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:

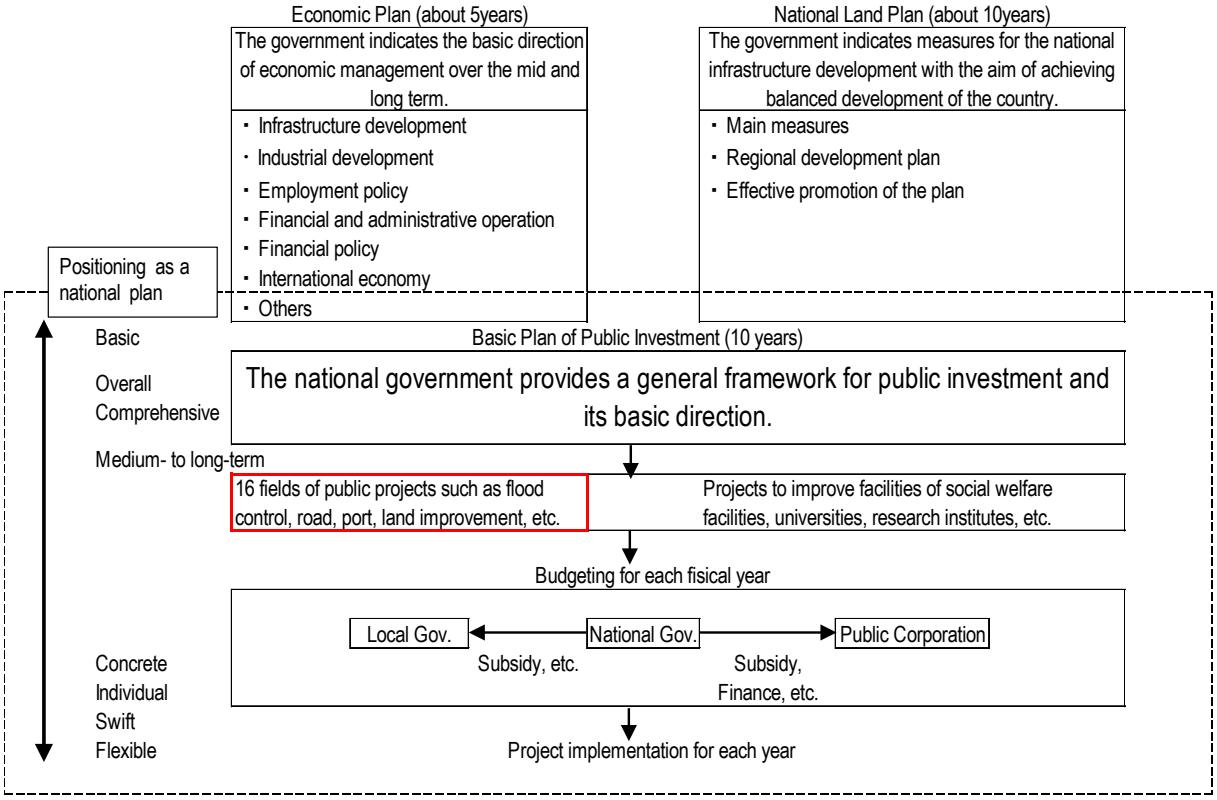
SDG 1. “No Poverty”, 2. “Zero Hunger”, 3. “Good Health and Well-Being,” 6. “Clean Water and Sanitation,” 11. “Sustainable Cities and Communities,” 13. “Climate Action”

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.

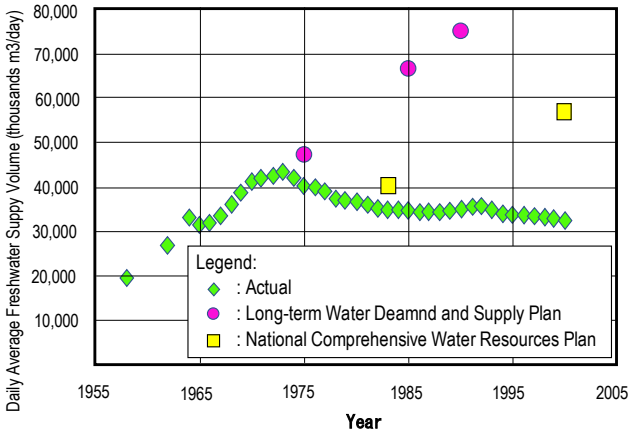
Table 2.1 Overview of Three National Comprehensive Water Resources Plans

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.

