutant	VOC	Heavy Metals	Nitrate and Nitrite Nitrogen
Nature	High volatility, low viscosity, heavier than water, difficult to decompose underground. Permeates through soil and easily moves into groundwater. (Benzene is lighter than water and more easily decomposes than other VOCs.)	Slightly soluble in water, but not easily conveyed because it is easily adsorbed in soil. (Some heavy metals are soluble in water and are conveyed easily.)	Not easily adsorbed in soil and easily transferred to groundwater. Produced when ammonia nitrogen is oxidized by microorganisms in soil.
Causes	Improper handling or leakage in solvent use or treatment processes. Inappropriate disposal in a landfill or waste solvents.	Leakage from storage or manufacturing processes, underground seepage of wastewater, improper disposal of waste in a landfill, natural origin	Excessive fertilizer, improper disposal of livestock waste, or underground infiltration of domestic wastewater.
Characteristics	Easily infiltrates the ground and spreads to deeper underground areas. Exists in soil in a liquid or gas form.	Not easy to move in soil, exists locally and does not spread to a wide area. Only those from a natural origin may exceed groundwater standards.	Wide source area such as farmland.

Source: To clean up Groundwater, Ministry of the Environment (2004)

3.2 Monitoring of Groundwater Quality

The Water Pollution Prevention Act stipulates continuous monitoring of groundwater. The national and local governments must prepare and implement monitoring plans every year. The results are disclosed on the websites of local governments or in annual reports on the environment (for example, the Environmental White Paper). When the measured values exceed the environmental standards, advice for users who may use contaminated groundwater for drinking must be announced immediately, and an area survey surrounding the contaminated wells is performed. A system and organization for immediate action are established. Three environmental standards have been established.

- Groundwater environmental standards (decided by the Basic Environment Act): standards must be formulated to protect human health (standards for preventing health damage to human beings).
- Groundwater purification standard (the Water Pollution Prevention Act): Targets must be achieved using measures for water purification (the standard of harmful substances for business entities to take measures for groundwater contamination that may impact human health)
- Underground infiltration standard (the Water Pollution Prevention Act): This standard prohibits the infiltration of harmful substances underground by business activities. The standard does not allow water contamination of more than 1/10th of the environmental standard or the lower detection limit of the test methods.

The survey methods comprise (1) a survey for general conditions, (2) an area survey surrounding contaminated wells, and (3) a monitoring survey as follows:

(1) Survey of General Conditions: A survey is conducted to determine the overall groundwater quality in the region. An annual survey plan is established according to the situation of the region. The survey is conducted by a fixed-point survey, a rolling survey, or both. The fixed-point survey intensively observes all observation items to detect groundwater contamination or observes a quality trend of groundwater quality at that point. A rolling survey is conducted sequentially at the mesh grids of a target area to detect local groundwater contamination. In general, a single fixed-point survey may not detect groundwater contamination.

(2) Area Survey surrounding Contaminated Wells: This survey delineates the contaminated area and identifies the cause of the newly detected contamination.

(3) Monitoring: The survey continuously monitors the contaminated area as flollows:

1) The area affected the most by contamination and the area downstream of the contamination source are included in the survey.

2) Installing observation wells is the most effective monitoring method.

3) The monitoring points are flexibly changed according to the contaminated area and the change in the underground flow.

CHAPTER 4 COMPREHENSIVE GROUNDWATER CONSERVATION

To ensure sustainable conservation and use of groundwater, management according to the regional conditions is required. Establishing a council of stakeholders comprising local government and water users is effective.

The demand for groundwater resources is likely to increase in Japan. People require safe and high-quality water, a stable water supply despite climate change, the sustainable preservation of the lives of residents, and temporary water use after natural disasters until restoration of the water supply system.

Groundwater is a key water resource and component of the water cycle system. To properly use and conserve groundwater, optimal groundwater management based on observed data accumulation and investigations of the actual groundwater use situation are required to understand the diverse groundwater use and availability in the region. The stakeholders who use groundwater and are related to the issue of groundwater conservation are required to participate.

A “groundwater council” comprising various stakeholders, including local governments and interested parties, is effective in facilitating flexible groundwater management according to a population’s diverse sense of values. The management policy must be updated in response to regional conditions to maintain a common understanding in the entire region. A groundwater management plan must be formulated based on this policy. Monitoring was conducted in accordance with the plan. The management policy may contain “ordinary groundwater use,” “utilization for local revitalization,” “preventive measures for risk,” and “solutions for groundwater contamination”. Efforts to conserve groundwater in the Kumamoto area are described below.

Groundwater Conservation Efforts in the Kumamoto Area

Approximately one million people live in Kumamoto City and the surrounding eleven municipalities, where almost 100% of the water source is groundwater. This is a unique area in Japan. (Figure 4.1). Groundwater management is addressed through a collaboration among local governments, private sector, local residents, universities, and research institutions. The "Kumamoto Groundwater Foundation," established in 2012, seeks to provide efficient, effective, and attractive measures for groundwater management through a scientific approach based on existing research (Figure 4.2).

Source: Kumamoto City Website

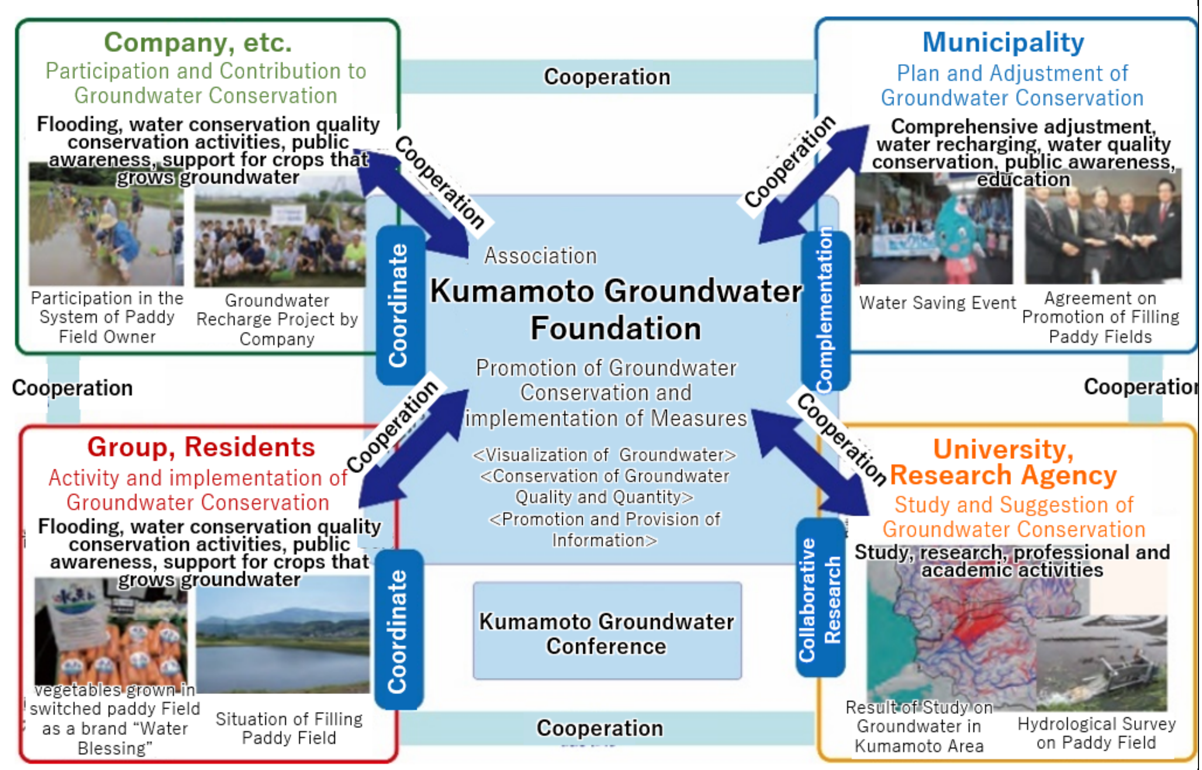
Figure 4.1 Kumamoto Area Sharing a Groundwater

Groundwater pollution by nitrate nitrogen has become an important issue in recent years. Nitrate nitrogen concentrations have increased mainly owing to the inappropriate disposal of fertilizers and livestock waste.

A simulation model was developed to predict nitrate nitrogen concentrations and support to implement projects of reducing nitrate nitrogen concentrations for each municipality. The projects include monitoring polluted soil and guidance to farmers to reduce the use of fertilizer.

The governments address conservation of the paddy fields, which are sources of groundwater, through subsidies. Companies and other local organizations also participate as owners of paddy fields to ensure groundwater conservation. They also maintain watershed protection of the local forest to ensure conservation of a healthy water cycle.

Together with promoting groundwater conservation activities such as disseminating information and education programs, the Kumamoto Groundwater Foundation provides subsidies to install equipment for measuring discharge and valves to water users to control groundwater extraction rates.



Source: Case Studies of Watershed Management, Water Cycle Production Headquarters Cabinet Secretary

Figure 4.2 Activities of the Kumamoto Groundwater Foundation

CHAPTER 5 LESSONS LEARNED

(1) **Excessive extraction of groundwater lowers the groundwater level, which may induce land damage, structural damage, aggravated flood damage, and saltwater intrusion.** Groundwater is a key component of a healthy water cycle. Land subsidence is an irreversible phenomenon resulting from the consolidation of underground clay layers owing to the drainage of water contained in the clay layers.. Excessive extraction of groundwater has caused land subsidence in major cities, including Osaka and Tokyo, at rates of over 20 cm per year and a total subsidence of more than 5 m. Coastal areas have experienced salinization in groundwater, which has precluded its usage for drinking and industrial purposes, and has caused salt damage to crops.

(2) **Regulation of groundwater extraction and the development of alternative water sources are necessary for groundwater conservation.** In Japan, acts and ordinances have been established by the national and local governments to regulate groundwater use. Governments developed industrial water supply systems that use surface water as an alternative source. Their acts and ordinances stipulate the criteria for groundwater use permits. Groundwater users have been registered and are required to record and report the amount of groundwater extracted. Local governments continuously monitor the groundwater situation and land subsidence.

(3) **Proper groundwater quality management is required to prevent the infiltration of hazardous substances into groundwater.** Once groundwater is contaminated and the contamination spreads, restoration of groundwater quality is difficult. Therefore, early monitoring and measures are necessary. Management systems require environmental standards for groundwater quality, annual monitoring plans, and a system that enables prompt responses to emergency situations.

(4) **To ensure sustainable conservation and usage of groundwater, a council of stakeholders should be established according to regional conditions.** Kumamoto City formulated mechanisms of groundwater management in collaboration with local governments, the private sector, residents, universities, and research institutions. Their management is supported by scientific evidence developed with universities and institutions in Kumamoto.

THEME 8 DAM MANAGEMENT: MANAGING AND OPERATING SAFELY

ABSTRACT

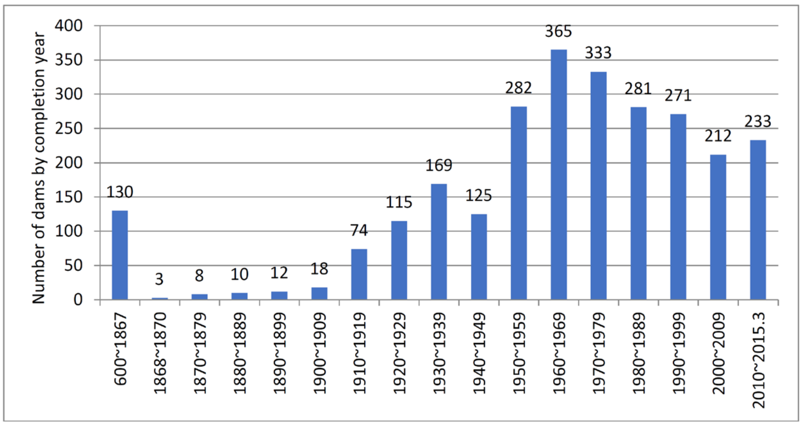
It is important to execute thorough safety management for dams to prevent breakage or the gate disoperation, which can cause extensive damage to the downstream areas. The establishment of technical standards for dam construction, systems for safety examination, and gate operation procedures is essential to ensure the safety of dams. To maintain dams in good condition, it is necessary to ensure their safety through the execution of routine and long-term inspections and maintenance, improve dam management, and reduce the lifecycle costs of dams. Dams must be operated in accordance with operation rules to ensure flood protection and an adequate water supply in a river basin. More than half a century has elapsed since the construction of modern dams began in Japan. Extending the service life of dams while maintaining and improving their functions is a challenge. The development of new technologies and dam rehabilitation projects are underway.

CHAPTER 1 INTRODUCTION

Dams can cause considerable damage to downstream areas when they break. In Japan, prone to frequent earthquakes and floods, safety management of dams is emphasized. The country has established various measures for this, such as technical standards, safety reviews in the design and construction stages, monitoring during operation, and necessary communication and inspection systems, together with the development of organizations and allocation of human resources.

The safety management of dams is important because dam failure has a severe impact on downstream areas. Safety is a priority in Japan, where earthquakes occur frequently, and the population is dense. This theme presents the technical standards and systems for dam safety and the guidelines for inspecting monitoring, and operating dams

Irrigation reservoirs have been constructed since ancient times. The oldest existing dams are Sayama-ike, which was constructed in the early 7th century, and Manno-ike, which was constructed in the early 8th century. From the 1930s to the high-economic growth period, many modern dams were constructed to secure water resources and reduce flood damage. Japan has experienced damage to dams caused by earthquakes and downstream areas caused by floodwater released from dams. In addition to ensuring dam safety in the design and construction stages, systems, rules, and organizations have been established to ensure dam safety throughout the dam operation period.



Source: Edited data from the Yearbook of Dams (Japan Dam Foundation)

Figure 1.1 History of Dam Construction in Japan

It is necessary to manage aging dams efficiently and maintain or improve their functions as necessary. Many dams were constructed in the 1960s and 1970s, and more than 50 years have passed, as shown in Figure 1.1. Because floods have become more severe in recent years, it is necessary to strengthen dam management with regard to both hardware and software.

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

Relationships between Dam Management and the SDGs:

(1) To enhance the adaptability to the intensified flood damage and water-related disasters due to climate changes through dam inspection and maintenance based on the systems and subsequent improvement, reinforcement, and improvement of the functions

SDG 13 "Climate Action":

13.1 "Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters"

13.3 "Improve education, awareness-raising, and human and institutional capacity on climate-change mitigation, adaptation, impact reduction and early warning"

(2) To contribute to solving water scarcity through the efficient operation of the existing dam facilities and improvement of their functions

SDG 6 "Ensure access to water and sanitation for all":

6.1 "Achieve universal and equitable access to safe and affordable drinking water"

6.4 "Ensure sustainable abstraction and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity"

6.5 "Implement integrated water resource management"

6.6 "Protect and restore water-related ecosystems"

CHAPTER 2 SAFETY MANAGEMENT OF DAMS

2.1 Standards and Systems for Ensuring Safety of Dams

The basic requirements for the safety of dam structures are provided by laws and supported by the standards, guidelines, and manuals from the planning stage to completion.

(1) Dam Accidents in Japan

The breaking of a dam may result in severe damage. The malfunctions of gate operation, outlet works, and other facilities may cause floods in the downstream areas or a dam break owing to the overtopping of the reservoir water. Table 2.1 presents dam breaks that have occurred in Japan. Most of the breaks occurred in dams constructed before current technical standards were established. The major causes of these breaks were defective construction or overtopping reservoir water. Some irrigation reservoirs constructed away from the river had not been evaluated for the construction stipulated in the River Law. It is possible that they did not satisfy the technical criteria for river facilities.

Table 2.1 Examples of Accidents of Dams in Japan

Name of Dam	Year Constructed	Year of Accident	Type of Dam	Description of Accident	Damage
Iruka-ike	1633	1868	Earthfill dam for irrigation	Heavy rain caused overflow and collapse.	941 persons dead
No. 1 Regulating Pond, Komoro Hydropower Station	1927	1928	Buttress-type concrete dam for hydropower	The dam was constructed without regulatory approval. The foundation ground was improper, and seepage water caused piping phenomena in the foundation.	5 persons dead
Horonai Dam	1939	1941	Gravity-type concrete dam for hydropower	Malfunction of gates due to clogging with flood wood resulted in overflow on the dam. The break was caused by shoddy construction work without removal of the sand layer and gravel in the foundation.	60 persons dead
Heiwa-ike	1949	1951	Earthfill dam for irrigation	Heavy rain caused overflow and collapse.	75 persons dead
Yoake Dam	1952	1953	Gravity-type concrete dam for hydropower	Heavy rains caused the water to overflow over both abutments and washed out earth behind the abutments. Some gates could not be fully opened, owing to the loss of power.	No direct damage
Taisyo-ike	1949?	1953	Earthfill dam for irrigation	The main dam was overflowed and collapsed, together with a downstream's reservoir.	105 persons dead
Wachi Dam	1968	1967	Gravity-type concrete dam for hydropower	One month after completion, the gate broke and collapsed during an operation test due to the gate's vibration.	1 person dead
Fujinuma Dam	1949	2011	Earthfill dam for irrigation	The dam collapsed due to the Great East Japan Earthquake in March 2011.	8 persons dead or missing

Source: Edited data from the documents of the No. 21 Expert Meeting on future policy and the concept of flood management.

(2) Mechanism of Evaluation for Planning, Design, and Construction

Safety is ensured at the planning, design, and construction stages through multilayered permits and approvals from the River Management Offices (RMOs) and third-party agencies. The River Law stipulates that "facilities located on the river should be safe in terms of water level, discharge, topography, geology, and expected loads such as dead weight and water pressure". The project-executing agency requires project approval from the supervising authority. The Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) or prefectures require permission to occupy the river land and water and install structures and dams (Table 2.2). Technical experts inspect the design, foundation, and structure of the dam at the designing, construction, and completion stages. The RMOs approve the operation rules. The main technical standards and guidelines are presented in Extra Table 1.

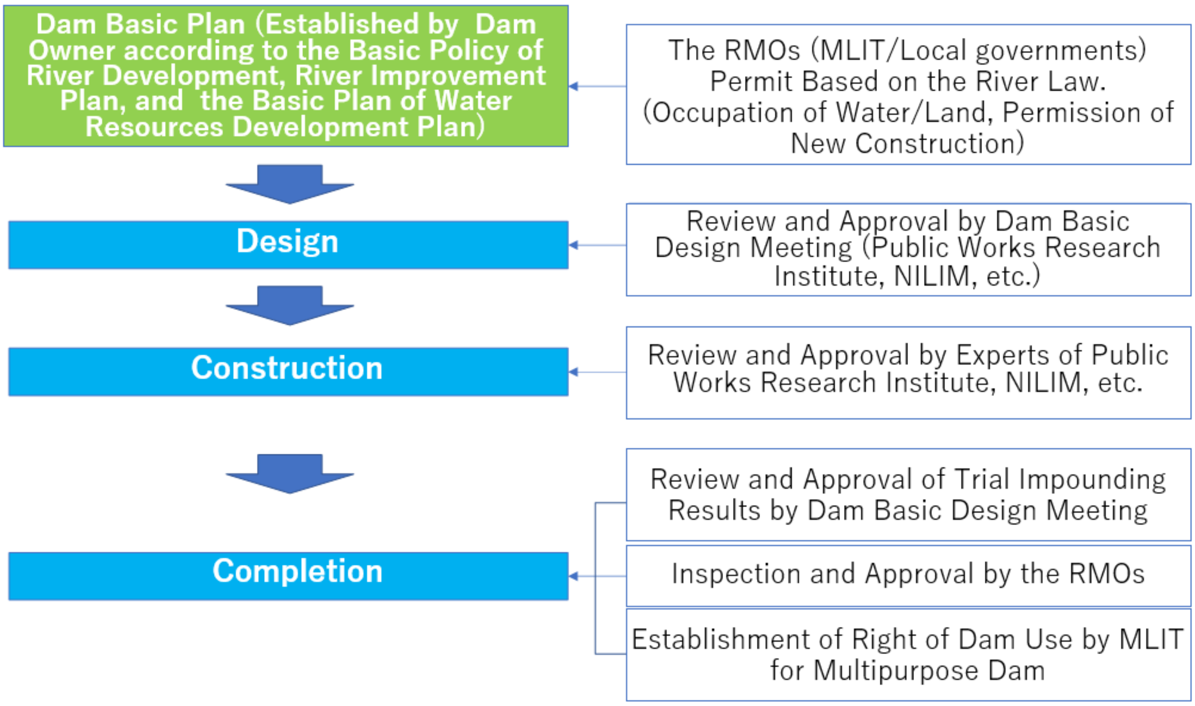
Table 2.2 Mechanism for Permissions and Approvals for Dam Construction in Japan

Purpose of Dam		River Class[a]	Dam Operator	Project Approval	Permission of Construction [b]	Approval [c]
Multipurpose dam (including single-purpose dam for flood protection)		A	MLIT, JWA, local governments	MLIT	MLIT	MLIT
		B	Local governments	Local governments	Local governments	
Water use dam	Irrigation	-	MAFF, JWA, local governments	MAFF	MLIT	MLIT MAFF
	Hydropower	-	Electric power companies	METI	MLIT	MLIT METI
	Domestic/ industrial water supply	-	JWA, local governments	MHLW METI	MLIT	MLIT MHLW METI

Notes:
a: A-class rivers in Japan are designated as rivers that are important with regard to nationwide land conservation and the national economy. B-class rivers are designated by the governors of the local governments as rivers that are important for public interest.
b: Permission from the RMOs for construction or installation of structures across the river.
c: Approvals for planning, design, and construction, including inspections upon completion and operation rules for the dam and appurtenant structures.

Abbreviations:
JWA, Japan Water Agency; MAFF, Ministry of Agriculture, Forestry, and Fisheries; METI, Ministry of Economy, Trade and Industry; MHLW, Ministry of Health, Labor and Welfare

Source: Preparation based on River Law, Specific Multi-Purpose Dams Act, "Construction of Multipurpose Dams" published by Japan Dam Engineering Center



Source: Preparation based on "Construction of Multipurpose for Dams" published by the Japan Dam Engineering Center

Figure 2.1 Technical Approvals of Multipurpose Dams at Planning, Design, and Construction Stages

(3) Review of Technical Standards Based on Disaster Experience

In Japan, where major disasters such as earthquakes and floods occur frequently, the safety of structures is ensured by studying the damage after major disasters updating the design criteria based on the new knowledge.

1) Review of Seismic Design Criteria after the Great Hanshin-Awaji Earthquake

The Great Hanshin-Awaji Earthquake in 1995, with magnitude 7.3, struck the urban area of the Hanshin region. This earthquake led to studies for evaluating the safety of various structures against large earthquakes. There were approximately 50 dams within a 50-km range of the epicenter. The maximum earthquake ground motion was recorded at Hitokura Dam (height of 75 m) a gravity-type concrete dam with a maximum horizontal acceleration of 183 Gal (0.19 g) in the bottom gallery and 482 Gal (0.49g) in the upper gallery. Post-surveys confirmed that there was no severe damage[1], but minor damage, such as cracks, was observed in some dams.