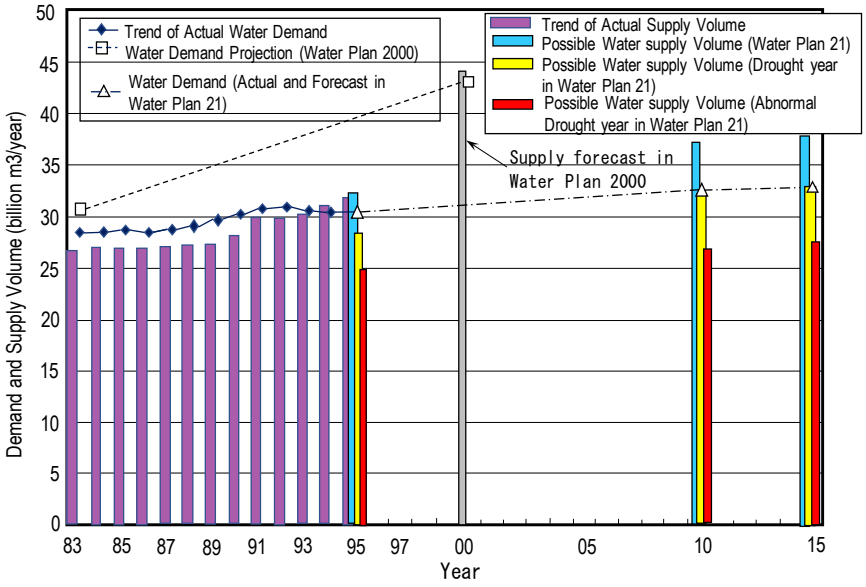
The Long-Term Water Demand and Supply Plan and Water Plan 2000 (National Comprehensive Water Resources Plan) forecasted water demand based on the increasing trend during a period of high economic growth. The forecast and actual demand were significantly different, as shown in Figure 2.3. Uncertain factors 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.



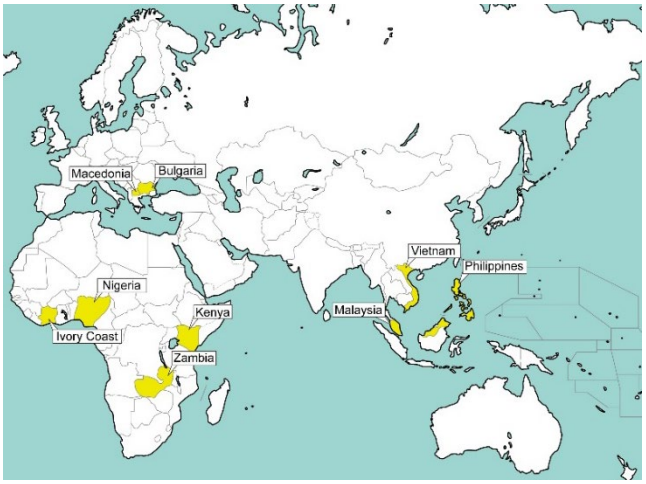
Source: Results of Policy Review for Fiscal Years 2004 and 2005 (Evaluation Report) Water Resource Policy–The State of Water Resource Planning–MLIT, March 2006.

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.	