The Japan Society of Civil Engineers (JSCE) proposed that the seismic performance of structures should be checked against the most probable earthquake motion at the structure site (Level 2 earthquake motion[2]). The MLIT established "Guidelines for the Seismic Performance Verification of Dams against Large-Scale Earthquakes (Draft)" to include this proposal in 2005. Before this earthquake, the earthquake-resistant design of dams was developed via the traditional method of static rigid-body

[1] Hanshin-Awaji Earthquake Journal, January 1997, Hyogo Prefecture
[2] In contrast to Level 2 earthquake ground motions, Level 1 earthquake ground motions are those with a probability of occurring once or twice during the service period of a structure and with an intensity too low to damage the structure.

stability verification of the seismic intensity method) using inertial forces calculated by multiplying by the self-weight of the dam. The design seismic intensity was determined empirically for each region.

2) Damage Due to Excessive Flooding

Flood damage occurred in the downstream areas of dams owing to floods that exceeded the flood-protection plan, although the dams were operated appropriately to release water in accordance with the operation rules. For example, flood damage occurred in July 1995 in the downstream area of the Kanogawa Dam on the Hiji River, and the flood damage occurred in July 2006, in the downstream area of the Tsuruda Dam on the Sendai River. According to these cases, a review of soft measures is underway, such as the utilization of information transmission measures, public awareness, forecasting technologies, and measures for hard facilities. Details are presented in Section 3.

(4) Safety Management of Irrigation Reservoirs

Approximately 210,000 reservoirs are used for irrigation in Japan. Approximately 65,000 reservoirs have beneficiary areas of ≥2 ha. Approximately 75% of the 65,000 reservoirs were constructed prior to the Edo period (1603–1868). Most reservoirs, including those constructed in the early Showa period (1926–1945), were constructed in the period from the 7th century to World War II[3]. For many reservoirs, there is no information on the reservoir foundations or construction materials. Numerous levees face problems of settlement and leakage due to deterioration caused by aging. Generational change among reservoir owners and users is progressing. Their relationships and rights to reservoirs have become unclear and complex. Management organizations have suffered from farmers leaving and aging, causing difficulties in the daily maintenance of the structures.

Some reservoirs cause damage to downstream areas owing to dam collapse due to large-scale earthquakes and floods. Eight people were killed when the Fujinuma Dam collapsed because of the Great East Japan Earthquake in 2011. The torrential rains in July 2018 caused the collapse of dams in 32 reservoirs in western Japan, resulting in human casualties. The Act Concerning Management and Conservation of Agricultural Reservoirs was enacted in 2019 to gather information on agricultural reservoirs and prevent disasters caused by the dam collapse. The Framework of Legal Systems for Disaster Prevention Projects for Ponds and Small Reservoirs is shown in Figure 2.4. The following measures were implemented.

- Developing a database and disseminating information about irrigation reservoirs
- Recommending that dam owners conduct disaster prevention work
- Designating reservoirs in danger of collapse resulting in damage to surrounding areas as “specific irrigation reservoirs”
- Restricting threatening actions
- Disseminating information to residents about reservoir collapse and evacuation (Figure 2.3)
- Ordering disaster prevention works to ensure proper management
- Managing reservoirs by the municipalities when their owners are not specified

[3] A guide to creating reservoir hazard maps, 2013, MAFF

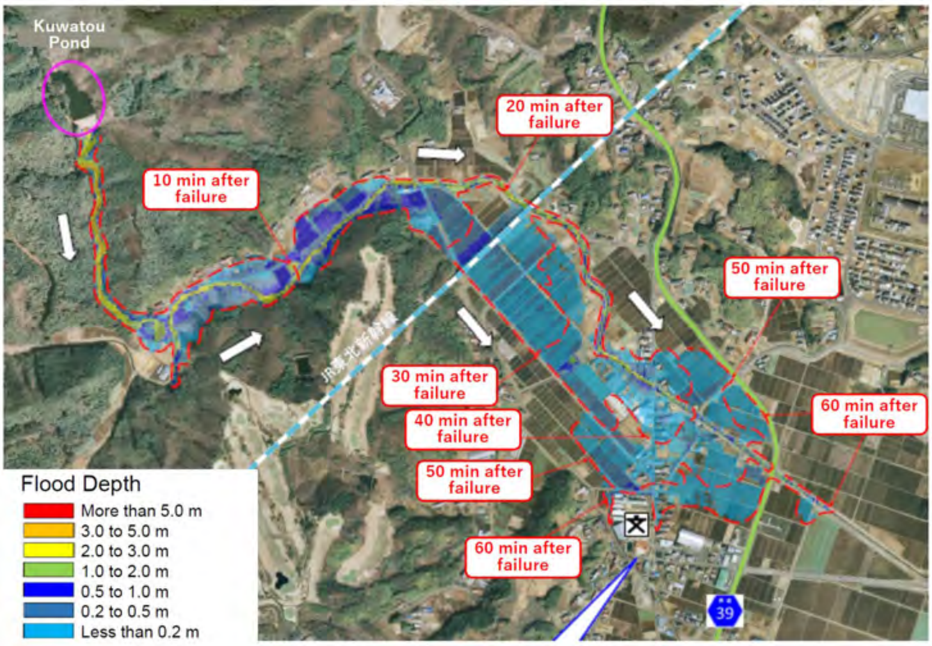
Failure of Fujinuma Dam Caused by the Great East Japan Earthquake[4]

Source: Brief session by Tohoku University one month after Earthquake dated on 13 April 2011

Figure 2.2 Failure of Fujinuma Dam

The Fujinuma Dam in Fukushima Prefecture, which had a height of 18.5 m and was a homogeneous earthfill-type dam, was completed in 1949 and irrigated 837 ha of farmland with a storage capacity of approximately 1.5 million m^3. The Ebanagawa Engan Agricultural Irrigation Area Improvement and Management Association was responsible for its maintenance. On 11 March, 2011, the Great East Japan Earthquake with a magnitude of 9.0 caused the dam to collapse, resulting in seven fatalities, one missing person, and damage to 124 houses. The upper part of the dam near its crest slipped into the reservoir, which triggered multiple slips (Figure 2.2). The slip was attributed to the following two factors:

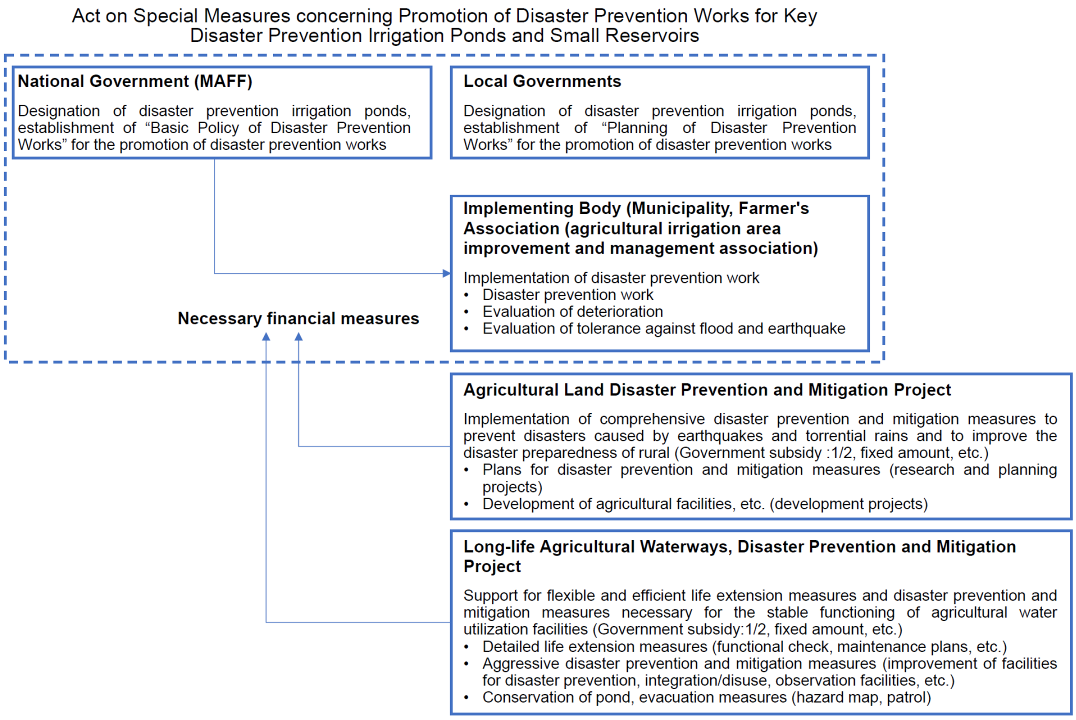
- The dam was constructed in the postwar period during which construction conditions were poor; the degree of compaction was low, and the embankment contained materials rich in the sand. The strength of the saturated part was reduced by the strong earthquake motion.
- The maximum seismic motion at the top of the embankment was 442 Gal (0.45g), and motion of >50 Gal lasted for 100 s, making the ground shaking unprecedented.



Source: Natori City Website

Figure 2.3 Example of Information Disseminated for the Failure of Ponds and Small Reservoirs and Evacuation Using a Hazard Map (Kuwatou-Tameike, Natori City, Miyagi Prefecture)

[4] Report of Survey on Causes of Failure of Fujinuma Dam, January 2012, Review Committee on Seismic Safety of Irrigation Ponds and Small Reservoirs in Fukushima Prefecture



Source: Preparation based on Act on Special Measures concerning Promotion Disaster Prevention Works for Key Disaster Prevention Irrigation Ponds and Small Reservoirs

Figure 2.4 Framework of Legal Systems for Disaster Prevention Projects for Ponds and Small Reservoirs

Example of Management of Old Ponds[5]

Lake Sanna (also known as Otani Pond) is owned and managed by the Fujioka Agricultural Irrigation Area improvement and Management Association in Fujioka City, Gunma Prefecture (Figure 2.5). It is an irrigation reservoir built in 1933 and irrigates approximately 380 ha. The homogeneous earthfill-type dam has a height of 19.7 m. Two staff members of the association manage several reservoirs, headworks, and irrigation channels. They adjust the water supply volume according to the demand of water users and operate gates accordingly. Once a year and as necessary after earthquakes with Japanese seismic intensities of ≥ 4, they conduct visual inspections of the facilities to investigate the deformation of the embankment and seepage lines in observation holes. They conduct cleaning of waterways, mowing, and maintenance of gates three times a year. The water users bear the management costs, including personnel costs. The prefectural and national governments provide subsidies for the rehabilitation of facilities damaged by disasters. The Sanna Lake Dam was constructed before the current structural ordinance was enacted, and seismic resistance reinforcement work is underway.

Source: Agricultural and Rural Development Plan in Gunma Prefecture (2020)

Figure 2.5 Seismic Resistance Reinforcing Works for Sannako Dam

[5] East Asia & Pacific and South Asia Regional Workshop and Exposure Visits for Dam Safety Management and Disaster Resilience, World Bank, April 4, 2017 and Website of Gunma Prefecture

(5) Capacity Building

MLIT and JWA staff receive on-the-job training at offices and national institutes. The Japan Dam Engineering Center consolidates dam technologies and allows engineers from prefectures to improve them. In the private sector, engineers are certified as general supervisory engineers for dam construction and as professional engineers (PE). Dams managed by parties other than the RMOs must be assigned personnel qualified as chief dam management engineers. To qualify, candidates must attend training at the National Construction Training Center and pass an examination. The center also contributes to the capacity building of dam managers by providing practical training in dam operation skills. The JWA has an online system for training involving a simulator of the gate operation during flooding.

The MLIT and local governments conduct “dam management exercises” at each office before the flood season. Assuming a flood that exceeds the planned flood-protection scale, the following drills are provided to communicate information and respond to extreme flooding.

A) Information dissemination (communication with relevant agencies, notification warnings on releasing flood discharges, and patrols)
B) Operation of dam gates (calculation of discharges to be released and setting of gate opening)
C) Risk management (use of emergency power supply and actions when the remote operation becomes impossible for gates and other facilities)

2.2 Inspection for Dam Safety

> Maintenance of dam safety, improvement of management, and reduction of lifecycle costs can be achieved by ensuring inspections and evaluating the inspection results from a third-party perspective.

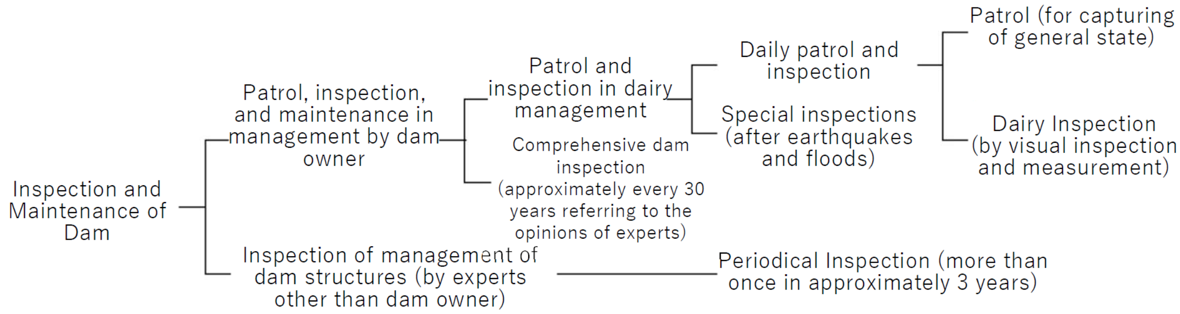
(1) Items, Methods, and Times of Inspection

Dam owners are obligated to maintain the facilities in good condition at all times. Mechanisms are in place to conduct daily inspections and patrols, and periodic inspections are performed by the RMOs and experts in accordance with various guidelines. Inspections of dams owned by the RMOs are classified as “daily patrols and inspections,” “special inspections” after earthquakes and floods, “periodic inspections” conducted at least once every three years, and “comprehensive dam inspections” conducted approximately every 30 years (Figure 2.6). For daily patrols and inspections, the "Dam Inspection and Maintenance Standards" (details are presented in Extra Tables 2-4 attached to the end of this theme) specify the frequency of patrols, inspections, maintenance, and repairs in daily management.

1) Periodic inspection: approximately once every three years. When the necessity of improvement is pointed out, the dam owner must prepare a response policy and report its implementation status to the RMO.

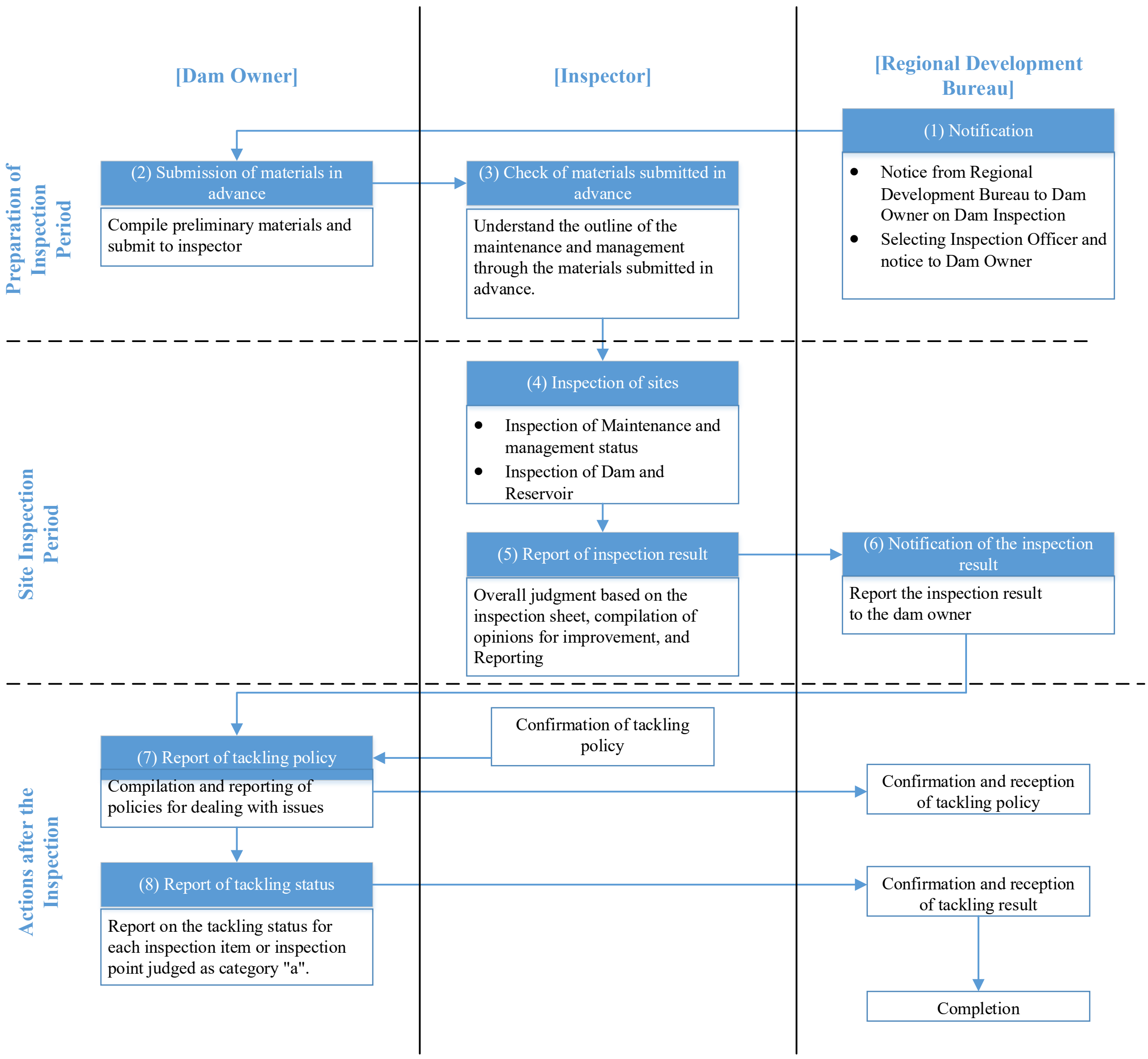
2) Comprehensive inspection: approximately once every 30 years, aiming at assessing dams from a long-term perspective and formulating maintenance and management policies, as summarized in Figure 2.7. Detailed investigations, such as nondestructive surveys and core sampling in dam bodies, are necessary, and dam management records are reviewed to assess

the soundness of dams. The major items for inspection are presented in Table 2.3.



Source: Operating Procedure for Dam Comprehensive Inspection and its Explanation, MLIT

Figure 2.6 Inspections and Maintenance for Dam-Structure Management



Source: Guide to Dam Periodic Inspection, MLIT

Figure 2.7 Procedure for Periodic Dam Inspection

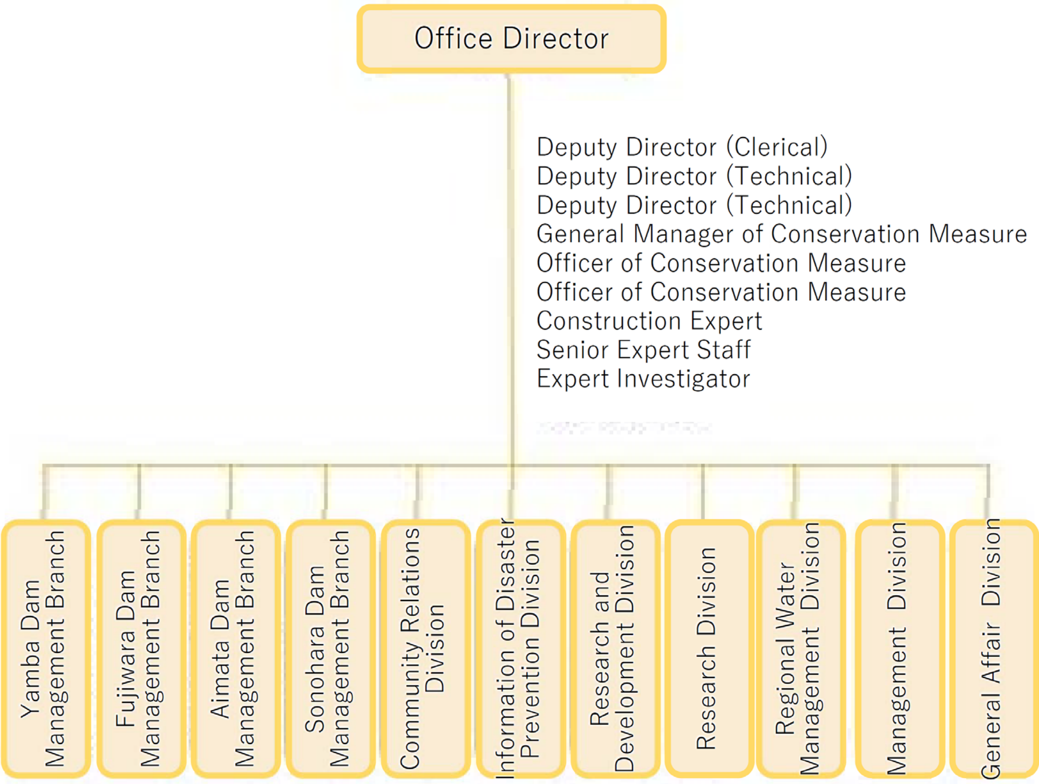
Table 2.3 Major Items of Periodic Inspection and Evaluation of Inspection Results

Classification	Major Inspection Items	Evaluation of Inspection Results
Inspection of the implementation status of maintenance	• Organization of dam management • States of dam operation, inspection and patrol, and data storage • Existence of measures based on lifetime improvement plan	A Urgent improvement is required. B Although some problems exist, these are no overall problems. C There are no problems.
Inspection of dam structures and reservoir	• Results of measurement and observation of dam and reservoir • Deterioration and damage of dam body and appurtenant structures	A Urgent measures against the deterioration or damage are required. B1 Although the structures are safe and functional, prompt measures are required. B2 Although the structures are safe and functional, measures are to be taken as necessary. C The structures are safe and functional. Inspections need to be continued.

Source: Guide to Periodic Dam Inspection, MLIT

(2) Management System

As an example of the organization of the dam management office, the Tone River Dams Integrated Management Office of the MLIT is shown in Figure 2.8 (see "Subclause 4.2: Integrated operation of dams"). The management branch offices of the four dams under the MLIT belong to the integrated management office.



Source: Website of Tone River Dams Integrated Management Office

Figure 2.8 Organization of the Tone River Dams Integrated Management Office

The standard personnel composition of each management branch office is seven to eight people in total: three staff members, one periodic service staff member, and three to four outsourced personnel. In the case of the Fujiwara Dam, the management office building is a four-story structure, as shown in Figure 2.9. Its layout is described in Table 2.4.

Table 2.4 Layout of the Fujiwara Dam Branch Office

4th Floor	Machine room (air conditioners)
3rd Floor	Operation room (consoles for gate operation), telecommunication equipment room
2nd Floor	Offices, conference rooms, lounge space, library
1st Floor	Nap room, power batteries for telecommunications during a power outage
Garage Building	Garage, generators for gate operation during a power outage

Source: Hearing from Tone River Dams Integrated Management Office

Source: Website of Tone River Dams Integrated Management Office

Figure 2.9 Management Branch Office of the Fujiwara Dam

CHAPTER 3 DAM OPERATION DURING FLOOD

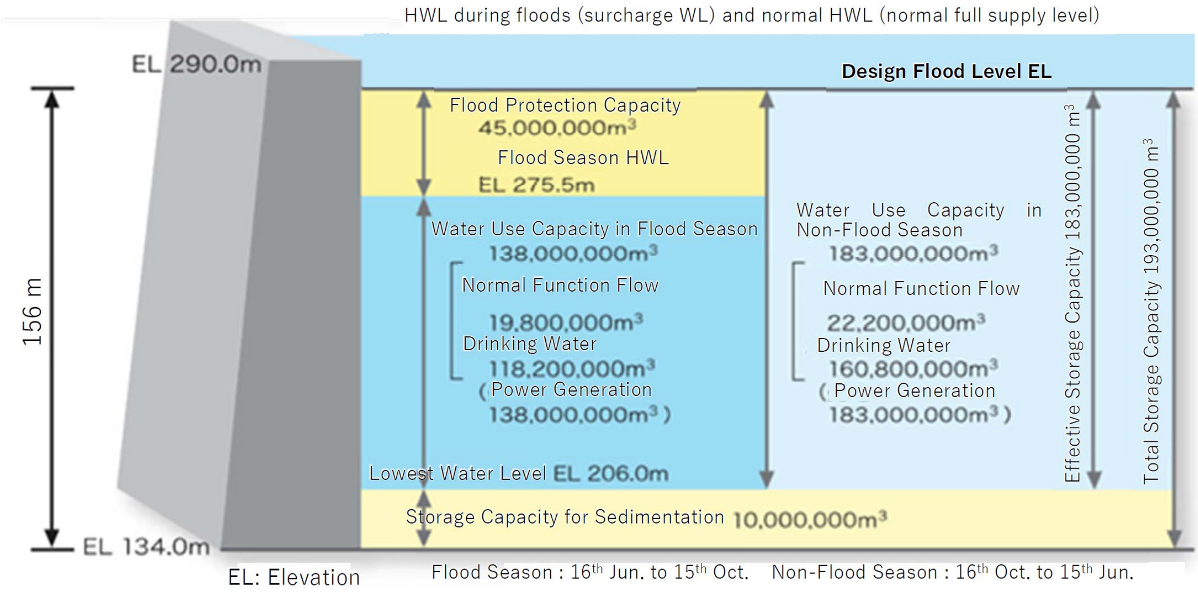
3.1 Storage Capacity Allocation and Flood Protection of Multipurpose Dam

The dam office determines the operation rules in accordance with the flood-protection plan of the river. During flooding, the office operates gates, patrols the downstream area along the river, and warns downstream people before releasing water.

(1) Reservoir Operation

The operational rules of dams for flood protection and water supply are prepared in accordance with the overall flood-protection and drought management plans for the river. The maximum flow does not cause damage to downstream areas or various facilities in the river. This flow volume is named" harmless flow rate". Dames release water to supply water at the drought safety level of once-in-ten year in Japan.

Figure 3.1 shows the storage capacity allocation of the Miyagase Dam in the Sagami River system. An effective storage capacity of 183 million m^3 is used for water supply during the non-flood season. During the flood season, the reservoir allocates a flood-protection capacity of 45 million m^3 by lowering the reservoir water level to the normal water level of El.275.5 m, while water is supplied by using 138 million m^3 of reservoir water below El.275.5 m.



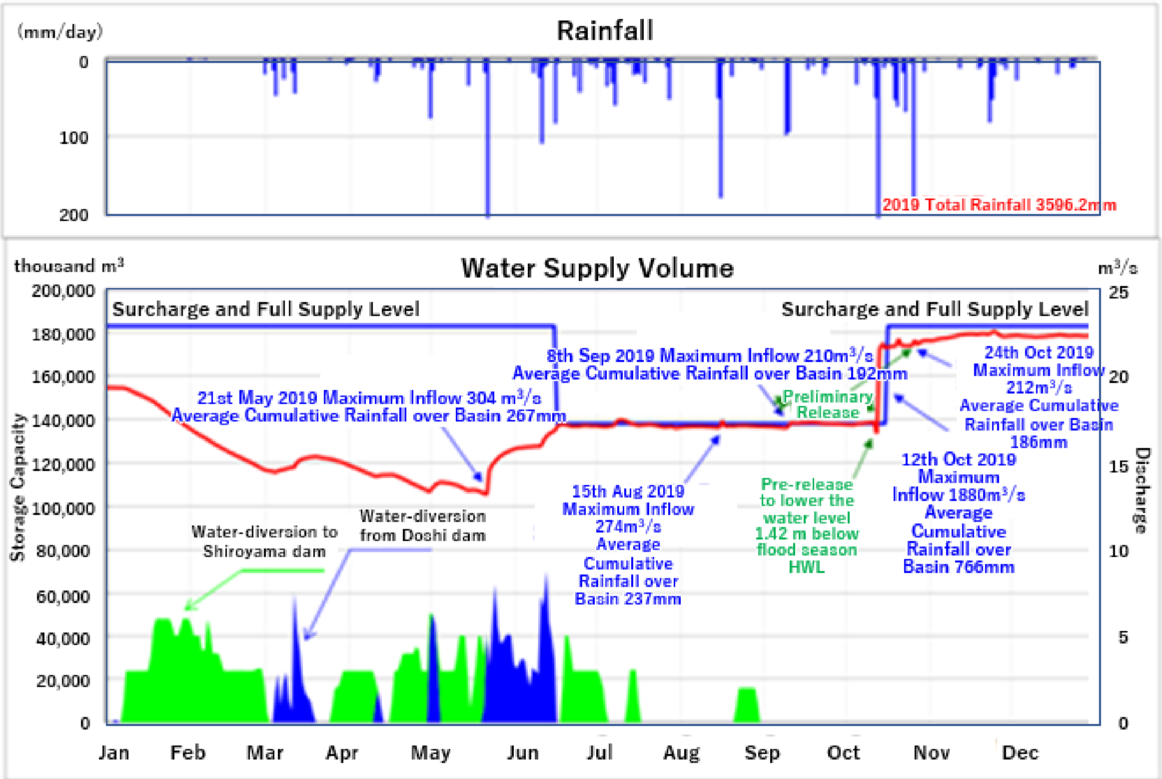
Source: Pamphlet of Miyagase Dam, Sagami River System Dam Management Office, Kanto Regional Development Bureau, MLIT

Figure 3.1 Storage Capacity Allocation of the Miyagase Dam

Annual Reservoir Operation of Miyagase Dam

Figure 3.2 shows the actual operating results for the Miyagase Dam in 2019.

- The reservoir was full as of December 2018, but the water level decreased owing to significant water release for water use during the non-flood season (January to May 2019).
- From June 2019 onward, the rainfall increased, and the water storage levels began rising.
- 15 June to 15 October was in the flood season; thus, the storage level was maintained below the flood season High Water Level (HWL) at El. 275.5 m for flood protection. The flow on the river that reaches downstream of the dam was sufficiently high for the required water abstraction (supply); thus, a small dam release was maintained. The storage level of the dam remained constant.
- After 15 October, it is in the non-flood season; thus, the storage level was restored to the full supply level to prepare for water supply during the non-flood season.



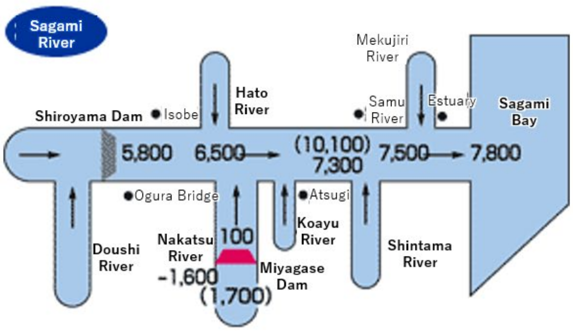
Note: Doshi dam diverts its water, when it is expected to start spilling therefrom, to the Miayagase Dam for storage therein while the Miyagase Dam diverts its water to the Shiroyama Dam, which has a shortage of stored water, to satisfy the water demand of Tokyo.

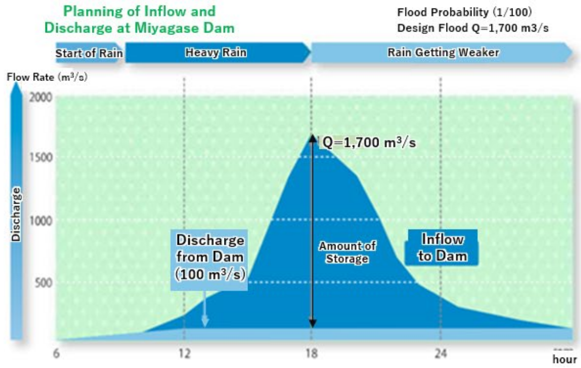
Source: Website of Sagami River System Dam Management Office

Figure 3.2 Annual Reservoir Operation Record of the Miyagase Dam for 2019

Operation of Miyagase Dam During Flood on 12 October 2019

The left figure in Figure 3.3 illustrates the flood-protection plan for Sagami River. The discharge of the design flood before regulation at the reference point, i.e., Atsugi, is 10,100 m^3/s. The upstream dams were expected to reduce the flood discharge by 2,800 m^3/s, and the river channel carries the remaining 7,300 m^3/s. The Miyagase Dam is expected to reduce the flood discharge by 1,600 m^3/s. The right figure in Figure 3.3 shows the flood hydrograph in the control plan of the Miyagase Dam. The flood inflow at the peak is 1,700 m^3/s, corresponding to a probability of once in 100 years. The peak flood discharge stored in the reservoir is 1,600 m^3/s, and the discharge released downstream is 100 m^3/s.

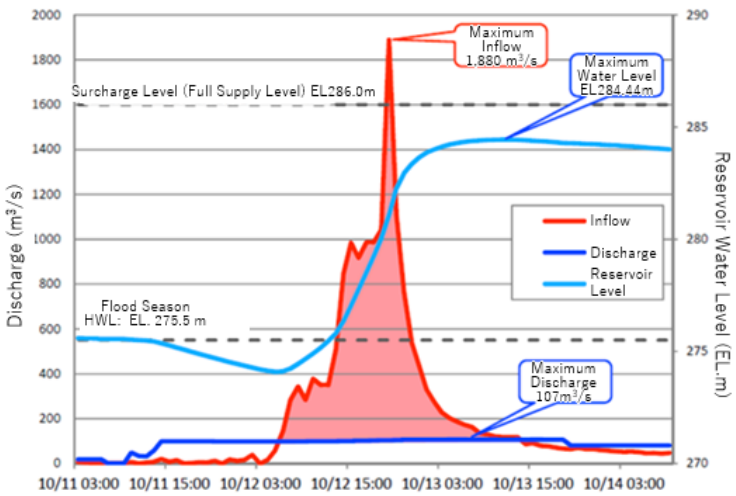




Source: Website of Sagami River System Dam Management Office

Figure 3.3 Flood-Protection Plans for Sagami River and Flood Protection for the Miyagase Dam

Figure 3.4 shows the operation for the flood caused by Typhoon No. 19 in 2019. The inflow was 1,880 m^3/s, exceeding the planned peak discharge of 1,700 m^3/s. Forty-three million m^3 were stored in the reservoir, and the maximum discharge was 105 m^3/s. This resulted in a reduction of 1.1 m in the river water level at the flood-protection reference point (Atsugi Point). The maximum water level in the reservoir was El.284.44 m, which was 1.56 m below the planned maximum water level of El.286 m, because the reservoir level was lowered to a level below the flood season HWL by pre-release preceding the flooding according to the flood forecast.



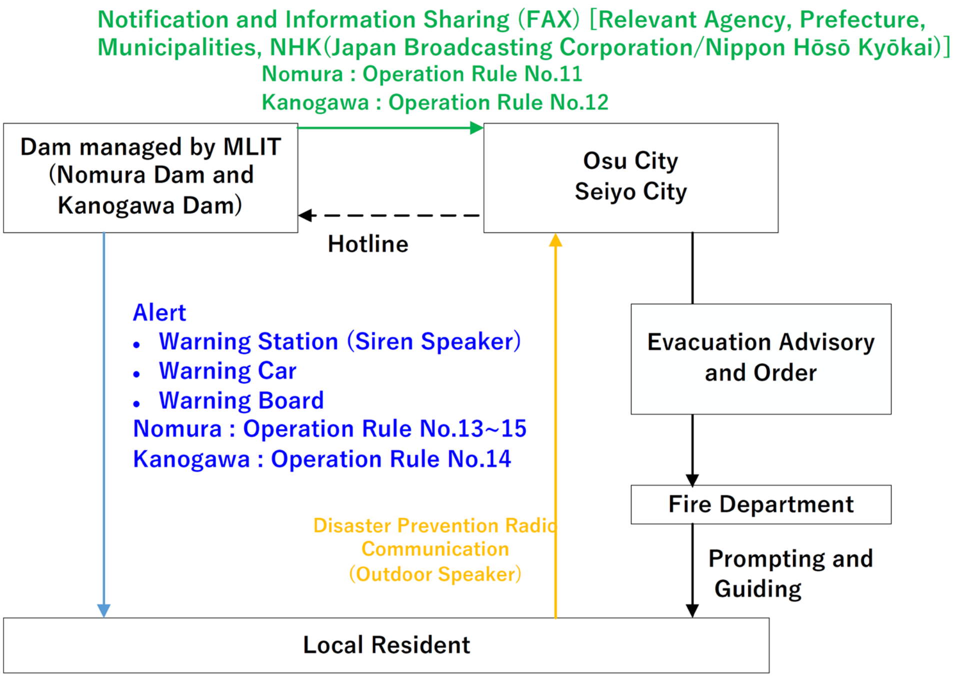
Source: States of Dams at Typhoon No. 19 in 2019, MLIT

Figure 3.4 Example of Flood Protection (Miyagase Dam for Typhoon No. 19 in 2019)

(2) Ensuring Safety of Residents and River Users in Downstream Area

In cases where the dam discharge increases rapidly, careful patrols and notifications should be made in advance to ensure the safety of residents and recreational users in the downstream area. The River Law stipulates that "the dam owner shall establish Dam Operation Rules and obtain approval from the RMOs". A diagram of the notification and sharing of information is shown in Figure 3.5. When the dam discharge is predicted to cause a sudden increase in the river flow in the downstream area, the dam discharge must be reported to the relevant local governor, mayors, and the chief of the relevant police station, as well as nearby residents and river users. Notification and dissemination methods should be specified in the dam operation rules. The notification methods include sounding, warning sirens and mobilizing warning vehicles. Further approval to operate during the extraordinary flood disaster prevention should be obtained from the Regional Development Bureau of the MLIT or the local governor.

In addition to the above, in accordance with Article 52 of the River Law (Instructions for flood protection), river administrators may instruct the owner of the water supply dam to take measures such as temporary storing of floodwater to prevent flood damage (Extra Table 5).



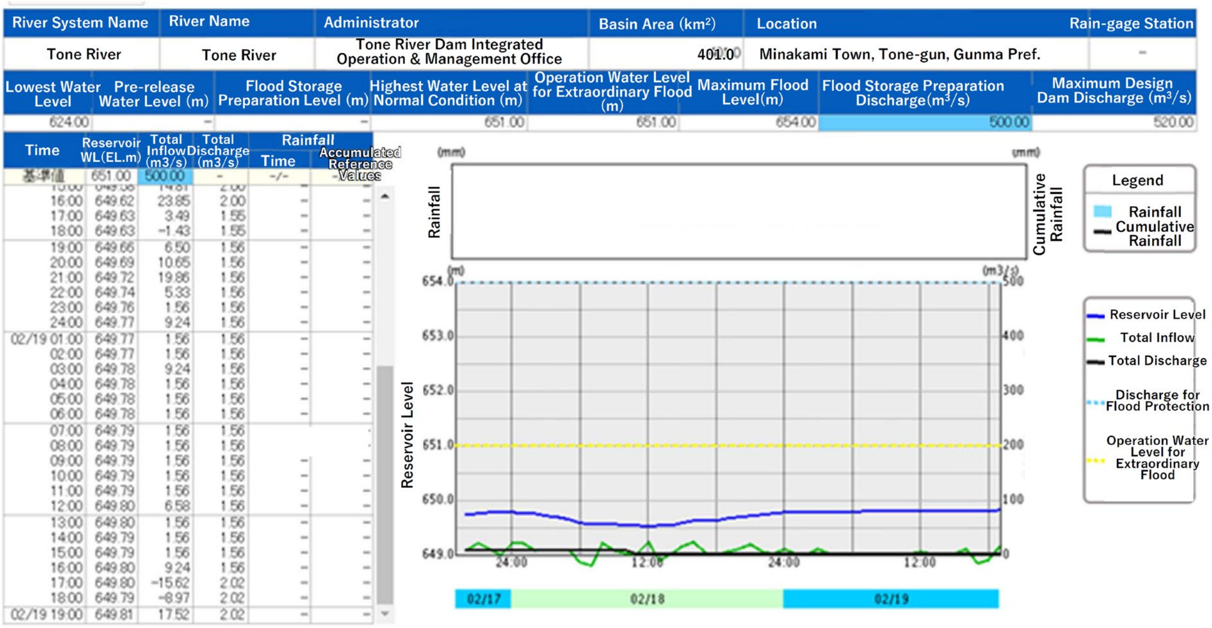
Source: Summary of Discussions for Verification of Information Sharing on the Operation of Nomura Dam and Kanogawa Dam, November 2018

Figure 3.5 Notification and Information Sharing

To share information with the public, (1) the dam information (inflow, discharge, reservoir water level, and rainfall) is provided in real time on the MLIT website (Figure 3.6), and (2) discharge warnings and other information are provided on the website. Each management office has a Twitter account that allows users to view the discharge status and other information (Figure 3.7).

It is necessary to avoid a sudden rise in the river water level due to dam discharge, which allows almost no time for river users to evacuate. The Guidelines for Planning and Designing Dam Discharge Warning

Systems (Draft) stipulate that the rate of increases of the water level due to dam discharge should be less than 30 cm in 30 min. at the most dangerous point on the downstream river.



Source: MLIT Website

Figure 3.6 Real-time Information Sharing for Hydrological Data of Dams via "Information of River Disaster Management"

Source: Fujiwara Dam

Figure 3.7 Information Sharing via Twitter for the Fujiwara Dam

(3) Records and Reporting

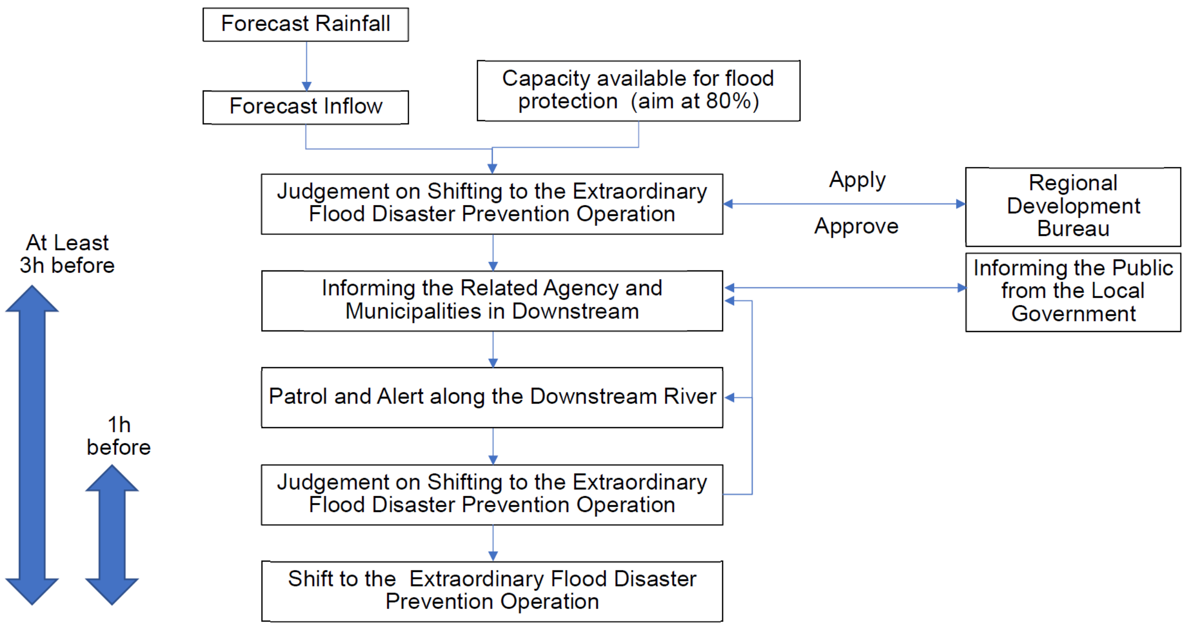
The River Law stipulates that "the dam owner records hydrological data such as inflow into the reservoir, discharge downstream, reservoir water levels, and river water levels at the dam, as well as the operation of the dam". They should notify the RMOs and local governments of the occurrence of floods. Observation, recording, and accumulation of hydrological data are necessary for not only the operation and maintenance of facilities but also verification of dam operations. This information is also important for formulating and reviewing flood-protection plans, studying conservation measures for the river water quality and biological environments, and implementing construction works. These data are shared with the public in real-time through the "River Disaster Prevention Information". Historical information from the past can be found in the "Dam Quantity Database".

3.2 Dam Operation During Extraordinary Flood Exceeding Design Discharge

When the dam is predicted to be unable to store floodwater that exceeds the capacity of the flood-protection plan, the dam discharge needs to be maintained at the same level as the dam inflow to ensure the dam safety and prevent damage in downstream areas. The downstream damage must be managed so that it does not exceed the damage level without the dam.

(1) Operation for Disaster Prevention at the Extraordinary Flood

When a flood exceeding the planned flood protection occurs, and it is predicted that the dam is in danger, extraordinary flood disaster prevention operations are conducted to ensure the safety of the dam. The dam discharge is managed to prevent the inflow into the reservoir. A diagram of this procedure is shown in Figure 3.8.



Source: Hearing from Tone River Dams Integrated Management Office and Notes on Procedure for Operation of Nomura Dam

Figure 3.8 Procedure for Shifting from Normal Operation to Extraordinary Flood Operation

Lessons Learned from Extraordinary Flood Disaster Prevention Operation Conducted in July 2018 at Nomura and Kanogawa Dams in Hijikawa River

The record-breaking torrential rains in July 2018 caused flood damage to 995 ha of land, inundating 3,703 houses on the Hiji River in Ehime Prefecture (Figure 3.9). Two multipurpose dams of the Nomura and Kanogawa Dams, had inflows far exceeding the planned one with a 100-year probability. For both dams, extraordinary flood disaster prevention operations were conducted, and notifications and warnings were sent to the relevant organizations in accordance with regulations. However, the information may not have been disseminated securely to all the residents. Consideration and review of the flood disaster were undertaken by the national government, local governments, and academics to discuss and verify how to provide more useful information, how to inform residents, and how to operate dams more effectively. As a result of this verification, the following measures were proposed (Table 3.1).