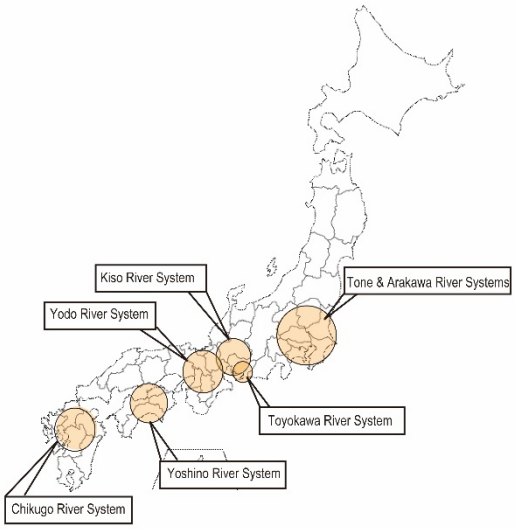
Source: "Study on Approach for Integrated Water Resources Management – Review of the JICA Master Plan of National Water Resources Management – Final Report," July 2011, JICA

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.

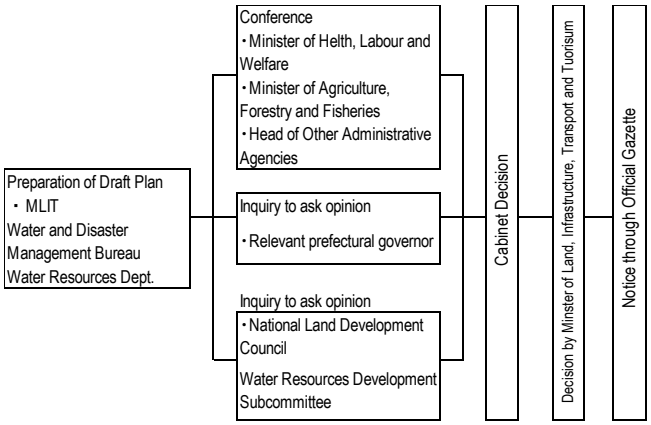
Since the 1950s, Japan experienced remarkable restoration and growth in industry, and concentration of the urban population, accompanied by improvements in living standards. Tokyo, Osaka, and other metropolitan areas faced severe water shortages due to the dramatic increase in water demand. There is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

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.



Source: Prepared based on website of MLIT

Figure 3.1 Location Map of River Systems for Water Resources Development



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.

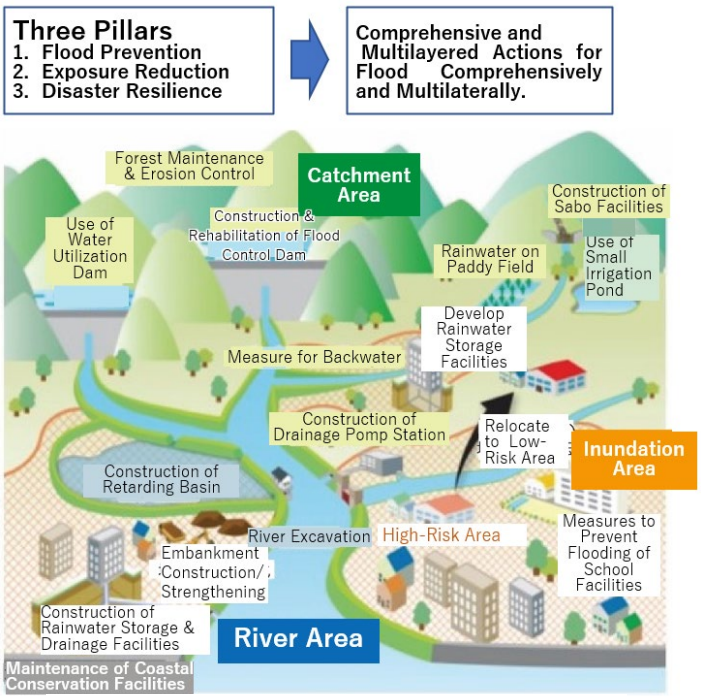
2) Sustainability: In the event of a major disaster, a region should be able to recover and rebuild quickly to maintain sustainable development and improve its international competitiveness, thereby contributing to Japan's growth strategy.

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.