Source: MLIT

Figure 3.9 Flood Inundation along Hijikawa River

Table 3.1 Proposed Measures for Reducing Flood Damage upon Extraordinary Flood Disaster Prevention Operation (Nomura Dam and Kanogawa Dam)

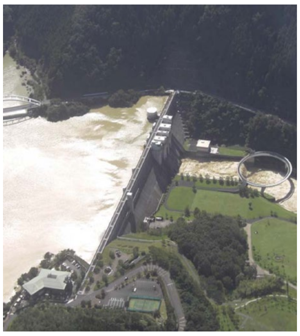
Subject	Main Measures
Information Sharing and Dissemination to Residents	• Establishment of criteria for issuing evacuation orders related to river water levels and dam discharge • Strengthening communicating with local governments using email and videophone • Dispatch of liaison personnel to provide information to local governments • Reinforcement of warning methods using electronic bulletin boards, local cable television, and administrative disaster prevention radio • Installation of water-level meters to provide detailed water-level information • Flood hazard maps related to Extraordinary Flood Disaster Prevention Operations • Development of a timeline (disaster prevention action plan) for government agencies to ensure evacuation • Briefing sessions and disaster drills for residents related to dam operations and information, publishing of disaster prevention books, and disaster prevention education at elementary and junior high schools.
Dam Operation	• Enhancement of advanced discharging (pre-releasing) based on flood forecasts • Modification of the Kanogawa Dam to increase the flood-protection capacity and revision of the flood-protection rules to make them more effective • Promotion of renovation of downstream rivers and accompanying changes in flexible dam operation rules

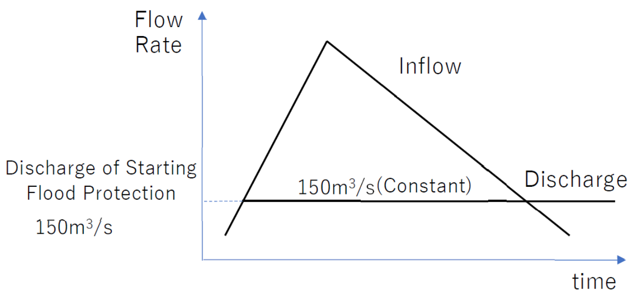
Source: Summary of Discussions for Verification of Information Sharing Concerning Operation of Nomura Dam and Kanogawa Dam, Shikoku Regional Development Bureau, MLIT

(2) Advanced Dam Operation During Heavy Flood

Advanced dam operation has been realized by adopting the latest technology, e.g., rainfall prediction. In the case of Typhoon No. 18 in 2013, the Hiyoshi Dam in the upper reach of the Katsura River in Kyoto Prefecture was operated by predicting the inflow volume. This significantly reduced the damage in the downstream areas.

The flood-protection plan of the dam involved applying the gate operation rule of constant release at 150 m^3/s to reduce the flood discharge to 1,360 m^3/s under the design flood with a peak discharge of 1,510 m^3/s. Typhoons caused a record inflow of 1,690 m^3/s into the reservoir, as shown in Figure 3.10. Because the river water level exceeded the flood risk level on the river reaches downstream of the dam, the JWA (the dam owner) and the Kinki Regional Development Bureau of the MLIT (the RMOs) decided to utilize the reservoir up to the highest water level of El.203.7 m, which was designed to ensure the safety of the dam. The dam stored floodwater level that exceeded the planned maximum flood level of El.201.0 m. Floodwater was retained in the reservoir up to the marginal level, judging by the remaining available reservoir capacity estimated from the rainfall and inflow forecasts based on the movement of rain clouds measured by weather radar. Although overtopping of the levee had already occurred on the downstream river reaches, the start of the extraordinary flood disaster prevention operation was delayed by 3 hours (Figure 3.11). It is estimated that the operation lowered the downstream river water level by 1.5 meters.





Source: Outline of flooding by typhoon No.18 September 2013 Kinki Regional Development Bureau (MLIT)

Figure 3.10 Flood Release from the Hiyoshi Dam (Left) and the Flood-Protection Plan (Right)

Source: Outline of flooding by typhoon No.18 September 2013 Kinki Regional Development Bureau (MLIT)

Figure 3.11 Overflow in the Downstream River

3.3 Operation During Flood

> Even if a dam is constructed exclusively for the purpose of water supply, it must not increase the flood flow or worsen the flood damage compared with those without a dam. Flood forecasting technology is utilized in Japan to temporarily increase the flood-protection capacity by reallocating some of the reservoir capacity for water supply.

(1) Operation Under Current Legal Framework

The River Law stipulates that "dams shall maintain the function of the downstream river to carry flood discharge in the same manner before dam construction." Dams constructed for water supply must maintain downstream flood conditions to avoid exceeding these flood discharges. In addition, the RMOs may instruct the dam owner to take measures such as temporary storage of floodwater for preventing flood damage.

(2) Flood Protection Utilizing Pre-release water for Water Supply

In light of the increasing severity of flood damage, the water supply reservoir capacity of existing dams is reserved for flood protection by releasing the stored water in advance. The MLIT and there are seven water supply dams to be modified. The MLIT published the "Guidelines for Pre-release of Water" in April 2020. The guidelines cover as follows:

【Standard for Start of Operation】

- Pre-release is considered when the predicted rainfall level upstream of the dam is equal to or higher than the standard rainfall level.
- The standard rainfall is defined as rainfall that causes flooding in the downstream area (equivalent to the current flow capacity of the river downstream).
- The model predicts rainfall up to 84 h in advance.

【Method for Determining Lowering Extent of Reservoir Water Level】

- The pre-release decision is made 3 d in advance.
- Numerical forecast data predictions up to 39 h in advance are also used, as well as predictions from the 84 h model, for comparison with the standard rainfall.

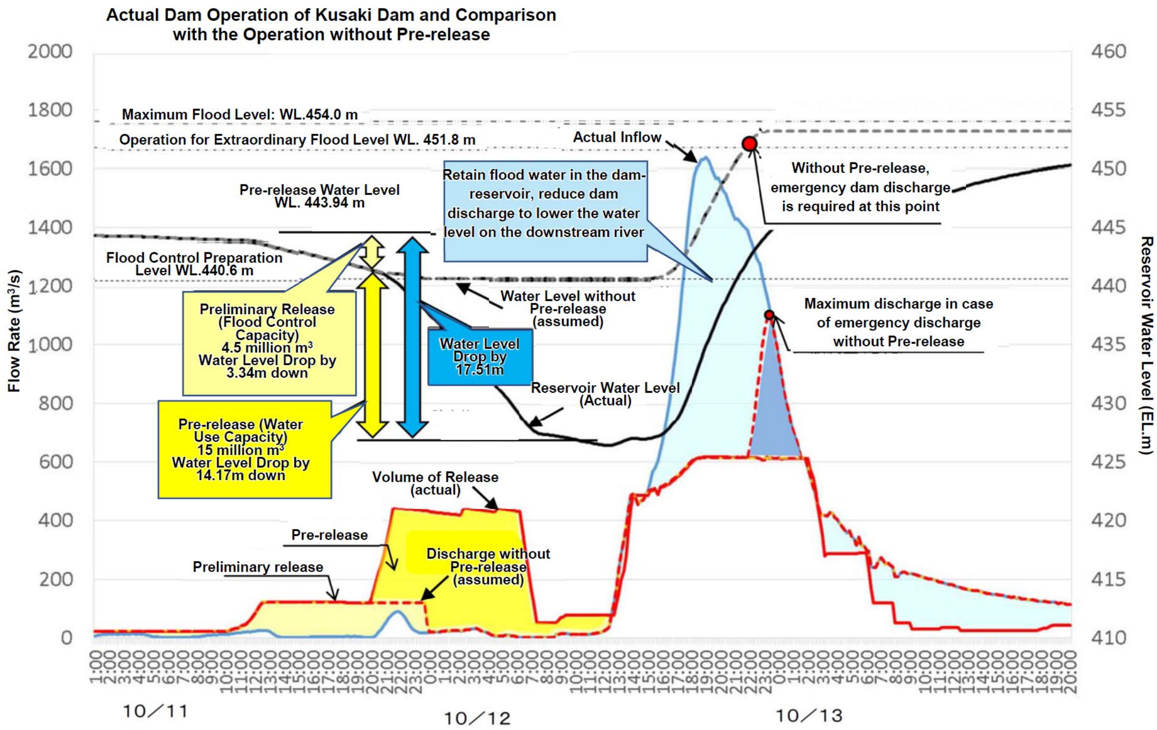
【Activities to be taken When Reservoir Water Level Does Not Recover After Pre-release Operation】

- If the water level lowered by the advanced release does not recover and water supply becomes difficult, the RMOs must provide the necessary information and ensure smooth coordination of water use among the parties concerned. Relevant water users must discuss water sharing at drought coordination meetings.
- If the water users suffer losses, the RMOs bears the costs.

Examples of Cooperation for Flood Protection by Pre-release Operation

Floodwater was partially stored in the reservoir of the Kazeya and Ikehara Dams for power generation on the Kumano River, after pre-release of water to prepare for the forthcoming heavy rain of Typhoon No. 10 in 2019. The operation lowered the river water level by 1.3 m on the downstream reaches and prevented damage to houses. The pre-release operation discharged 98 million m^3 of water in total, which was approximately 30% of the total effective reservoir capacity of the two dams (Figure 3.12).

The Kusaki Dam on the Watarase River released 15 million m^3 of water in advance of Typhoon No. 18 in 2019. In addition to the flood-protection capacity of 20 million m^3, a reservoir capacity of 35 million m^3 was secured, including the pre-release from the water supply capacity. Thus, the extraordinary flood disaster prevention operation was avoided to prevent an increase in the dam discharge to the downstream river.



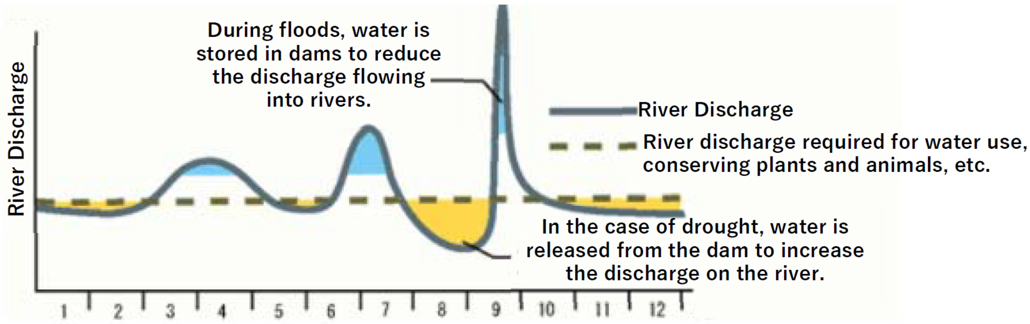
Source: MLIT Website

Figure 3.12 Pre-release Operation of the Kusaki Dam for Typhoon No. 18 in 2019 and Its Effect

CHAPTER 4 EFFICIENT OPERATION FOR WATER SUPPLY

Integrated operation of multiple dams allows efficient and appropriate use of reservoirs.

The reservoir capacity for water supply is determined to increase the river discharge during a drought, which generally occurs once every 10 years in Japan. When the discharge is lower than the normal level at the water use reference point, the dam reservoir is supplied. Figure 4.1 shows the river discharge changes over a year to supply the dam reservoir.



Source: MLIT Website

Figure 4.1 Water Supply Increase Caused by a Dam

The integrated operation of multiple dams located in a single river system contributes to the efficient use of reservoir water. This operation is performed by considering the locations, reservoir capacities, and basin characteristics of each dam. For example, nine dams in the Tone River Basin are utilized in the Tokyo metropolitan area, as shown in Figure 4.2. Because of the wide catchment area of the Tone River Basin, the rainfall characteristics (area, pattern, and duration) are not uniform. The river discharges from the sub-basins downstream of dams vary significantly, and the water use is complex. The river flow conditions vary over time. It takes a long time of approximately 1.5 days for the upstream dam discharges to reach the reference point, namely Kurihashi. Watarase Reservoir is close to Kurihashi. Owing to its location, Watarase Reservoir is mainly used for the supply adjustment of the discharge at Kurihashi, which may change rapidly.

Water supply priority is given to the dam that has the largest ratio of the catchment area to the reservoir capacity. This indicates that the reservoir has the highest probability of recovering full storage through flood operations. The priority order in releasing dam discharges is set to account for the snow depth of the current year, the annual time of reservoir water recycling, and other factors.

Source: Tone River Dams Integrated Management Office

Figure 4.2 Dams Operated by the Tone River Dams Integrated Management Office

CHAPTER 5 MEASURES FOR REHABILITATION AND IMPROVEMENT OF DAM FUNCTIONS

> The functions of existing dams can be used effectively and sustainably. The soft and hard technologies can enhance the functions of flood protection and water supply.

(1) Measures for Dam Rehabilitation

The impact of climate change has become apparent. The damage caused by floods and droughts has intensified and become more frequent. Amid financial constraints, it is important to utilize the existing infrastructure effectively while controlling the total cost. Existing dams should be used effectively and sustainably over the long term. The rehabilitation of dams is promoted to extend their service lives, maintain efficient and advanced dam functions, and restore and improve their functions. Dam rehabilitation efforts include the measures presented in Table 5.1.

Dam rehabilitation is efficient because of its relatively low cost, short duration, and minimal impacts on the natural and social environments. In particular, dam raising can significantly increase the water storage capacity with small submerged areas. The augmentation of dam discharge pipes facilitates the reallocation of reservoir capacity and the use of the water supply capacity for flood protection. In addition, sediment control facilities, such as sediment discharge bypasses, can extend the service life. Flood forecasting with rainfall radar is a soft measure that allows more efficient and advanced use of dams for a temporary capacity for flood protection.

(2) Dam Rehabilitation Technologies in Japan

1) Katsurazawa Dam Raising

The Katsurazawa Dam, which has a height of 75.5 m and is of the gravity concrete type, was constructed in 1957. It was raised by 11.9 m to enhance the flood-protection and water supply functions, as shown in Figure 5.1. In addition to efficiently increasing the water storage capacity with a small submerged area, dam raising is less expensive and less environmental impacts compared with the construction of a new dam.

(3) Dam Rehabilitation Technologies in Japan

1) Katsurazawa Dam Raising

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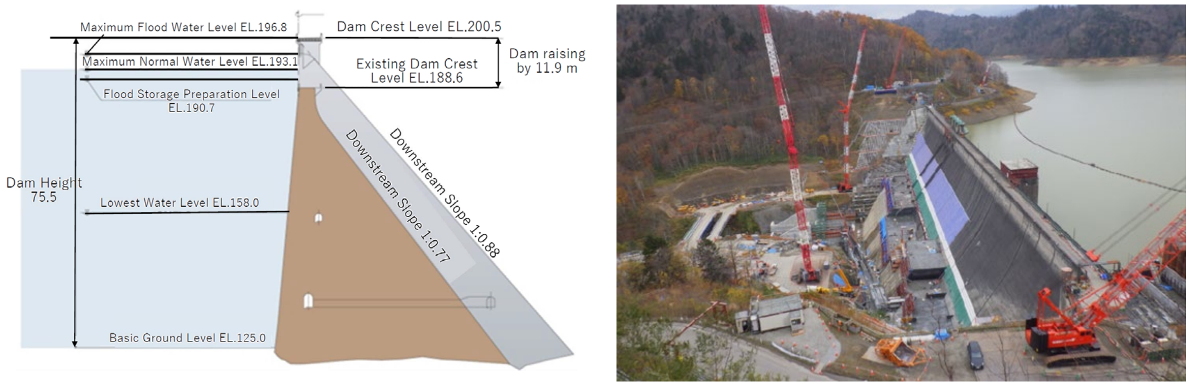
Table 5.1 Measures for Dam Rehabilitation

Measures	Descriptions
(1) Extending the service life	• Sediment control measures (excavation and dredging, installation of sand storage dams, sediment bypasses, and sand discharge gates) • Systematic maintenance and management of machinery and equipment based on the Plan-Do-Check-Act (PDCA) cycle through periodic inspections, life extension planning, levelling, and reduction of lifecycle costs
(2) Streamlining the maintenance and management	• Underwater maintenance robots (trial stage) • Flexible and safe inspection via remote inspection and measurement with a drone camera
(3) Improvement of flood protection and water use functions	
1) Operational improvements and capacity reallocation	• Expansion of the real-time high-precision rainfall radar (XRAIN) • Reduction of flood damage via flood forecasting using rainfall data obtained using rainfall radar • Utilization of the water supply capacity for flood protection through the pre-release of water and shifting of the reservoir capacity from water supply to flood protection (Hattahara Dam, Sakuma Dam)
1) Operational improvements and capacity reallocation	• Reallocation of the water storage capacity through reorganization of dam groups (Naruse River Integrated Development, coordination of dam groups upstream of the Kinugawa Dam, coordination of the Kitachiba Headrace and Misato Flood Bypass)
2) Increasing the water storage capacity	• Dam raising (Shin-Katsurazawa Dam, Tsugaru Dam)
3) Expanding the dam discharge capacity	• Construction of additional river outlet facilities via large-scale drilling of the concrete dam body (Tsuruda Dam, Amagase Dam) with construction technology under a high water pressure
(4) Improvement of river environment	
1) Improvement of river environment through flexible management	• Avoiding flow stagnation with flushing discharge (Sagae Dam) • Sediment supply to the downstream river reaches in combination with sediment control measures (Shimokubo Dam) • Creation of an unspecified capacity (environmental capacity) through dam coordination (Gojiri and Kawaji Dams)
2) Improvement of the river environment through facility development	• Continual sediment transport facilitated by a sediment bypass • Improvement of the water environment through a freshwater bypass, a selective water intake system, and an aeration circulation system (Urayama Dam) • Improvement of the biological environment through the installation of fishways and maintenance of forests (Tokuyama Dam)

Source: Vision of Dam Rehabilitation, Water and Disaster Management Bureau, MLIT

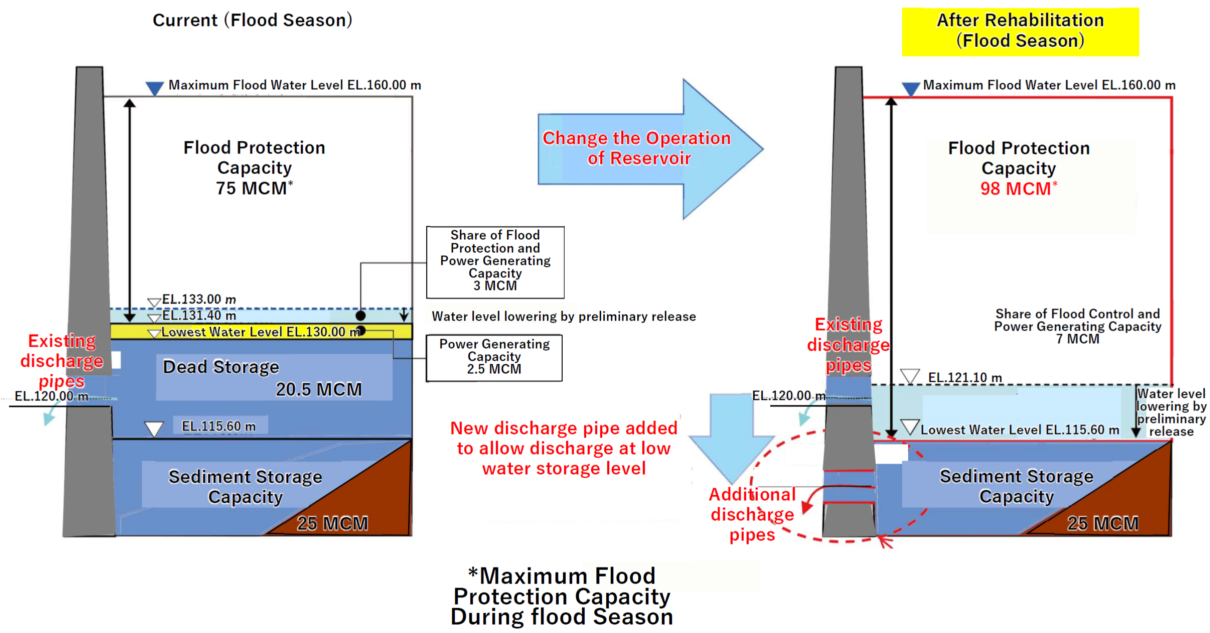


Source: Sapporo Development and Construction Office, Hokkaido Regional Development Bureau

Figure 5.1 Cross Section of the Body of the Shin-Katsurazawa Dam and Photograph of Construction Works

2) Installation of Additional River Outlet Facility via Drilling in Tsuruda Dam

The Sendai River was severely damaged in 2006, with two deaths, 2,777 ha of inundated land, and 2,347 houses damaged. This led to a rehabilitation project for enhancing the flood-protection function of the Tsuruta Dam, which is located upstream of the Sendai River. This dam, which is 117.5 m high and of the gravity concrete type, was constructed in 1966. It is a multipurpose dam used for flood protection and power generation. By reallocating some capacity for power generation to flood protection, the flood-protection capacity of 75 million m^3 (MCM) was increased to 98 MCM. Construction work was performed to drill and install flood discharge pipes, intakes, and penstocks for power generation in the existing dam body, as shown in Figure 5.2. Dam rehabilitation was conducted using the latest temporary coffering technology to minimize the interruption of the reservoir operation of existing dams during construction, as shown in Figure 5.3.



Source: Sendai-gawa River Office, MLIT

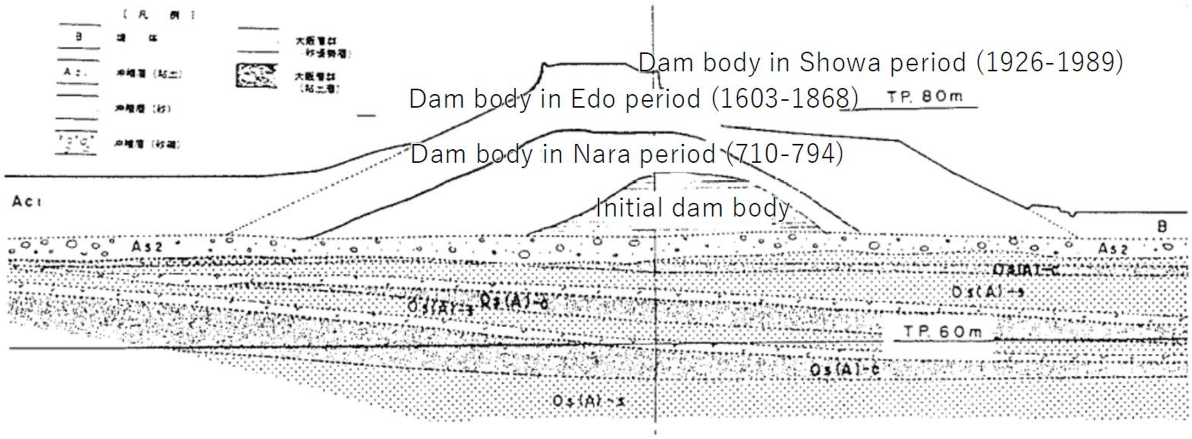
Figure 5.2 Reformulation of Reservoir Operation for the Tsuruda Dam

Note: (Upper left and center) upstream coffering, (Upper right) drilling of dam body, (Lower)before and after the works
Source: Sendai-gawa River Office, MLIT

Figure 5.3 Rehabilitation Works for the Tsuruda Dam

3) Rehabilitation of Japan's Oldest Dam (Sayama-ike)

The Sayama-ike (pond) in Osaka City was constructed for irrigation in the first half of the 7th century. It is the oldest dam reservoir in the country and is recorded in Kojiki (Records of Ancient Matters) and Nihonshoki (Chronicles of Japan). The dam has been renovated many times, e.g., by Gyoki in the Nara period, Chogen in the Kamakura period, and Katagiri Katsumoto in the Azuchi-Momoyama period. Figure 5.4 shows the cross-section of the dam body, which indicates the history of the embankment. In recent years, the number of paddy fields in downstream areas has decreased owing to urbanization, and flood damage has occurred frequently. In 1982, Typhoon No. 10 flooded the downstream Nishiyoke River, inundating more than 3,000 houses. In 2001, renovation was performed to add flood-protection functions. The pond bed was excavated approximately 3 meters down, and the embankment was raised by approximately 1.1 meters to secure a new flood-protection capacity of 1.0 MCM and a new water supply capacity of 1.8 MCM for agriculture, as shown in Figure 5.5.



Source: Sayama-ike Dam, Old Dam Talks about History of Civil Engineering, Kanamori et al, Historical Studies of Civil Engineering No. 15

Figure 5.4 History of Rehabilitation Works for Sayama-ike

Source: Website of Osaka Prefecture

Figure 5.5 Sayama-ike Before and After Rehabilitation

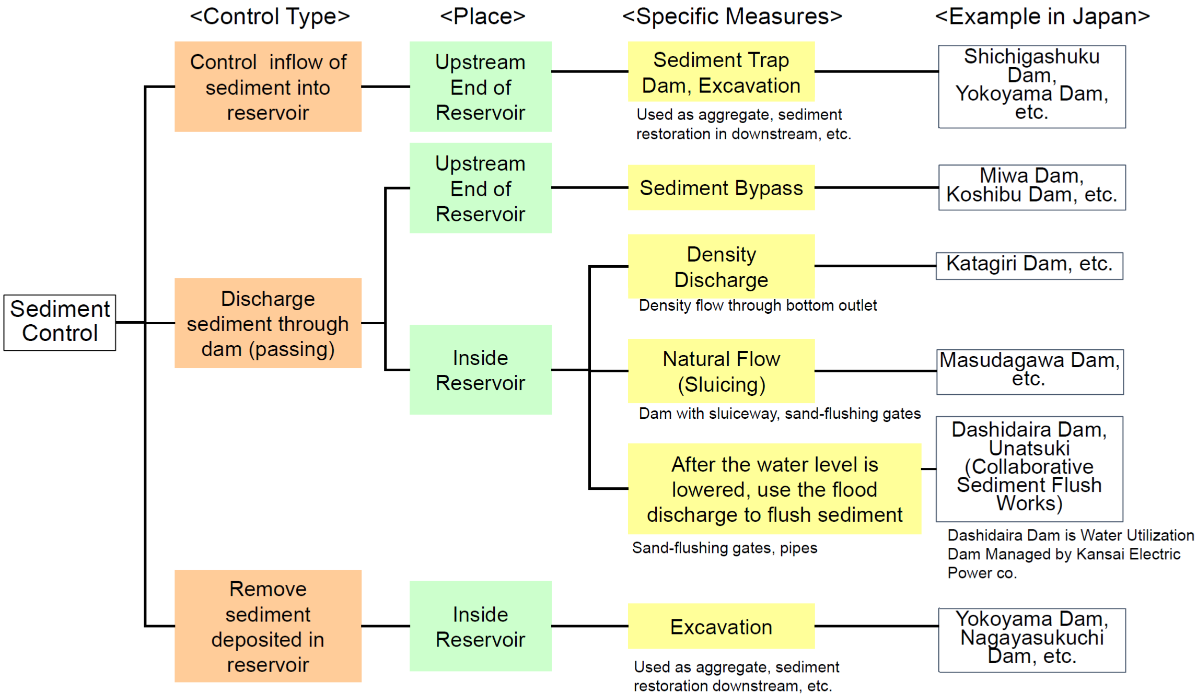
(4) Technologies for Sediment Control

The sedimentation capacity of the reservoirs is determined by estimating the sedimentation volume to be deposited over 100 years. Dams located on steep-sloped rivers with high rates of sediment production might be faster than estimated. In some cases, sedimentation reduces the reservoir capacity and degrades the functions by submerging intake facilities. Reservoir sedimentation changes the environment of the entire downstream river, including coarse-grained riverbed lowering, as well as the recession of the sea shoreline. The measures for sediment control in Japan are presented in Figure 5.6. Typical measures include the excavation and flushing of sediment by lowering the water level in the reservoir and the construction of a sand discharge bypass (Figure 5.7).

The excavated sediment materials were used by the local governments for road construction and other public works. In "to return sediment to the downstream river" (Figure 5.8), the excavated sediment materials are piled on the riverbed downstream to be transported downstream by flood flows. This can restore the natural and biological environment of the river by resolving the coarse-grained riverbed, washing, and renewing the old algae adhered to the riverbed.

(5) Enhancing Functions by Utilizing Rain Radar

The rain radar system covers almost all of Japan, with a resolution of 250 m. The delivery time interval is 1 min. Data from this system are utilized for flood forecasting, which enhances dam functions for flood protection and water supply.



Source: MLIT

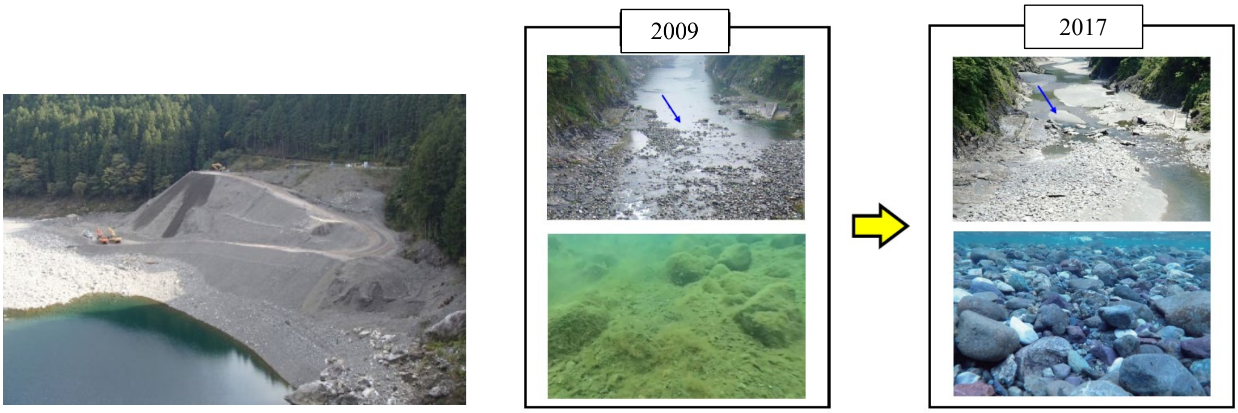
Figure 5.6 Measures for Sediment Control in Japan

Sediment bypass facility

Flushing through sediment gates

Source: Guide for Dam Sediment Control (Draft), Tenryu River Dams Integrated Management Office, Hokuriku Regional Development Bureau, MLIT

Figure 5.7 Examples of Sediment Control in Japan



Source: Nakagawa River Office

Figure 5.8 Example of an Activity for "Restoring Sediment Downstream" and the Improvement of the Riverbed Environment (Nagayasuguchi Dam)

CHAPTER 6 LESSONS LEARNED

(1) **To secure dam safety, legislation, technical guidelines, and examination system should be established.** The mechanisms of dam safety should involve thorough examination at each stage, i.e., planning, design, construction, and maintenance. It is important to conduct daily inspections and patrols, as well as periodic inspections, and not to overlook any small changes or signs of risk. The periodic and comprehensive inspections and establishment of extension plans for the service life can improve the management and reduce the lifecycle costs. Because many ponds built in the old days have structural problems, accidents should be prevented through legislation and financial support for the inspection and reinforcement of dam structures.

(2) **To secure a dam and its downstream areas during flooding, operation rules should be followed.** The operation rules prescribe gate operations and procedures for the patrol and warning methods for downstream areas. They also cover the gate operations for extraordinary floods that exceed the design flood. This is intended to prevent artificial flooding in downstream areas, even under extraordinary floods. The flood inflow should be discharged in the same amount as entering the reservoir. The inflow volume can be obtained from the flood-inflow forecast based on rain radar data. Flood forecasting is effective for introducing and deciding whether to pre-release reservoir water for increasing the flood-protection capacity before floods.

(3) **Integrated operation of multiple dams can ensure an adequate water supply.** The integrated operation of multiple reservoirs in the basin and reallocation of the reservoir capacity may enhance the reliability of the water supply and improve the river environment.

(4) **Rehabilitation works can extend lifetime and functions of dams.** Existing dams can be rehabilitated at a relatively low cost, in a short time, and with minimal burdens on nature and society. Additionally, it is possible to improve the dam functions by using the latest software and hardware technologies, e.g., flood forecasting and countermeasures for reservoir sedimentation, dam raising, and the construction of dam-discharging facilities. Some rehabilitation works can be implemented without interfering with the dam operation.

REFERENCES

Extra Table 1 Examples of Technical Standards for Surveying and Designing Dams in Japan

Standard	Contents
Cabinet Order on Structural Standards for River Management Facilities, etc. and its Ordinance for Enforcement	It establishes general technical standards required for the management of river structures such as dams, levees, and other permitted structures.
Technical Criteria for River Works and its Practical Guide	These are extensive technical standards for the investigation, planning, design, and maintenance of not only dams but also river and erosion control structures. They consist of four volumes for investigation, planning, design, and maintenance.
Construction of Multipurpose Dams	This contains technical standards for the planning, survey, design, construction, and management of multipurpose dams, which are applicable to all dams (not only multipurpose dams). It consists of chapters related to planning and administration, environment and research, design, construction, and management.
Technical Standards for Dam and Weir Structure	These are technical standards mainly for steel structures of gates and intake facilities of dams. They describe the hydraulic design, structural design, and inspection and maintenance procedures.
Detailed Technologies for Concrete Dams/Fill Dams	These are guidelines that describe the structures of concrete dams and earthfill dams in detail with examples.
Guidelines for Grout	These are guidelines for foundation treatment with curtains and consolidation grouting in dam design.
Technical Data for Design, Construction and Quality Control of CSG (Cemented Sand and Gravel) Trapezoidal Dam	This is a technical document on the original trapezoidal CSG dam published in Japan in 2012. The trapezoidal CSG dam is not yet listed in the structural ordinance for river management facilities; i.e., it is a non-legal dam type and requires special approval from the MLIT for its construction. (English version available)
Guidelines for Verification of Seismic Safety for Dams against Severe Earthquakes	These are guidelines on the requirements for seismic performance against Level 2 earthquakes (probable maximum earthquake at the site) and their verification method, which were published after the Hanshin-Awaji Great Earthquake in January 1995.

Source: Project Research Team

Extra Table 2 Standards for Dam Operation and Maintenance (Inspection) (1/2)

Structures		Inspection	Frequency	Timing and Method
Dam Body and Spillway		Normal inspection	Daily	Confirmation of changes in appearance by visual inspection, etc.
		Periodic inspection	Once/year	Confirmation of scouring, etc. by visual inspection, etc.
Measurement Instrument for Dam		Periodic inspection	Once/month	Check for abnormalities by operation check
Discharge Facilities	River Outlet Facilities	Periodic inspection	Three times/year	Check for abnormalities by operation test for maintenance before, during, and after flood season
		Inspection before discharge	Before each release	Check for abnormalities by visual inspection
		Inspection after discharge	After each discharge	Check for abnormalities by visual inspection
	Intake Facilities	Inspection during long-term closure	Once/year	Check for abnormalities by visual inspection
		Inspection after flood	After each flood	Check for abnormalities by visual inspection
Emergency Generators		Normal inspection	Once/month	Check for operation by controlled operation
		Inspection before flood	At each flood	Check for abnormalities by visual inspection, etc.
		Periodic inspection	Following safety regulations	Detailed inspection with controlled operation in accordance with safety regulations
Control Facilities for Dam Management		Normal inspection	Daily	Confirmation of display contents, etc. by visual check
		Periodic inspection	Once/year	Operation check by distant operation, etc.
Observation Facilities	Observation Stations	Periodic inspection	Once/year	Detailed inspection by test measurement
	Management Offices	Normal inspection	Daily	Visual inspection for display and records
	Observation Equipment	Periodic inspection	Once/year	Detailed inspection by test measurement
Discharge Release Warning System	Management Office	Normal inspection	Daily	Check for abnormalities by visual inspection
		Periodic inspection	Twice/year	Detailed inspection by test measurement
	Warning Stations	Periodic inspection	Twice/year	Check for abnormalities of power supply, etc. by test operation
		Inspection before flood	At each flood	Check for abnormalities of power supply, etc. by test operation

Source: Technical Criteria for River Works and its Practical Guide for Maintenance (Dam), MLIT

Extra Table 2 Standards for Dam Operation and Maintenance (Inspection) (2/2)

Structures		Inspection	Frequency	Timing and Method
Power Equipment		Normal inspection	Daily	Check for abnormalities by visual inspection, etc.
		Periodic inspection	Following safety regulations	Detailed inspection based on safety regulations
Telecommunication Equipment		Normal inspection	Daily	Check for abnormalities by call test, visual inspection, etc.
		Periodic inspection	Once/year	Detailed inspection including measurement of each part
Vehicles		Normal inspection	Daily	Check for abnormalities by inspection
Patrol Boats, Work Boats		Periodic inspection	Once/month	Check for abnormalities through controlled operation, etc.
Trash Booms		Periodic inspection	Once/year	Check for abnormalities by visual inspection, etc.
Mooring Facilities		Periodic inspection	Once/year	Check for abnormalities of equipment by test operation
Drainage Facilities	**Drainage Facilities**	Periodic inspection	Once/month	Check for abnormalities by visual inspection
	Abnormal Alarm Facilities	Periodic inspection	Once/two weeks	Check for abnormalities of facilities by test operation
Signs, Handrails, Lightings		Periodic inspection	Once/month	Check for abnormalities of facilities by hammer sounding, lighting, etc.
Tools for Survey and Measurement		Normal inspection	On each occasion	Detailed inspection of the tools
All Dam Structures		Occasional inspection	On each occasion	Check for abnormalities of structures after earthquakes and floods exceeding a certain scale

Source: Technical Criteria for River Works and its Practical Guide for Maintenance (Dam), MLIT

Extra Table 3 Standards for Dam Operation and Maintenance (Monitoring)

Measurement Item	Stage	Concrete Dams					Fill Dams	
		Gravity & Hollow Gravity Types			Arch Type		Homogeneous Type	Zoned & Facing Types
		<50 m high	50–100 m high	>100 m high	<30 m high	>30 m high		
Seepage	1	Daily						
	2	Once/week						
	3	Once/month						
Deformation	1	—	Once/ week	Daily	Once/ week	Daily	Once/week	
	2	—	Once/ month	Once/ week	Once/ month	Once/ week	Once/month	
	3	—	Once/ 3 months	Once/ month	Once/ 3 months	Once/ month	Once/3 months	
Uplift	1	Once/week			—	Once/ week	—	
	2	Once/month			—	Once/ month	—	
	3	Once/3 months			—	Once/ 3 months	—	
Seepage Line	1	—					Once/ week	—
	2	—					Once/ month	—
	3	—					Once/ 3 months	—
Seismic Motion		When an earthquake occurs, measurements must be performed at the dam crest, the dam foundation/bottom, and other locations.						

1st stage: Period between commencement of initial impounding and more than two months after the reservoir water level has reached its full supply level

2nd stage: Period between the end of the first stage and the time when the dam behavior is judged to remain stable, and measurement values respond properly to the reservoir water level (for dams with heights of ≥100 m and dams with special forms, the second stage can last more than three years)

3rd stage: After the second stage

Source: Technical Criteria for River Works and its Practical Guide for Maintenance (Dam), MLIT

Extra Table 4 Standards for Dam Operation and Maintenance (Patrol)

Structures		Frequency	Confirmation Items upon Patrol
Dam Body, Spillway, etc.		Once/week	Abnormalities of appearance, e.g., deterioration, abrasion, cracking, and opening of joints
Discharge Facilities		Once/week	Abnormalities of the facilities
Inspection Roads, Slopes around the Reservoir		Once/week	Abnormalities of the structures and reservoir
		After flood	Abnormalities of the structures and reservoir
Observation Facilities	Observation Stations	Once/month	Abnormalities of the facilities
Discharge Warning Systems	Warning Station	Once/month	Abnormalities of the facilities
	Notice Boards for Warning	Twice/year	Quantity, paint condition, damage to the facilities
Trash Booms		Once/month	Abnormalities of the facilities
Mooring Facilities		Once/month	Abnormalities of the facilities
Signs, Handrails, Lightings		Once/week	Abnormalities of the facilities

Source: Technical Criteria for River Works and its Practical Guide for Maintenance (Dam), MLIT

Extra Table 5 Types of Water Supply Dam and Necessary Actions to Release Flood Water

Type	Characteristics of Water Supply Dam	Necessary Actions
Type 1	The dam causes by its construction to increase in the flood flow velocity and results in greatly increasing the flood discharge in the downstream river of the dam compared with that in normal time. The dam reservoir has a space to control the increased volume of the flood.	The operation to release discharge equivalent to flood inflow into large-scale water supply dam leads to flood damages with shorter flood concentration time. The reservoir needs to store a part of the flood inflow.
Type 2	The dam of which the flood water level rises in the river near the upstream end of the reservoir due to sedimentation in the reservoir and its upstream river, or the area of land owned by the dam operator covers only the reservoir area without area allowance may have flood damage in the upstream river due to such rise of the water level. The dam needs to lower the reservoir water level to its preliminary release level in the summer season to provide a space for flood protection.	Advance release of reservoir water is required.
Type 3	The dam has spillways whose discharge capacity is large compared with the reservoir storage volume. Spillway gates operation is rather complicated. Such dams lower the reservoir water level in the summer season.	Flood protection by advance releasing the reservoir water is required to take appropriate actions when rapid rise of the reservoir water level is observed during the flood.
Type 4	There is no effect on the flood management.	None.

Source: Website of Japan Dam Foundation

THEME 9 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS IN LARGE-SCALE PROJECTS: SUPPORTING THE RECONSTRUCTION OF SUBMERGED COMMUNITIES

ABSTRACT

Large-scale projects, such as dam construction, could adversely impact local communities and ecosystems if appropriate measures are not taken. The entire community could be submerged and collapsed. After residents protested the construction of dams in Japan, the government recognized that environmental and social considerations were important and revised policies for constructing large-scale facilities. One lesson learned from the opposition movements was the necessity of involving local communities in planning and implementing the processes of rehabilitating their daily lives with sufficient explanation and thorough dialogue.

Resettlement may have led to difficult compensation negotiations. The Japanese government has compensated for the resettlement appropriately and fairly in accordance with uniform compensation standards and effectively supported the relocated residents to reestablish their daily lives by developing the relocation site as a part of the project. Furthermore, the involvement of the people residing downstream of the urban areas is important in revitalizing reservoirs and upstream water source areas, expecting to achieve a deep understanding and connection with the relocated residents.

The necessity and profitability of the project and its environmental impact must be considered in public works projects. Japan has established a system to define procedures for environmental assessment and provide opportunities for residents and related parties involved in providing their opinions as part of the assessment process.

The government implements various conservation measures to mitigate the impact of water resource development facilities on the natural and social environment. A sustainable economic society is achieved by incorporating environmental conservation into society’s development as a social objective and internalizing it in society.

CHAPTER 1 INTRODUCTION

Large-scale projects, such as dam construction, may adversely impact local communities and ecosystems. The negative environmental and social impacts of large-scale projects should be managed and the livelihoods of communities and individuals be reconstructed, in addition to providing compensation, recognizing that entire settlements and communities could be submerged and collapsed.

Water resource management projects aiming to enhance quality of life should avoid adverse effects on ecosystems and societies. This theme introduces a system to reconstruct the livelihoods of communities and individuals of the areas that may be submerged when dam projects are implemented and explains the system used to assess and mitigate the impact of dam projects on the environment.

Large-scale water resource development projects may have adverse effects on the natural and social environment if the projects do not implement appropriate mitigation measures. Large-scale structures may change the way of life of residents and communities, dividing or dismantling communities, and prevent their cultural inheritance. Residents resettled from reservoir areas sometimes face difficulties in reconstructing their lives with a change in work style.

Construction projects often alternate the natural topography and adversely affect beautiful landscape. River-crossing structures such as dams and weirs change the flow of water and sediment. Such physical changes may threaten the habitat and behavioral range of plants and animals in the project area. Changes in the flow of water and sediment will also impact the downstream and sea areas.

In Japan, the movement opposing the construction of dams in the 1960s changed the mechanisms of land compensation, reconstruction of residents' lives, mitigation of the impact of reservoir areas, and revitalization of the areas around the reservoir. If efforts are not made to support and compensate residents who suffer losses due to dam development, this would lead to intensification of their opposition resulting from doubt and anxiety. Supporting people in reconstructing their lives would mitigate or eliminate their losses and promote project implementation and revitalization around reservoir areas.

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

Relationships between Environmental and Social Considerations and the SDGs:

(1) Local education is provided through the Upstream-Downstream Exchange Project in which people submerged by the reservoir area and those residing in the downstream dam area benefiting from the project participate:

SDG4 "Quality Education" 4.7 "Knowledge and skills they need to create a sustainable society."

(2) Measures are being implemented to mitigate the environmental impact of discharges released from the dam on the downstream areas:

SDG6 "Clean Water and Sanitation" 6.6 "Protect and restore water-related ecosystems"

(3) Legislation is in place to stabilize the lives and improve the welfare of residents in reservoir areas affected by submergence due to dam construction and others and revitalize these areas. The affected residents are supported by the national government and downstream beneficiary areas:

SDG10 "Reduced Inequalities" 10.4 "Introduce policies, including tax, wage, and social security policies."