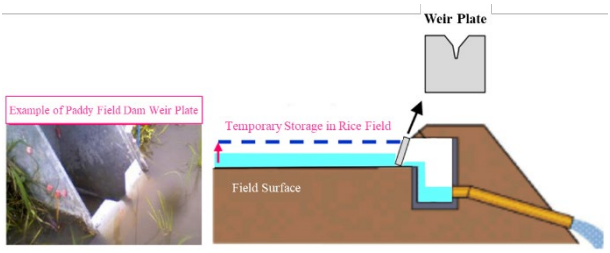


Source: MLIT Website

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.

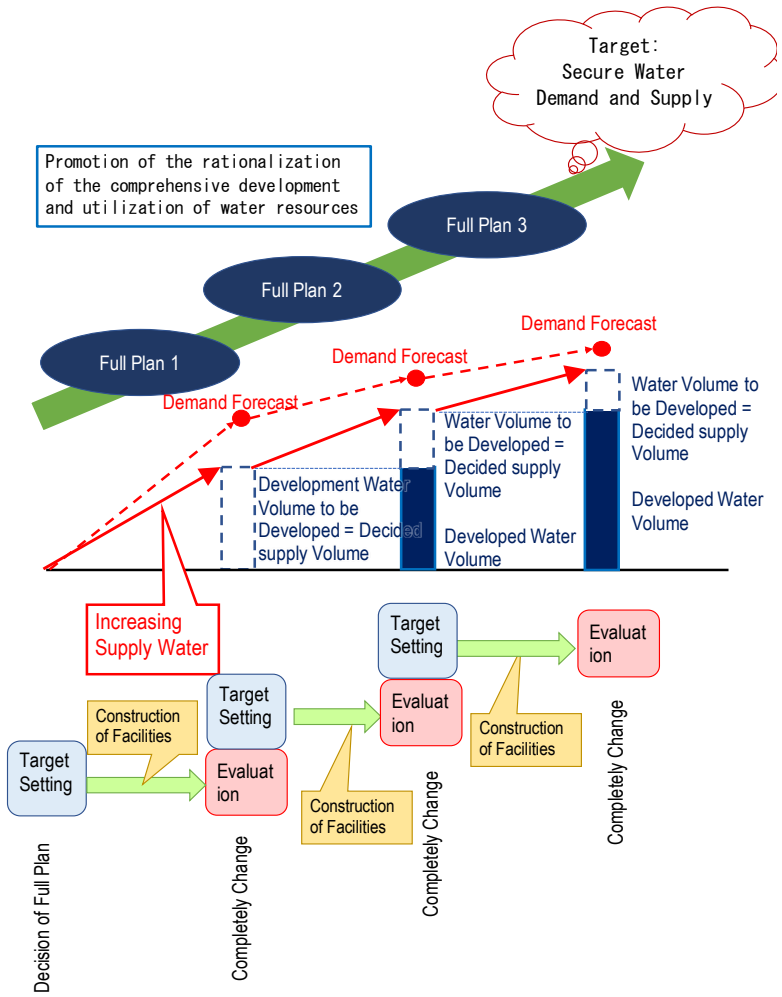


Source: Cabinet Office

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.