(4) Legislation concerning the Forest Environmental Tax and the Water Resources Tax has been developed and financial resources from these taxes have been used for forest conservation and development:

SDG15. "Protect the richness of the land" 15.2 "Promote the implementation of sustainable management of all types of forests"

(5) People outside the reservoir area, such as those in the area downstream of the dam construction and in the adjacent urban areas, are getting involved in the issues concerning the reservoir and water source areas, resulting in a deep understanding and connection with the affected residents and revitalization of the areas:

SDG17. "Partnerships for the Goals" 17.7 "Encourage and promote effective public, public-private, and civil society partnerships"

CHAPTER 2 PROMOTION TO DEVELOP WATER SOURCE AREAS AND SUPPORT FOR RELOCATED RESIDENTS

2.1 Measures for Local Communities and Residents who would be Submerged due to Dam Construction

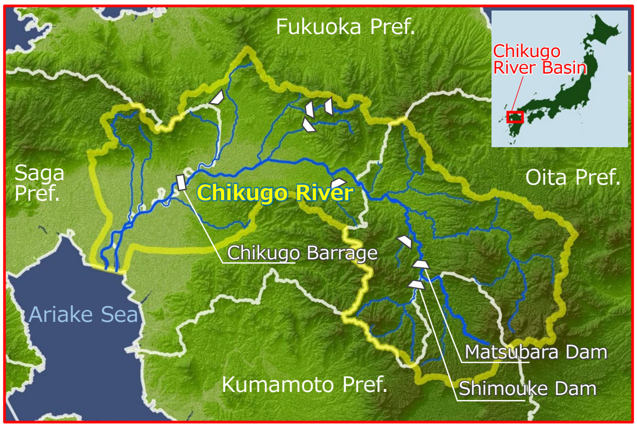
> As dam construction may affect local communities, the government should reconstruct the submerged local communities and revitalize the livelihoods of affected residents.

Dam projects may divide and destroy local communities by creating reservoirs. This section explains how the Japanese government changed policies for supporting local communities submerged through learning from the epoch-making opposition movement against the Shimouke dam project.

(1) Opposition Movement against Constructing the Shimouke Dam "*Hachinosu-jo* Dispute"

In Japan, the *Hachinosu-jo* dispute over the construction of the Matsubara-Shimouke dams had an overwhelming impact on the environmental and social considerations of public works projects. It was the largest opposition movement in Japanese dam history and lasted for 13 years from 1958 to 1971.

The catalyst for constructing the dams came in 1953, when the Chikugo River basin was hit by torrential rains causing severe flooding that affected 1.7 million people and claimed 980 lives. As part of flood protection measures, the national government planned the Matsubara and Shimouke dams (Figure 2.1).



Source: Preparation based on the Japan Water Agency's website

Figure 2.1 The Chikugo River Basin and Shimouke Dam

Hachinosu-jo (literally Beehive Castle) is the name of a series of watchtowers built at the planned site by residents opposed to the dam. The administrative lawsuit filed by Murohara, who spearheaded the movement, questioned the consistency between public works and basic human rights and stressed the importance of protecting the property rights of residents whose homes would be submerged. Murohara devised many unique ways of interference by releasing ducks into the river, forcing cows and horses to participate in the protests, stretching water pipes at various places, and attaching name cards of supporters to the surrounding trees (memorial trees for the struggle). The government clashed with the residents, removed the castle by force, and promoted dam construction. The dam lake was named Beehive Lake in 1988, referring to the conflict at Hachinosu-jo and expressing the hope that the movement would be remembered. The nameplate of Shimouke Dam was copied by the Ministry of Construction (now the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT)) from a signboard written by Murohara. In addition to the Hachinosu-jo dispute, the following words by Murohara should be remembered in the context of public works projects: "Public works should be reasonable, lawful, and compassionate."

(2) Establishment of a Support System for Residents of Submerged Areas

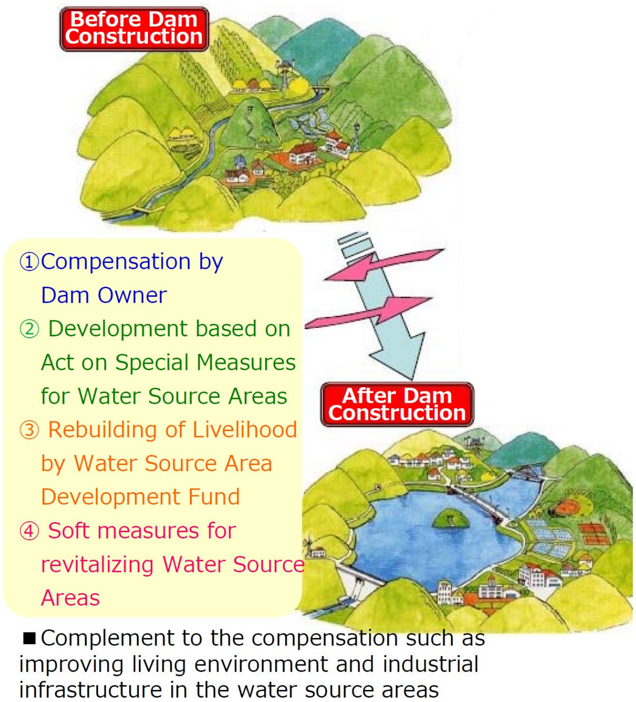
This movement had a big impact on the government, and the Act on Special Measures for Water Source Area was enforced in 1974 when the dam was completed. In 1962, the Outline of Standards for Compensation for Losses was issued, setting out standards for "general compensation" for land owned by individuals. A special income tax deduction system was established for expropriation and exchange. The details are discussed in Section 2.3.

The government supports the reconstruction of the lives of those involved in the submergence and to mitigate the impact on, and revitalize, the water source areas. These measures comprise four pillars that complement each other (Figure 2.2). The details are provided in Sections 2.2, 2.3, 2.4, and 2.5.

1) The implementing agency compensates by developing relocation sites for residents of the submerged land and by relocating public facilities.

2) The government implements projects for improving agricultural lands, roads, water supply, sewerage, public facilities, welfare facilities, and facilities for tourism and recreation in accordance with the Act on Special Measures for Water Source Areas, in the case that the construction of dams causes significant changes in the basic living conditions of the residents.

3) The Water Source Area Development Fund, with contributions by the downstream beneficiaries, is used to reconstruct the livelihood of residents, promote the development of water source areas, and maintain forests. The fund has been established by local governments downstream since 1975 to supplement compensations provided by implementing agencies and projects under the Act on Special Measures for Water Source Area.



Source: Water Resources in Japan (2014)

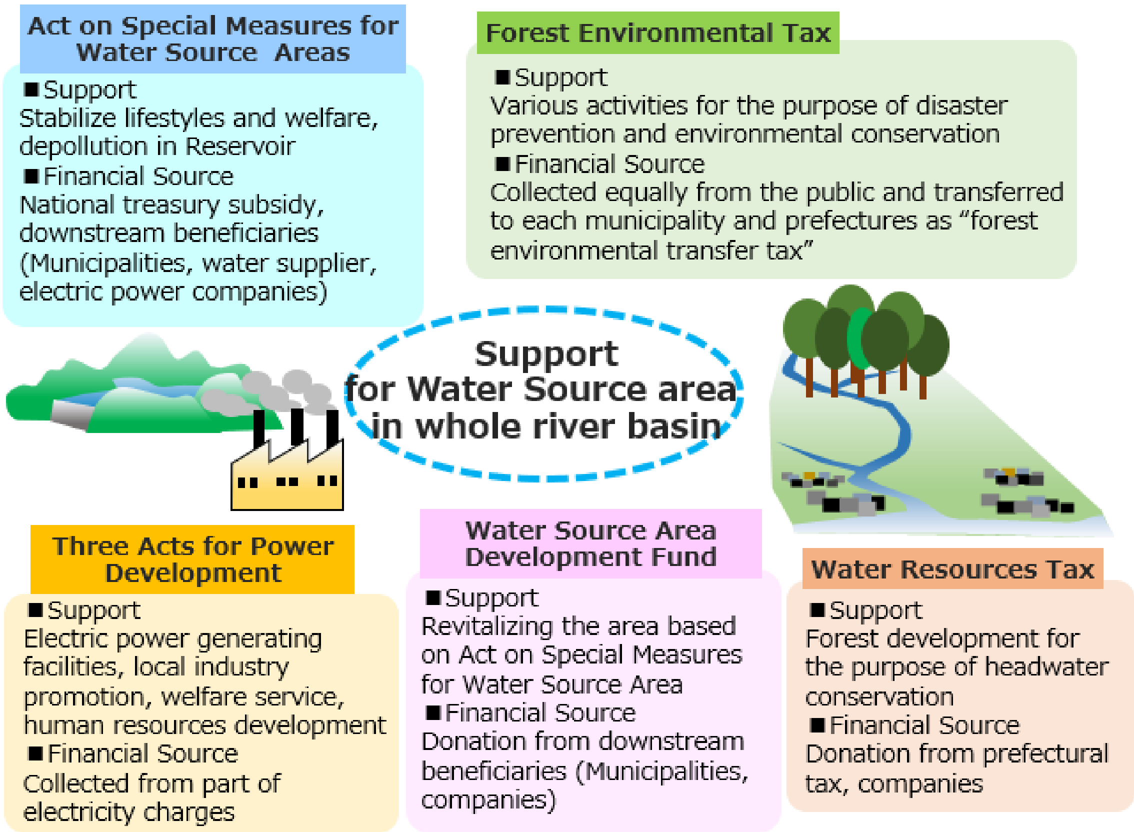
Figure 2.2 Overall Picture of Measures for Water Source Areas in Dam Construction

4) Soft measures include activities to support the area, such as a contest to design a tour to the water source area and introduction of its local specialty, establishment of a support network, and formulation of a vision. The support network is established by people and organizations that are willing to work for regional revitalization. The activities of the network aim to resolve problems and design new initiatives by sharing knowledge and information and expanding their relationships. The local governments and residents jointly formulate the water source area vision, which is an action plan to revitalize reservoir and water source areas. As of 2019, 120 dams had already formulated their vision.

2.2 Establishing Legal System and Securing Financial Resources

It is necessary to establish a legal system and financial mechanisms for developing the water source area.

To support environmental conservation in the water source area and livelihood reconstruction for residents in submerged reservoir areas, various legal systems were established to secure financial resources in Japan (Figure 2.3) (Theme 3: Finance, Section 3.2).



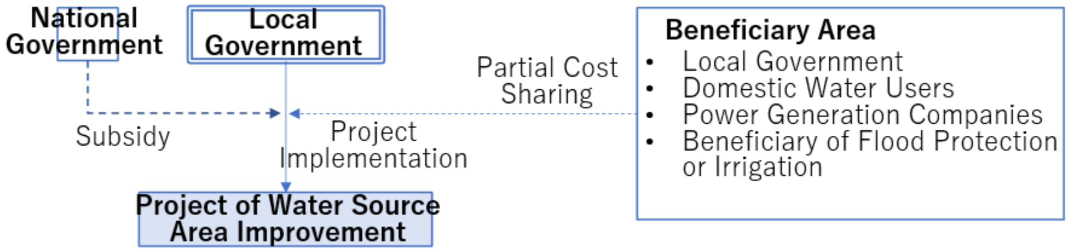
Source: Project Research Team

Figure 2.3 Support for Water Source Areas in the River Basin

(1) The Acts Concerning Water Source Area Measures

1) The Act on Special Measures for Water Source Area (Established in 1973)

The Act provides infrastructure improvement for people's lives and industries by supporting residents, communities, and related local governments in areas where residents suffer from submergence due to dam construction. The improvement work aims to revitalize the reservoir and upstream water source areas, and stabilize and improve residents' lives and welfare. The prefectural governor prepares a draft plan for the improvement of the designated water source area based on proposals from the municipal mayors. The MLIT decides on a "water source area improvement plan" covering 24 fields (Table 2.1). The percentage of national subsidies has increased. Part of the cost borne by the local government of the water source area can be covered by beneficiary organizations. The beneficiaries include domestic water users, power generation companies, irrigation associations, and local governments in the beneficiary areas. In many cases, the cost-sharing ratio is based on the cost allocation of the dam construction (Figure 2.4). Tax incentives can also be granted for a certain period to manufacturers and inns to help revitalize the region.



Source: Project Research Team

Figure 2.4 Cost Sharing for Projects Related to the Water Source Area Improvement Plan

Table 2.1 Projects Covered by the Water Source Area Improvement Plan

Development Projects for Designated Dams	
1) Land improvement projects	13) Project for improvement of joint use facilities for modernization of management of agriculture, forestry, and fishery
2) Erosion control projects	14) Projects to improve facilities for the protection and use of natural parks
3) Flood protection projects	15) Projects for the development of community centers and other assembly facilities, or facilities for the preservation and utilization of cultural properties
4) Road improvement projects	16) Sports and recreation facility projects
5) Businesses related to small-scale water supply	17) Projects for the development of nursery schools, children's halls, and children's amusement parks
6) Projects related to the development of sewerage systems	18) Projects to develop day service centers for the elderly, welfare facilities, etc.
7) Projects related to the construction of compulsory education facilities	19) Projects to improve facilities related to the care, activities, and welfare of the elderly or physically disabled
8) Projects related to the development of clinics	20) Projects to improve wired broadcast telephone service facilities or radio telephone
9) Projects for the development of residential land	21) Projects to improve firefighting facilities
10) Projects for construction of public housing	22) Project for the construction of sewage treatment facilities for livestock management
11) Projects to improve forest roads	23) Project for improvement of sewage treatment facilities
12) Afforestation projects	24) Refuse Disposal Facility Improvement Project

Source: MLIT, Outline of the Act on Special Measures for Water Source Area

2) Three Acts for Power Development

Three acts for power resources is the generic term for 1) The Act on Tax for Promotion of Power-Resources Development, 2) The Act on Special Accounts for Electric Power Development Acceleration Measures, and 3) The Act on the Development of Areas Adjacent to Electric Power Generating Facilities. The main purpose of these laws is to promote power supply development, including hydropower dam construction, and to facilitate operations by helping the project areas. The special account designated in (2) above, of which the resources are taxes paid by the power company for promotion of power resources development, provides subsidies for employment of the residents and development of improvement projects around the project area. Until 2002, subsidies were restricted to public facilities. However, in

2003, the subsidy was expanded to include soft projects such as promoting local industries, welfare services, and human resources development, with the aim of revitalizing local industries and economies and improving the welfare of local residents.

(2) Establishment of Water Source Area Development Fund

The Water Source Area Development Fund is used for reconstructing residents' livelihoods and developing the community to supplement compensation undertaken by implementing agencies and projects implemented under the Act on Special Measures for Water Source Areas. The funds' resources are collected from beneficiaries located downstream, including local governments, power generation companies, water suppliers, and private companies. The government implements various measures for the reconstruction of the livelihood of submerged residents, such as dispatching counselors, providing interest subsidies for the acquisition of relocation sites, conducting community development, and maintaining water conservation forests. Fund resources can be used for projects that benefit a specific group, provided the projects are in line with the purpose of the donation. Generally, taxes are spent on the public and cannot be used to benefit a specific person or company.

In the Tone River System, the governments of the Tokyo Metropolitan Area in the downstream area, and Gunma Prefecture in the source area jointly implemented the upstream-downstream exchange project since the 1996 drought event. This exchange project aims to revitalize the water source area through a mutual exchange of opinions and activities of the residents. The main exchange projects conducted to date are listed below:

- Tours to the water source area during summer vacation (tours to dams, nature observations)
- Afforestation in the water source area
- Release of salmon fry and tour to river facilities
- Fair for the water source area in Gunma Prefecture (presentation to introduce water source area using display panel, sale of local specialty)
- Tours to understand the current situation concerning water in Tokyo (tour to water treatment plants, tour along river by water bus)

The website of the project introduce the exchange project, reports on the projects, essays by children participating in the projects, and various information to deepen the understanding of the project.

(3) Financial Support by Private Companies

The financial resources of private companies have been used, as well as public resources, to promote the development of water source areas. For example, financial support from private companies that have a company policy of social contribution based on corporate social responsibility (CSR) is expected to improve water conservation forests.

In 1992, during the construction of the Miyagase dam in Kanagawa Prefecture, the Miyagase Dam Area Promotion Foundation was established to support activities in water source areas. In addition to the relevant local governments, the foundation includes seven private companies as contributors, all of which are actively engaged in CSR activities in various industries, such as transportation, machinery, banking, and seedlings. The foundation manages and operates parks, training facilities, canoeing areas, exhibition facilities, and other facilities in harmony with the natural environment. The foundation also organizes events, such as product exhibitions, marathons, and canoeing classes.

(4) Financial Resources for Water Source Area Conservation

1) Forest Environmental Tax and Forest Environmental Transfer Tax

The Forest Environmental Tax and Forest Environmental Transfer Tax were enacted in 2019, and local governments started using the tax to improve resilience against natural disasters, prevent soil erosion and excessive runoff, improve water resource conservation, conserve biodiversity, and increase carbon dioxide absorption. In Iga City, Mie Prefecture, the artificial forests without maintenance are increasing. A forest improvement project is promoted using a forest environmental transfer tax for water resource conservation and the prevention of soil erosion and global warming (Figure 2.5).

Source: Forestry Agency Website

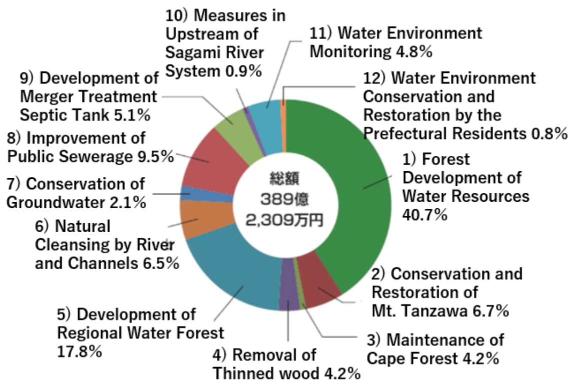
Figure 2.5 Photos of the Forest Improvement Project in Iga City, Mie Prefecture (Left: Before Implementation, Right: After Implementation)

2) Water Resources Tax

The water resource tax is used to restore the forest function of water resource conservation. Local residents bear the tax burden. Kanagawa Prefecture formulated the Kanagawa Five-Year Plan to conserve and revitalize the water source environment. The prefecture has also promoted measures using the water source environment conservation tax. For example, the reforestation project aims to conserve forests upstream of dams, which serve as natural water reservoirs for cities. The project covers a forest area of approximately 60,900 ha, located mainly upstream of the Shiroyama, Miyagase, and Miho dams, which supply drinking water to metropolitan areas including Yokohama and Kawasaki (Figure 2.6). The prefectural government manages the private forests owned by individuals. The average annual contribution per prefectural resident is 890 JPY (8 USD), and the total annual

Source: Kanagawa Prefecture website

Figure 2.6 Forest in Water Source Area



Source: Comprehensive Evaluation (Interim Evaluation) Report, June 2020, Kanagawa Prefectural Council for Conservation and Restoration of the Water Source Area Environment

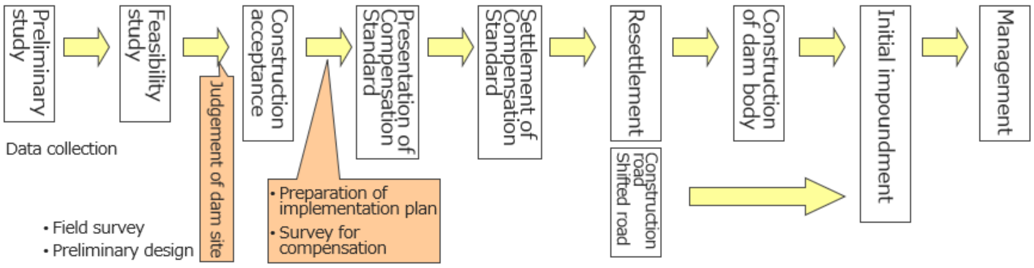
Figure 2.7 Projects Funded by Kanagawa Prefecture's Reservoir Environmental Conservation Tax

contribution is approximately 3 billion JPY (27 million USD), including donations from companies (Figure 2.7).

2.3 Fair and Satisfactory Compensation Process

The government should establish a system for appropriate and equitable compensation based on a unified standard.

Land compensation is provided for the expropriation or use of land based on the Land Expropriation Act and River Law. A survey for compensation is conducted, and compensation negotiations commence based on the survey results and by presenting the standards (Figure 2.8).



Source: MLIT Website

Figure 2.8 Process of Dam Project Implementation including Compensation Negotiations

Compensation includes general compensation for the land and buildings of individuals and companies and public compensation for public facilities. General compensation is based on the concept of compensating for property values. For example, the price of land is calculated by examining normal transaction prices for surrounding land, public notice prices, and standard land prices; benchmarking the appraisal value by a real estate appraiser; and examining various factors such as street conditions, environmental conditions, size, frontage, and shape of the land. Public compensation involves maintaining the function of the target public facility and does not constitute compensation for property value.

A land compensation process in dam projects covers a wide range of roles beyond merely acquiring the necessary land. This process can promote communication between the implementing agency and landowners, which may deepen mutual understanding. This process also helps underpin the livelihoods of affected persons by reflecting the thoughts of landowners.

2.4 Relocation Site Development as Part of the Project

From the perspective of ensuring continuity for the community and industry, development of the relocation site should be included as part of the project.

By preparing relocation sites, the local community and industry can continue their activities, and it is easier to reconstruct the livelihoods of relocated residents. Dam projects may result in the total loss of bases for living, such as the functions of the community for residents in submerged areas. Developing relocation sites is recognized as one of the keys to the reconstruction of livelihood for the residents and restoration of their loss.

In Japan, implementing agencies basically cover compensation. In recent years, however, affected persons expressed their wishes to relocate within their communities; thus, providing a relocation site has become a more popular option. The 2001 revised Land Expropriation Act stipulates that the implementing agency should make efforts to help residents acquire relocation areas when affected residents lose their bases for living. The provision clarified the role of implementing agencies in their efforts to reconstruct residents' livelihoods. If affected persons wish to relocate in groups, large-scale relocation sites are required. The related issues are as follows:

- Given the lack of suitable land for relocation, acquiring appropriate land might be difficult.
- Relocation plans involve uncertainty because the decision to relocate as a group depends on negotiations.
- There are restrictions on the price of the relocation site, and it is necessary to consider whether the price is within the range of compensation for losses.

The project provides relocation sites in cooperation with local governments, and activities under the Act on Special Measures for Water Source Areas support this process. Regarding (c), if the cost exceeds the assessed value of land compensation, the affected persons need to bear the difference.

For example, the Ministry of Construction developed the Miyanosato housing complex as a relocation site for the Miyagase dam project in Atsugi City, Kanagawa Prefecture. Of the 281 persons who relocated due to the project, 190 (68%) were relocated to the Miyanosato relocation site. In Kawarayu Onsen in Gunma Prefecture, the Yanba Dam submerged the hot spring resort, and many residents requested that their living infrastructure, including inns and public baths, be relocated en masse to a higher ground (Theme 1-3: Public Participation and Decision-Making Process. Chapter 2). This method is called the on-site reconstruction (slip-up) method. It enables relocation while retaining the existing local community to ensure that the living infrastructure remains unchanged. The construction of a relocation site was delayed due to prolonged opposition, and many residents had to leave their hometown. One lesson learned is that constructing relocation sites from an early stage, as a basis for reconstructing people's lives, could provide relief to people with submerged land. Smooth negotiations facilitate group relocation, which leads to early construction and shortens the construction period.

2.5 Involvement of People Outside the Water Source Areas

> It is necessary to involve people residing outside the water source areas, such as downstream urban area, in revitalization of the water source area through deep understanding about, and connection with, people in the reservoir and water source areas with interaction and cooperation in various aspects.

(1) Supporting Livelihoods

Measures for revitalizing reservoir and water source areas include coordinating between people involved in revitalization, supporting human resource development, developing tourism programs, and expanding marketing channels for sales of local special products. Since 2009, the MLIT has been implementing the "villages support project in water source area" to revitalize villages in the water source area. This support promotes the creation of a mechanism to earn money in the area through economic activities such as sales and promotion of local special products and attracting tourists conducting PR nationwide. However, many villages have little human resources and expertise for revitalization, resulting in insufficient activities.

Source: Headwater Villages Support Project, MLIT

Figure 2.9 Contest to Design a Tour to Villages in Water Source Area

A contest suggests a trip to introduce the local resources of villages in the water source area (Figure 2.9). The MLIT organized this in cooperation with the tourism industry. In 2019, eight award-winning designs were selected from across the country using applied travel planning designs. The award-winning designs, including the past winning designs, are shown on the website. Also, the MLIT and food distribution industry have jointly promoted exhibitions targeting buyers nationwide to support the wider distribution of special products.

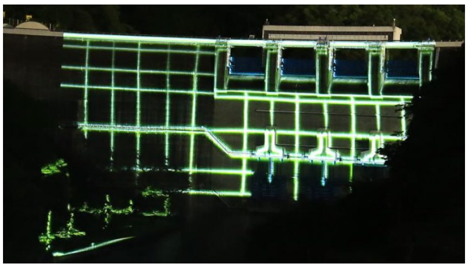
(2) Economic Revitalization Using Reservoirs

Utilizing reservoirs as tourism resources supports the local economy. According to an MLIT survey in 2014, 567 events were held during the year at 91 dams nationwide, with approximately 1.29 million participants. The events included sporting events, facility tours, and nighttime events, such as illumination, exhibitions, and performances.

Devising Ways for Facilities to Enhance their Appeal

<u>Projection mapping on the dam body (Amagase Dam)</u>

The event was planned based on an idea by a young employee of the Kinki Regional Development Bureau that many would enjoy a laser light source show at a dam. With the cooperation of a local university, a video was created, and 1,200 people visited the dam in two days.



Source: Yodo River Dams Integrated Management Office website

Ingenuity to Utilize the Space Created by the Infrastructure

◆ <u>Triathlon tournament utilizing the dam environment (Obara Dam)</u>

A triathlon event is held, optimally exploiting the dam environment. The reservoir hosts swimmers and bikers, and the run course covers the scenic circumference. With almost no waves, swimming is easy, and it is a popular course.

Source: Izumo River Office website

Devising ways to collaborate with the private companies to secure response personnel

◆<u>Backstage tour by private companies (Kawaji Dam, etc.)</u>

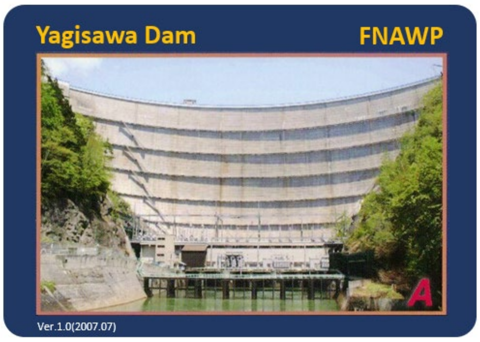
A social experiment is underway to conduct dam tours by private companies. The tours are fee-based and take visitors to three dams located nearby. Since the tour takes visitors to the dam embankment and the catwalk, private operators are pre-trained in safety management and facility guidance by the facility manager. Some tours also include the reservoir tours by amphibious bus. Local travel agencies have been actively attracting foreigners to infrastructure tours. The tour is designed to meet inbound needs by combining a elements unique to Japan, such as experiencing kimonos, watching Japanese dance performances, and a dam tour using an amphibious bus.

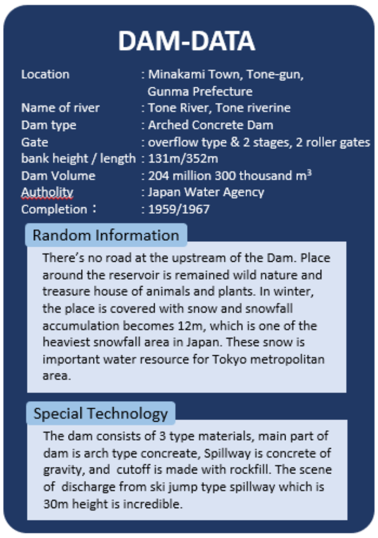
Source: Website of Kinugawa dam integrated management office

Source: Nikkou City website

(3) Dam Data Card Distribution

The dam offices of the MLIT and the Japan Water Agency (JWA) have been distributing “dam data cards” to visitors since 2007. Currently, prefectures and power generation companies also distribute these cards. The size of the cards and the information contained are standardized with the front side photographs of the dam and the rear showing the dam type, reservoir capacity, and technical features (Figure 2.10).





Source: MLIT Website

Figure 2.10 Example of Dam Data Card

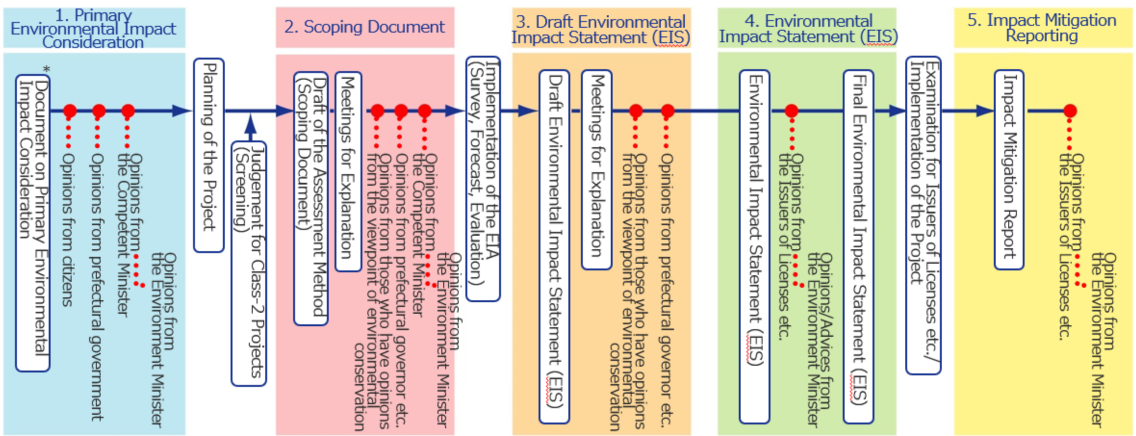
CHAPTER 3 ENVIRONMENTAL AND ECOSYSTEM CONSERVATION IN WATER SOURCE AREAS

3.1 Environmental Impact Assessment and Countermeasures

An appropriate project planning requires adequate assessment of the environmental impacts and preparation of environmental conservation measures to be undertaken.

(1) Environmental Impact Assessment (EIA)

To prevent serious environmental impacts caused by the project of water resource management, it is important to consider not only the necessity and profitability of the project but also the requirements of environmental conservation measures. The environmental impact assessment (EIA) system consists of an investigation, prediction, and evaluation of the environmental impact, disclosure of the results, and requests for feedback from the public. Based on the results, a better project plan is developed from an environmental conservation perspective. EIA were first institutionalized in the United States in 1969 and have since been rolled out in many countries worldwide. In Japan, EIA were introduced in 1972. Subsequently, the system was established for port and harbor planning, landfills, power plants, and bullet trains around 1980. The EIA Act was enacted in 1997. Water resource management projects subject to EIA include 1) dams and weirs, 2) floodways, and 3) lake development. They are divided into two types according to scale: Class-1 projects, which EIA are always conducted, and Class-2 projects, which it is individually determined whether EIA are necessary.



* Primary environmental impact consideration for Case-2 projects will be conducted voluntarily.

Source: Ministry of the Environment website

Figure 3.1 Procedure of Environmental Impact Assessment

A statement of consideration is a document that summarizes the review results prepared for a Class-1 project. This review includes issues for environmental conservation. This enabled environmental considerations at the early stage of the project. In 2011, the Act was revised to introduce the statement of consideration procedure as a strategic environmental impact assessment (SEA) before the project implementation stage (Figure 3.1). Before the revision of the Act, EIA was conducted at a stage when the framework of the project, including the general location and scale of the project, had already been decided. Thus, it was sometimes difficult for the project owner to respond flexibly to the consideration and implement the measures. The procedure for a statement of consideration introduced by the revision of the Act covers the stage of consideration of individual project plans (the stage of consideration of the location, scale, layout, and structure of facilities of a project), which enables more flexible environmental considerations and is expected to avoid or reduce environmental impacts more effectively than before.

All prefectures and most major cities have EIA ordinances. The content varies according to the local circumstances and plays a key role in environmental conservation. However, duplicated procedures required by the EIA Act and the local government for one project may cause an excessive burden on project owners. Local governments can establish procedures for related items, such as communities and cultural properties, which the EIA Act do not cover.

To promote high-quality EIS, the Ministry of the Environment (MOE) has been operating the Environmental Impact Assessment Database ("EADAS") since 2014. Various data related to environmental conservation can be viewed in an integrated manner through Web GIS, and a website for mobile devices such as smartphones has been established.

(2) Ensuring Consultation Processes with Residents

EIA requires a process that reflects the information and knowledge on conservation from many residents. In Japan, five EIA documents are specified by the Act according to the procedural stage: Consideration Document, Methodology Document (Scoping Document), Preparatory Document (Draft Environmental Impact Statement), Evaluation Document (Final Environmental Impact Statement), and Report (Impact Mitigation Report). There are three opportunities for residents to express their opinions to project owners. Any person with an opinion on the methodology document and preparatory document can express their views by submitting a written opinion within six weeks of the publication of each document. The opinions received on the methodology and preparatory documents were then summarized by the project owner before being sent to the prefectural governor and the mayor of the municipality. Information about the briefing session and the public inspection and publication of the EIA report is publicly announced through the official gazette, the PR magazine of the local government, or a daily newspaper. The information can be publicly inspected at places easily accessible to the public, such as the offices of project owners, relevant local governments, and websites.

The MOE has prepared a collection of best practices and made them available online. This reflects issues highlighted about the publication of documents and explanatory meetings held during the EIA process, such as "insufficient public awareness of the meetings," "explanatory materials are not easily understandable," and "insufficient time secured for questions and answers in explanatory meetings." During the case studies, issues related to public awareness, EIA reports, and explanatory meetings were summarized, and the best practices were introduced.

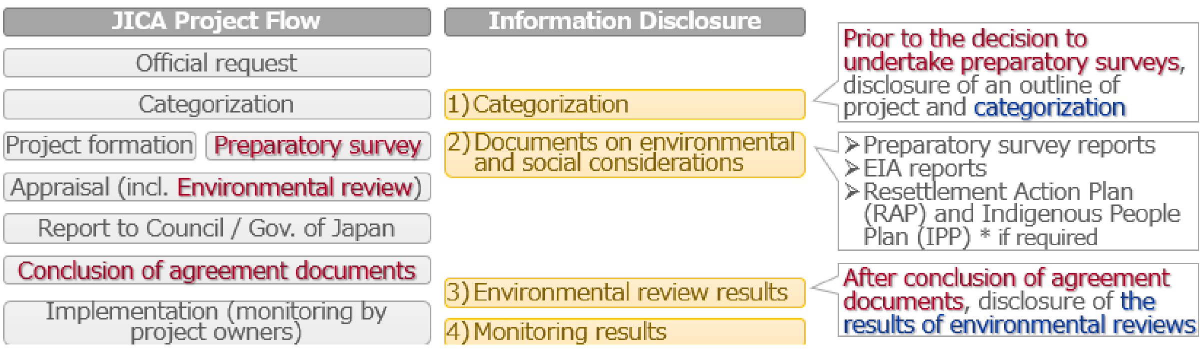
(3) JICA's System on Environmental and Social Considerations

Guidelines for Environmental and Social Considerations of the Japan International Cooperation Agency (JICA) (2010) present the responsibilities and procedures for environmental and social considerations and the requirements for project owners. JICA applies SEA to the master plan and encourages project owners to ensure that environmental and social considerations are efficiently implemented. JICA recognizes the following seven principles:

1) Addresses wide-ranging impacts
2) Measures from the early stage to the monitoring stage of the project.
3) Responsible for accountability.
4) Ensures participation of stakeholders.
5) Discloses information.
6) Enhances its organizational capacity for environmental and social considerations.
7) Strives for achieving promptness.

Projects are classified into four categories according to the extent of impacts: A) likely to have significant adverse impacts, B) likely to have fewer adverse impacts than those of Category A, C) likely to have minimal or little adverse impact, and FI) funding to a financial intermediary or executing agency. The sub-projects cannot be specified prior to JICA's approval of funding. The categorization was disclosed before deciding whether to undertake preparatory surveys (Figure 3.2) and revised as necessary. When the preparatory surveys were completed, relevant documents were disclosed for Category A projects prior to environmental review. An environmental review was conducted to confirm whether the environmental and social considerations of the project were appropriate.

To implement environmental and social considerations that are more in line with the actual situation and build an appropriate consensus, project owners should take the initiative in consulting with local stakeholders as a rule. In particular, for projects in Categories A and B, project owners are encouraged to consult local stakeholders at an early stage to identify development needs, locate problems, consider alternatives, and provide necessary support. Project owners should provide timely and adequate compensation and assistance for those affected by involuntary relocation and loss of livelihood. A relocation plan and sufficient information should be disclosed in advance, and consultations with the affected communities should be conducted. JICA supports project owners through cooperative projects when necessary. Recipient countries must establish procedures to handle complaints arising from communities affected by a project.



Source: Advisory Committee on Revision of JICA Guidelines for Environmental and Social Considerations, The 1st Meeting materials (August 2020, JICA)

Figure 3.2 Environmental and Social Considerations Process in JICA Projects

JICA established an environmental and social consideration advisory committee to gain support and advice on the environmental and social consideration processes. The committee comprises external experts sufficiently familiar with JICA projects, and support and advice are available during the preparatory surveys, environmental review and monitoring phases, full-scale studies, and emergencies (Figure 3.3).

Source: JICA

Figure 3.3 Advisory Committee for Environmental and Social Considerations.

3.2 Environmental Conservation Measures

> By incorporating environmental conservation as one of the project objectives, water resource management projects can be realized in harmony with the environment to build a sustainable society.

Environmental, social, and economic aspects are intricately intertwined. Thus, environmental considerations should be incorporated into socioeconomic systems to maintain a healthy, bountiful, and sustainable environment. Various measures have been implemented to construct and manage infrastructure to avoid or mitigate undesirable impacts on the environment in Japan.

(1) Conservation of Ecosystems by Biotopes and Fishways

When rare species or natural treasures are found inhabiting a construction site, the related parts of the construction are changed to ensure that the habitat remains undisturbed, and conservation measures are implemented. These measures include creating a biotope and transplanting the species. Since the construction of the Miyagase dam was predicted to have a significant impact on the natural environment owing to changes in topography and other aspects, extensive conservation measures were planned to restore and create the environment. These measures could conserve habitats for diversified organisms, such as streams, ponds, and stone masonry. A variety of organisms of various sizes are now inhabiting the reservoir, including large mammalian animals (deer and wild boar), aquatic insects (tadpoles and cybister japonicus), and wild birds (mountain cicada and pied flycatcher) (Figure 3.4).

A fishway is installed for a weir and dams to avoid impeding the movement of migratory fish. To further improve the environment in which fish can easily travel upstream and downstream, natural stones in fishways are installed for wide-ranging aquatic organisms, including benthic fish and amphibians. Some fishways are installed in the sidewalls so that the run-up and fall of organisms can be observed. Figure 3.5 shows the features of the fishway at Pirika Dam.

Source: Website of the Sagami River Wide Area Dam Management Office, Kanto Regional Development Bureau, MLIT

Figure 3.4 Higashizawa Biotope Created in the Miyagase Dam Area

Full view of fishway
When the dam was completed in 1991, a fishway was not installed. After various studies were conducted based on the request from the basin municipalities, the fishway with an extension of 2.4 km was completed in March 2005.

Lower channel in low flow channel
In the section of about 360 m from directly downstream of the dam, the river channel was dug down to secure the fish migration. Its shape meanders to imitate a natural river.

Refuge pool
A refuge space was created by placing channel bars and fallen trees for variety so that fish passing through the fishway can rest or overwinter.

Fish ladder
By installing an overflow bulkhead with a notch in a staircase pattern at the part where the height difference is large, the fish can run upstream with stops along the way.

Nature-oriented fishway
The fishway is designed to have the same conditions as the natural environment as much as possible. Cobblestones are laid on the bottom of the fishway and trees providing food and shade for the fish are planted on both banks.

Observation window
Observation windows are provided on the fishway so that people can observe the process of fish migration.

Source: Website of Hakodate Development and Construction Department, Hokkaido Regional Development Bureau, MLIT

Figure 3.5 Characteristics of the Pirika Dam Fishway

At the water source area of the Tone River, the private companies worked with residents to improve the environment. They regularly conducted landscaping and greening using flowers and other plants and cleaned up the river, targeting an attractive, beautiful, and comfortable water source area. They also built a resource recycling system by planting field mustards as educational and enlightening activities in the local environment (Figure 3.6).

Source: The Tone River Dams Integrated Management Office website

Figure 3.6 Activity of Environmental Conservation with Residents in the Water Source Area of the Tone River

(2) Reduction of the Impacts on the Natural Environment

1) Maintenance of Normal River Flow Functions

Multipurpose dams can maintain the normal functions of river water during droughts. A decrease in river flow adversely affects the river environment, including narrowing the habitat of fish and causing water deterioration. It is necessary to maintain a normal flow that satisfies both the environmental and water use requirements, determined by considering the following factors: water rights, navigation, fisheries, tourism, maintenance of clean water flow, prevention of damage by salt, prevention of blockage of river mouth, protection of river management facilities, maintenance of groundwater levels, landscape, protection of animal and plant habitats, and securing close contact between people and rivers (Theme 1-2: Water Rights and Theme 2-2: River Basin Planning).

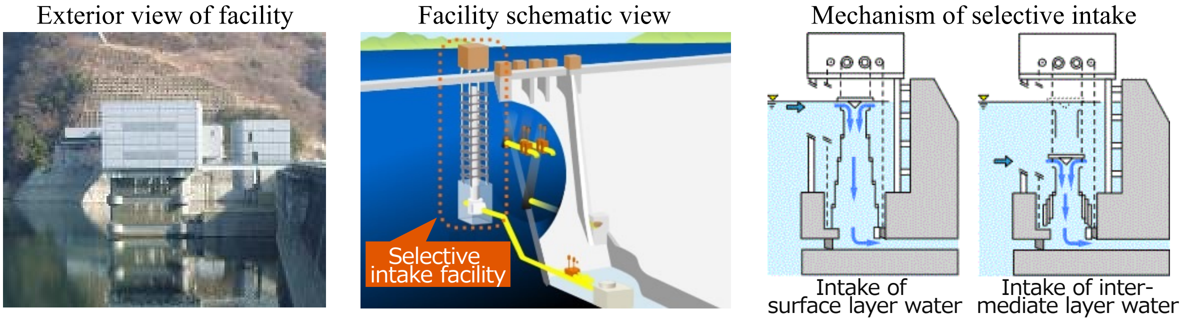
Hydropower generation dams released insufficient environmental flow downstream, resulting in improper river management. Power companies have secured appropriate environmental flow when water rights are renewed (Theme 3-1: Public Participation and Decision-Making Process, Section 3.2).

2) Measures for Water Quality Deterioration Caused by Dam Discharge

The environmental impacts of discharge from the dam on the downstream include the cold-water phenomenon, prolonged turbid water phenomenon, and eutrophication. Countermeasures to mitigate these issues are presented below.

(a) Measures against Cold Water

A selective intake facility is installed on the dam to release warm surface water in the reservoir (Figure 3.7). Japan has four seasons, and in summer, reservoir water forms a temperature stratification with high water temperature in the upper layer and low water temperature in the middle and lower layers. Because of the different densities of the upper high-temperature water and middle/lower low-temperature water, the water does not mix easily. If the water intake is located only at the lower part of the reservoir, low-temperature water with low oxygen concentration is discharged downstream, which may affect irrigation, river ecosystems, and social activities in the downstream areas. An aeration system is also used to prevent temperature stratification (Figure 3.9).

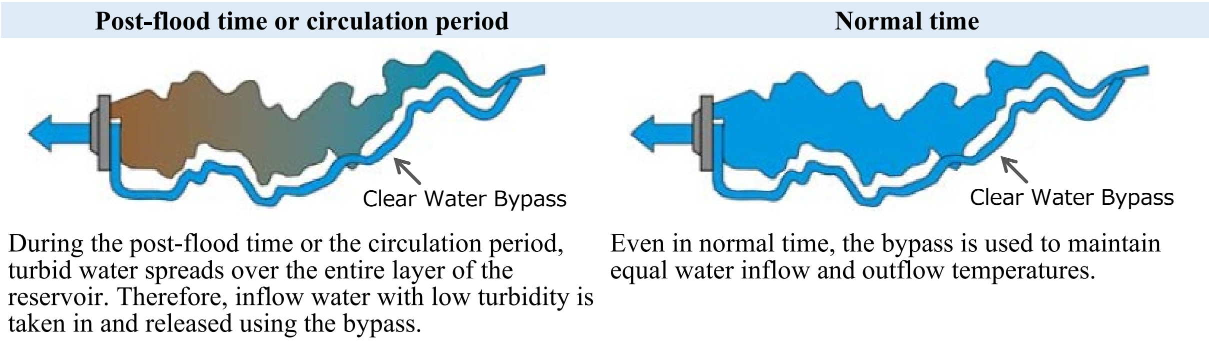


Source: Website of the Sagami River Wide Area Dam Management Office, Kanto Regional Development Bureau, MLIT

Figure 3.7 Selective Intake Facility of the Miyagase Dam

(b) Measures against Turbid Water

During flooding, turbid flood water may be retained in the reservoir owing to the fine-grained sediment. The release of turbid water causes long-term turbidity of the river water downstream. Selective intake facilities are installed to reduce the period of turbid water release. Selective intake facilities can release reservoir water from the highly turbid layer during floods, minimizing the amount of suspended solids to be deposited in the reservoir. At the Urayama Dam, a pipeline system of the clear water bypass was installed in 2007 to take the clear water near the upstream of the reservoir after flooding, thereby diverting, and releasing the water downstream of the dam (Figure 3.8).