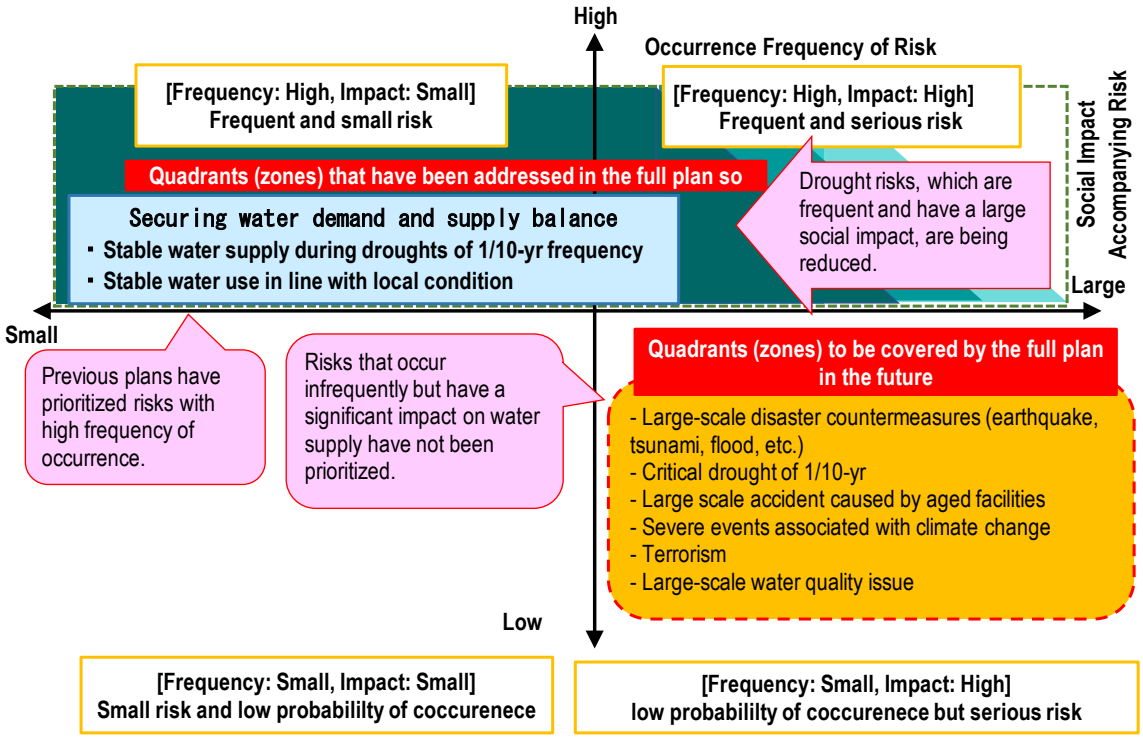
2) Comprehensive plan ensuring the safety level of water supply: Steady implementation of measures in line with the local conditions through a comprehensive evaluation of the water supply and demand balance, considering the uncertainties.

[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)

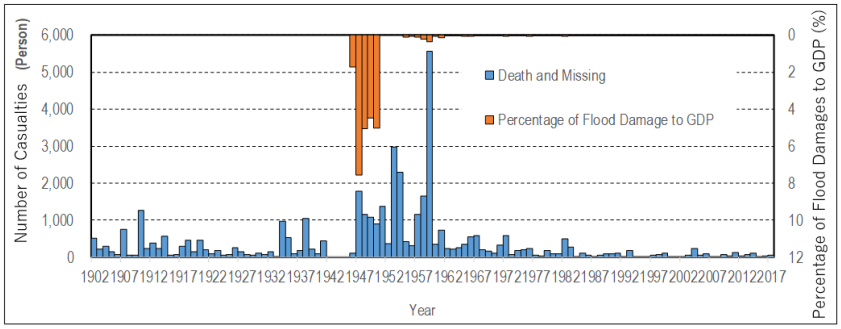
CHAPTER 5 CONTRIBUTION TO SOCIETY THROUGH WATER RESOURCES MANAGEMENT

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

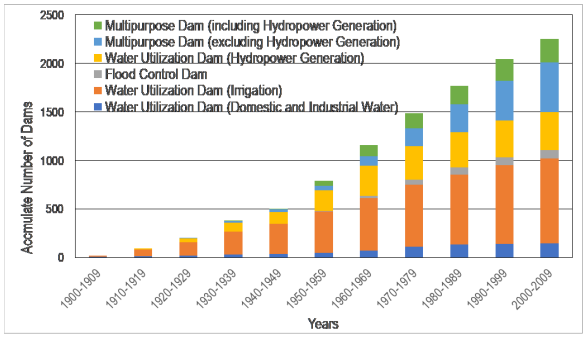
Investment in flood protection reduces flood damage (Figure 5.1). Japan is vulnerable to floods because major cities are located downstream of key rivers, and the population is increasingly concentrated in these major cities. After 1945, flood damage frequently occurred until the 1950s, with more than 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

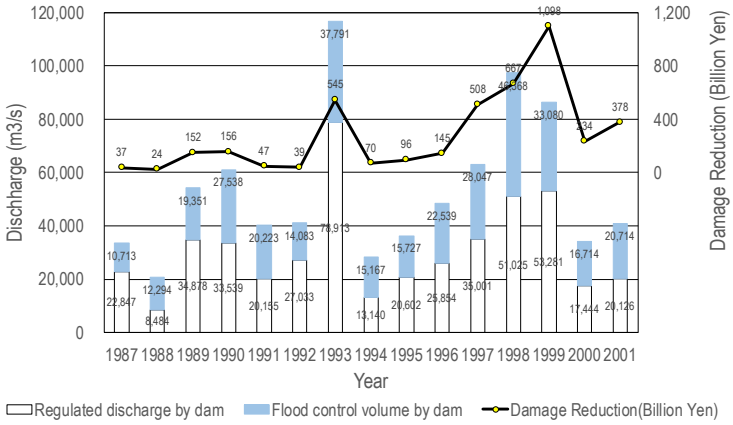


Source: Prepared based on data from "Dams in Japan"

Figure 5.2 Increase in Number of Dams Constructed

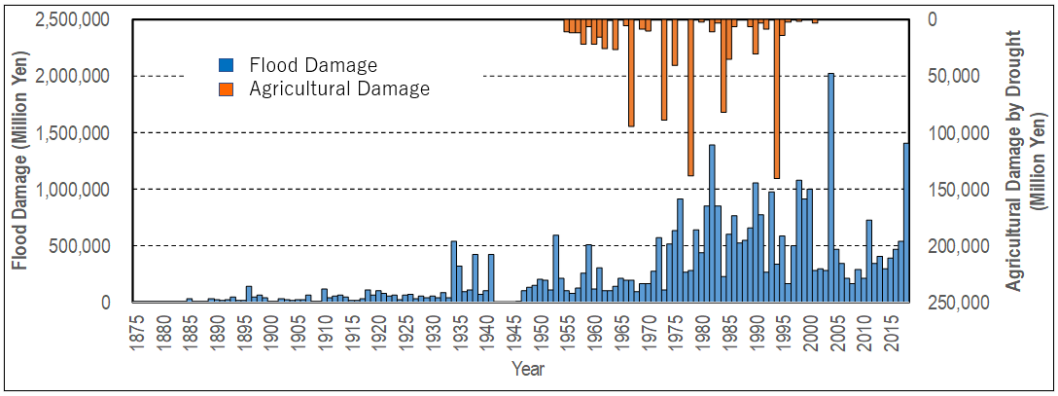
approximately 340,000 m^3/sec. The total reduction in flood damage was approximately 4.2 trillion yen[6] (Figure 5.3).

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.

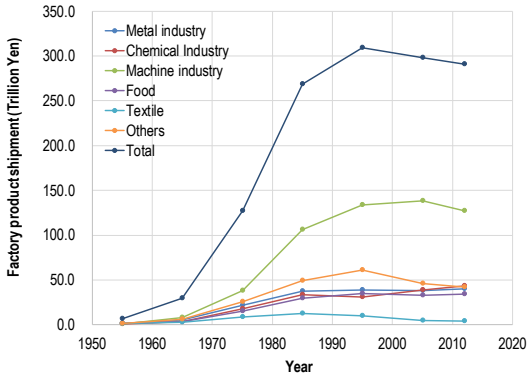
Figure 5.4 Amounts of Flood and Drought Damages

(2) Water Utilization Effect

1) Industrial Water

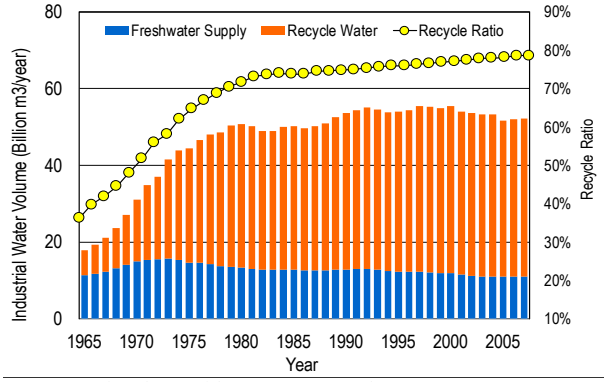
Industrial water facilities supported a large increase in industrial product shipments. The value of product shipments in 1985 was nine times that in 1965 (Figure 5.5). Industrial water demand increased significantly since the 1980s. The use of recycled water increased in line with the growth in industrial 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