Source: Website of Kanto Regional Development Bureau, MLIT

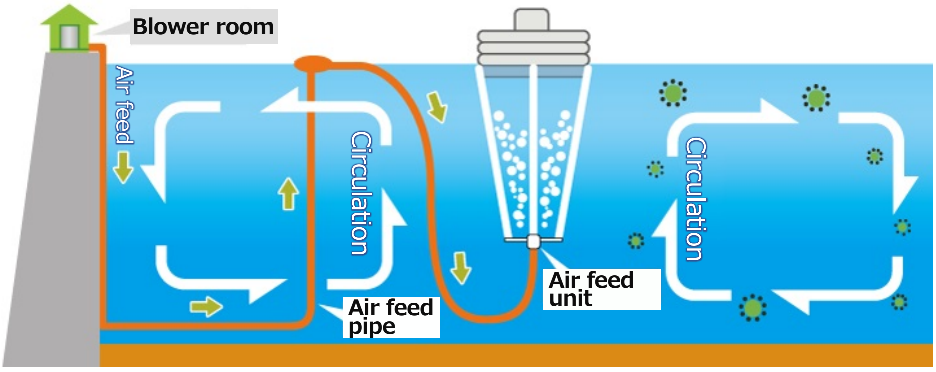
Figure 3.8 Clear Water Bypass at the Urayama Dam

(c) Measures against Eutrophication

Large reservoirs are prone to the abnormal occurrence of plankton and blue-green algae. Reservoirs have an extended retention period because of the large storage volume against a small inflow of considerable pollutants from the watershed. This causes musty odors in domestic water and increases trihalomethanes and other pollutants during chlorination and other processes.

Aeration suppresses the generation of plankton by circulating stored water and moving plankton downward. Aeration also suppresses the elution of nutrient salts from the bottom sediment by channeling oxygen to the deeper layers of the reservoir (Figure 3.9).

Fences are installed to channel nutrient-rich inflow water to the deeper layers and bypass channels to prevent polluted water from flowing into the reservoir. Measures were taken to prevent the upstream area of the reservoir from becoming polluted.



Source: Website of the Hijikawa River Dam Integrated Management Office, Shikoku Regional Development Bureau, MLIT

Figure 3.9 Mechanism of the Aeration System

3) Environmental Monitoring

Continuous environmental monitoring is needed because a dam project is expected to cause environmental changes in the habitat and ecosystem. The MLIT has implemented a follow-up system to improve the efficiency and transparency of the management process. The effects of the project and its impact on the environment were analyzed and evaluated, and the necessary measures were implemented. Follow-up committees comprising academic experts were established in each region to scientifically review the results of various surveys. The results were periodically disclosed.

(3) Forest Development in Water Source Areas

Forests play a key role in the preservation of water resources in water source areas. Rain falls on the forest, and its water infiltrates and recharges the forest area, eventually flowing out over an extended period. The ability of forests is indispensable for maintaining and restoring a sound water cycle. To ensure sustainable restoration of the recharging function of forests, forest management is required with human intervention. Artificial and countryside forests would be healthy through continuous maintenance.

Forests that are critical for the recharge function in the water source area are designated as water source area conservation forests under the Forest Act. Deforestation and other changes are regulated. Conservation forests are located in areas important for basin protection to stabilize river flow, mitigate floods and droughts, and secure water for various purposes. In 2018, the designated area was approximately 9.2 million ha, which is equivalent to approximately 23% of the national land area and 35% of the forest area. The Act requires permission from the prefectural governor when the development area exceeds 1 ha in private forests. The act requires a notification to the municipality mayor in advance regarding logging, afforestation after logging, and owing new forests.

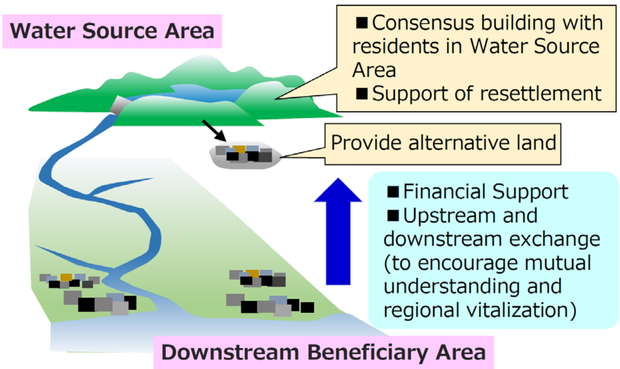
Prefectures and municipalities' forests are often located in more remote areas than private forests. Prefectures and municipalities maintain forests to secure recharge functions in the water source areas. They have introduced a taxation system and the ownership of forests by citizens and fostered citizens' understanding of the importance of maintaining the functions of forests (section 2.2(2) for details).

The number of NPOs conserving forests increased from approximately 600 in 2000 to approximately 3,000 in 2012. Water users in some downstream areas proactively conserve forests in the water source areas. Consequently, upstream and downstream exchanges and communication have been created. In addition, as part of CSR activities, private companies have helped conserve forests in collaboration with customers, residents, and NPOs or helped the local community by utilizing corporate-owned forests.

CHAPTER 4 LESSONS LEARNED

(1) Large-scale projects should be planned for the benefits of affected local communities also. Large-scale projects, such as dam construction, could adversely impact local communities and ecosystems if appropriate measures are not taken. The entire community could be submerged and collapsed. Projects should support local communities and industries in rehabilitating their lives and activities. The project should include relocation site development as a part of the project. Support for livelihood reconstruction is required for the affected residents. Affected people must be involved in the process of consensus building and planning for reconstruction and resettlement programs.

(2) Measures for water source areas, including financial resources, need to be institutionalized. It is necessary to implement various effective measures for water source areas. Legal systems should be provided to implement measures and secure the financial resources necessary for implementation, such as river basin funds (Figure 4.1).



Source: Project Research Team

Figure 4.1 Concept of Support for Water Source Area

(3) Partnerships with various stakeholders should be established to support the water source areas. Cooperative relationships with downstream areas, private companies, and civil society organizations are crucial for mobilizing resources and developing activities. People outside the water source areas, such as those from downstream or urban areas, should be involved in efforts to revitalize the water source area. Interactions between people and those in the water source area deepen their understanding about each other and develop cooperative activities.

(4) Assessing the environmental impact and considering conservation are prerequisites for large-scale projects. Large-scale water management projects may affect the natural environment. To improve the project plan, there is a need to properly assess the environmental impacts, and carefully consider environmental conservation measures. It is also necessary to establish a procedure for environmental impact assessments, prepare the necessary documents at each stage, and incorporate residents' opinions into the assessment. Various environmental conservation measures should be implemented when constructing and managing facilities to avoid or reduce the adverse impacts.

THEME 10 DEVELOPMENT OF HUMAN RESOURCES AND TECHNOLOGY: ESTABLISHING SYSTEMS FOR DEVELOPMENT OF HUMAN RESOURCES AND TECHNOLOGY TO MEET CHANGING NEEDS

ABSTRACT

To modernize engineering technology, the Japanese government has invited foreign engineers since 1870 and has promoted technology learning. In addition, the government dispatched students abroad to acquire western technology. Engineers who returned to Japan led public works projects and trained their successors. Currently, the university entrance ratio stands at 49%, and a certain number of civil engineering graduates are entering society. On-the-job training provides opportunities for practical knowledge and skills development at the workplace according to the job position. In addition, off-the-job training is conducted through lectures and seminars, acquisition of technical qualifications, and academic society activities. The Japanese government strives to disseminate its research results to local governments and the private sectors. Government institutions issue guidelines and manuals to disseminate their research and development results. The government should actively use water resources technologies owned by the private sector. The government has been promoting technological development by inviting companies to develop new technologies.

CHAPTER 1 INTRODUCTION

> It is necessary to secure and develop diverse human resources in water resources management and develop necessary technologies to respond to changing social conditions and needs.

Water resource management covers a wide range of fields, including legislation, finance, planning, surveys, design, construction, maintenance, and operation. An array of specialties, such as civil engineering, environment, forestry, architecture, machinery, information and communications technology (ICT), law, finance, and economics, are required. Thus, human resources should be secured and trained. The development of technologies and adaptation to changing social conditions and needs is also required. This theme describes the situation of securing human resources and measures for human resource development in Japan. It also introduces the role of governmental organizations in technology development and the measures taken to utilize the technologies developed by the private sector.

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

Relationships between Human Resources and Technology and the SDGs:

To develop abilities of people through human resources development:

SDG 13 “Climate Action” 13.3 “Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning”

CHAPTER 2 SECURING AND DEVELOPING HUMAN RESOURCES

2.1 Securing Human Resources

> It is necessary to continuously secure the human resources engaged in water resources management by expanding the education system in line with society's development.

Since 1870, the Japanese government has invited foreign engineers to modernize engineering and promote technology learning. Dutch engineers have mainly transferred river technology to the field. Engineers who studied abroad at national expense led public works, taking over the position of foreign engineers. They taught science and engineering and trained their successors.

While the Japanese society developed, the number and quality of human resources remained insufficient, even in the mid-20th century. Japan continued to develop human resources by acquiring, inheriting, and developing advanced technologies learned from Western countries. The country received assistance from developed countries in executing large-scale projects (see boxed article).

The number of students entering universities is 2,556,000 in 2015, and the percentage of students entering universities has increased from 17% in 1970 to 49%. Universities send out many civil engineering graduates annually.

2.2 Development of Human Resources

> It is necessary to develop human resources through off-the-job training (off-JT) with on-the-job training (OJT).

(1) Training

In Japan, the capacity development of human resources is practically conducted by accumulating self-development through OJT relevant to the workplace and position held. In addition, off-JT was conducted to promote ability development. Government agencies provide off-JT opportunities.

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) administers "the College of Land, Infrastructure, Transport, and Tourism" as a training institute for officials of the national and local governments and other organizations. This college offers many training courses[2], allowing participants to not only acquire knowledge and skills in specialized fields but also gain insights as civil servants, improve administrative skills, and respond to newly emerging administrative issues (e.g., overseas infrastructure business and digital transformation). "The Japan Construction Training Center," an affiliated organization, provides training in different fields of expertise. In addition to officials from local governments and other organizations, the center also accepts engineers from companies.

[2] 120 courses for civil engineering positions. Its lecturers are external experts and senior officials of MLIT.

Large-scale Projects during the Post-war Reconstruction Period: Aichi Irrigation Project

Source: Japan Water Agency Aichi Canal Integrated Management Office

Figure 2.1 Construction with Large Machinery

During the 14 years, from 1953 upon restoring sovereignty to 1966, Japan received finance of 7,566 million dollars (at present value) from the World Bank as loans for reconstruction and development of the nation. The loan was invested in 31 large-scale projects including hydropower development, water resources development, highways, and high-speed railways (Shinkansen) construction. "The Aichi Irrigation Project" was one of the 31 projects (Figure 2.1). A dam, 104.5 m in height, was constructed with an effective storage capacity of 68 million m^3. The dam also had irrigation channels consisting of 112 km long main lines and 1,000 km long branch lines to convey water for agricultural, municipal, and industrial uses.

Japan relied on the technologies of developed countries for the construction of large-scale projects. The planning, design, and construction management of this project were entrusted to American consultants. The consultants proposed a construction method with American-made large pieces of machinery, which contributed to a significant reduction in the construction period and costs. Through this project, more than 500 engineers and local government officials received technical guidance and knowledge transfer. These experiences, along with the increase in public works, contributed to the development of the construction industry and consultants' services.

(2) Lectures, Seminars

The "National Institute for Land and Infrastructure Management (NILIM)" and the "Public Works Research Institute (PWRI), " which are research institutes of the MLIT, hold lectures and seminars. These institutions publish their research results online. Officials of the MLIT report their work results at technical seminars throughout the country.

(3) Acquisition of Technical Qualifications

Acquiring technical qualifications is an effective way to obtain comprehensive knowledge on technical fields of specialty and related social trends to improve communication skills with others clearly and logically. The representative official qualifications certified are professional engineers (PEs), first-class construction management engineers, and first-class architects. In many construction projects and services procured by public authorities, a bid condition is that the person appointed as the managing engineer should have one or more of these qualifications. Thus, it is recommended that engineers and architects acquire these qualifications.

(4) Academic Activities

There are academic societies related to water resources, such as the "Japan Society of Civil Engineers (JSCE)," "Japan Society of Hydrology and Water Resources (JSHWR)" and "Japan Society of Dam Engineers (JSDE)." They discuss issues and present research results related to water. One of the unique activities related to water resources is the "Symposium on River Technology, " which is organized by the River Section[4] of the JSCE Hydraulic Committee. It organizes poster sessions and panel discussions, focusing on river maintenance and management.

2.3 Japan's Support in Developing Human Resources

> Japan is supporting the capacity development of practitioners and engineers in developing countries by dispatching experts and inviting officials to Japan.

JICA is working to support human resources development for sustainable development by dispatching experts and providing study programs:

- **Dispatching JICA experts:** Experts are assigned to the implementing agency of the counterpart government. They assist in improving the system and organization, and provide capacity building to the staff of the implementing agency with their specialized skills and knowledge.
- **Technical cooperation projects:** These projects are implemented by optimally combining various methods, such as dispatching JICA experts, inviting officials and engineers, and providing the necessary equipment. Capacity building is conducted through daily on-the-job training, seminars, and workshops. In the fields of water resources, 101 projects have been implemented to date.
- **Task-specific training:** JICA mainly invites officials and engineers engaged in practical work in developing countries to contribute to resolving the issues faced, by providing the relevant knowledge and experiences of Japan. Lecturers vary depending on the lecture theme. This helps build human networks of participants from developing countries and Japan.
- **Japanese yen loan:** JICA supports the development of human resources in developing countries. For example, in Mongolia, a study in Japan program is being implemented as part of the "Higher Education Support Program for Engineering" through the "Study Abroad Program of Technical College."
- **Scholarship Program for Human Resources Development:** The program aims to assist outstanding young officials expected to be future leaders by inviting them as international students in Japanese postgraduate courses. They are expected to be actively involved in the socio-economic development in their countries and expand friendly relations between their countries and Japan.
- **Science and Technology Research Partnership for Sustainable Development (SATREPS):** The Japan Science and Technology Agency (JST), Japan Agency for Medical Research and Development (JIRA), and JICA are collaboratively implementing a research program. Researchers

[4] Proposed by the Water and Disaster Management Bureau of the MLIT and newly established in the Hydraulics Committee of the Japan Society of Civil Engineers.

from Japan and developing countries are engaging in collaborative research to develop human resources and improve research capabilities in both countries (Figure 2.2).

Source: JICA

Figure 2.2 Higher Education Support Program for Engineering in Mongolia

CHAPTER 3 TECHNOLOGY DEVELOPMENT

3.1 Roles of Government Agencies

The national government should lead technology development on themes that meet social needs. It should also disseminate the technology developed to local governments and the private sector.

The NILIM, PWRI, and the MLIT have shared the results of their research and development activities by publishing guidelines and manuals. The MLIT is revising the Technical Criteria for River Works to reflect technological trends. The criteria establish standards for the plan, design, and maintenance of river works.

The MLIT is leading technology development by setting themes through industry-government-academia collaboration to meet social needs. The roller-compacted dam concrete (RCD) method is a featured example of a technology developed. This method allows the effective use of large machinery in concrete dams and contributes to reducing construction costs. The RCD construction method6 was developed based on the results of studies conducted by a researcher group. It was established in 1973 under the initiative of the Ministry of Construction (currently MLIT) and consisted of members from companies in various fields, government, and academia. After the trial construction of cofferdams by the RCD in 1976, the RCD method was refined with a series of improvements accumulated through applications (Figure 3.1). This method was adopted for projects in Laos and China.

3.2 Utilization of Private Sector Technologies

The government should promote the development of technologies by the private sector.

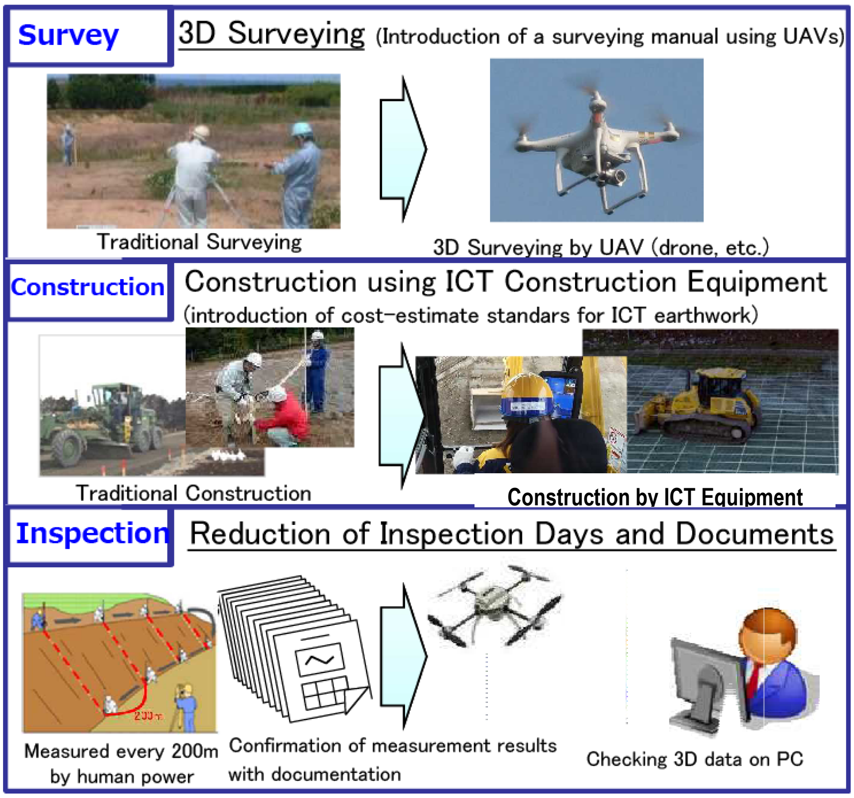
The government can encourage the private sector to invest in research and development by inviting them to research programs, changing bidding systems, and issuing certificates.

Source: Japan Dam Engineering Center

Figure 3.1 RCD Method (Yunishigawa Dam)

(1) I-Construction: Japan is currently experiencing a serious shortage of workers in the construction industry, owing to the aging workforce and stagnation in the employment of the younger generation. The government is actively working on a project called i-Construction, which aims to boost productivity in all aspects of construction by 1) fully utilizing ICT, 2) standardizing specifications, and 3) distributing the timing and load of construction more evenly throughout the year. A consortium comprising industry, government, and academia promotes projects that innovate new technologies or

require collaboration among companies (Figure 3.2).



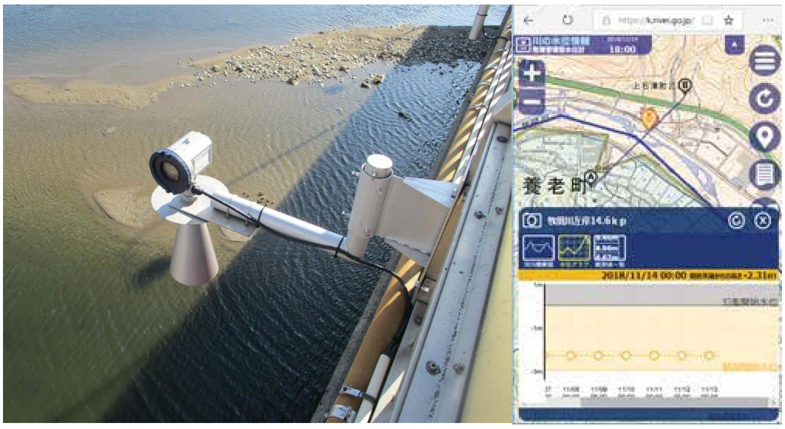
Source: MLIT Website

Figure 3.2 Improvement of Productivity with i-Construction

(2) Public Invitation for Research and Development in River Works Technology: This system was established to research and develop (R&D) river works technology. Themes are selected by inviting proposals from universities, public corporations, and companies. An evaluation committee consisting of experts examines and suggests entrusting R&D to certain organizations. For example, the invitation theme of FY2021 was "Development of evaluation technologies that contribute to strengthening structures of river levees against overflow." This theme aims to cope with large-scale floods that have frequently occurred in recent years.

(3) Innovative River Management Project: The MLIT launched this program in 2016 to develop products that contribute to river and disaster management, in a short period, utilizing advanced technologies. It is promoted through "open innovation," which combines the elemental technologies of companies that own know-how that meets the specifications7 required by the government. For example, a development team formed by a water level gauge manufacturer and a telecommunication company was engaged in developing the "risk-management type water level gauge." Another team formed by a camera manufacturer and an IT vendor was engaged in developing8 the "simple river monitoring camera." The two teams completed product development in 2017, one year after the commencement of development. They are currently in the implementation phase9. By the first half of 2020, approximately 8,800 risk management type water level gauges and 3,700 simple river monitoring cameras were installed (Figure 3.3). The project is now developing "all-weather drones," "land and underwater laser

drones," and "full automated and manpower-saving flow observation equipment."



Source: Foundation of River and Basin Integrated Communications

Figure 3.3 Risk Management Type Water Level Gauge

(4) Issuing verification certificates for new construction technology: Public service corporations, under the MLIT administration, issue verification certificates for new construction technologies developed in the private sector. Public-service corporations also support the dissemination of new technologies. A web system is operated to provide reference information for new technologies.

(5) Bidding system: From the quality assurance and improvement perspective, the comprehensive bid evaluation method requires bidders to submit their technical proposals. This bid evaluation method has become the standard for contracts of construction and services procured by government offices in Japan. Therefore, each company conducts its own research and development.

CHAPTER 4 LESSONS LEARNED

(1) **To continuously secure human resources to manage water resources, the education system should be expanded in line with the development of society.** Various human resources with different specialties are required to manage water resources. The number of personnel need to increase with progress in infrastructure development. To meet these requirements, it is necessary to develop and successfully implement technologies transferred from developed countries and steadily expand the skills of human resources. It is also necessary to establish an education system to support technology and human networks.

(2) **To develop skills by broadening the knowledge of human resources, off-JT and OJT should be positioned as the core for capacity development in water resource management.** It is effective in providing various opportunities and encouraging off-JT. The utilization of training programs would also be helpful.

(3) **To transfer technology to domestic administrators and engineers, financing from development agencies may provide good opportunities.** After World War II, Japan utilized loans from the World Bank for large-scale development projects. Western consultants were engaged as per the loan conditions of the World Bank. Japan utilized the opportunity to acquire knowledge and the latest technology to organize and manage large-scale projects.

(4) **To meet social needs, the national government should lead technology development on the themes needed.** The national government takes the initiative to promote large-scale technology development that meets social needs and requires cooperation among the government, industry, and academia..

(5) **The national government should strive for the dissemination of research results.** It is important to establish unified technical standards that meet national requirements and share these standards among the parties concerned to ensure the quality of water resource management.

(6) **The government can encourage the private sector to invest in research and development.** The Japanese government uses advanced technologies, including those from different fields, to rationalize water resource management through inviting research programs and technical proposal for bidding.

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