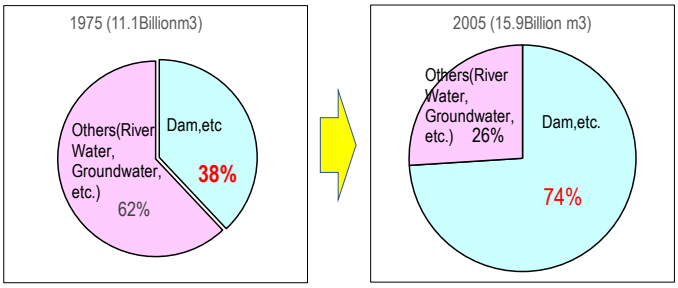


Note: Data for plants with 30 or more employees
Source: Industrial statistical survey

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).

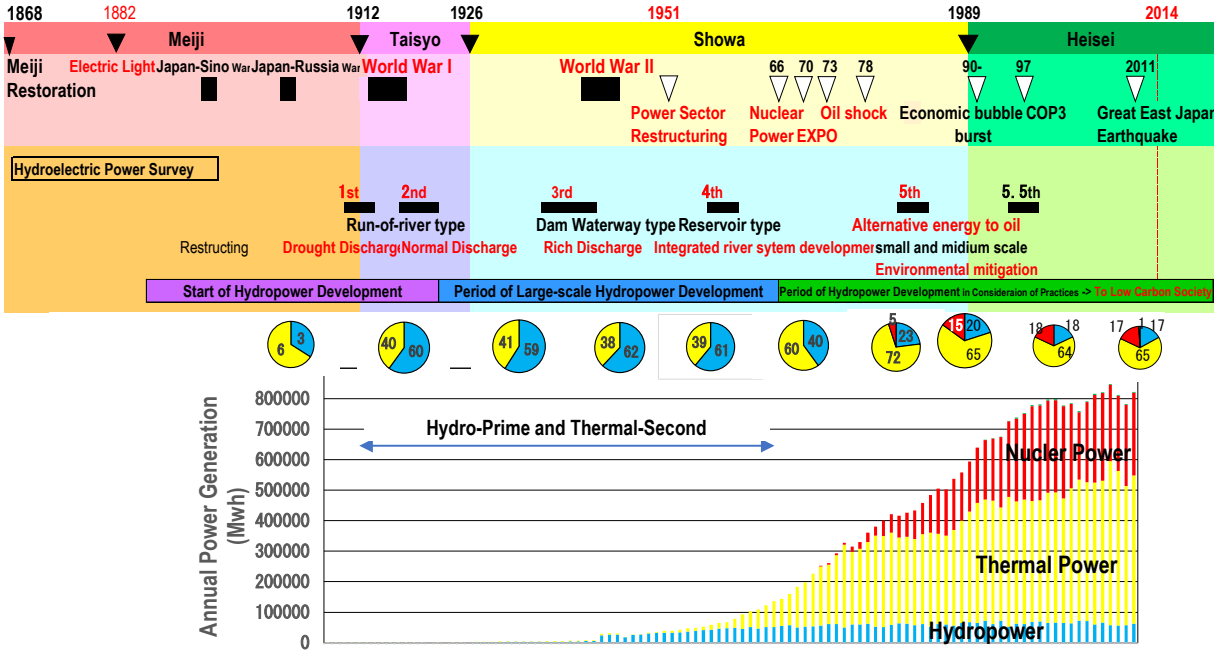


Note: 1975: 11.4 Billion m^3 x 0.38 = 4.3 Billion m^3, 2005: 15.9 Billion m^3 x 0.74 = 11.8 Billion m^3
Source: "The Role of Dams and Hydropower" Japan Commission of Large Dam

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).

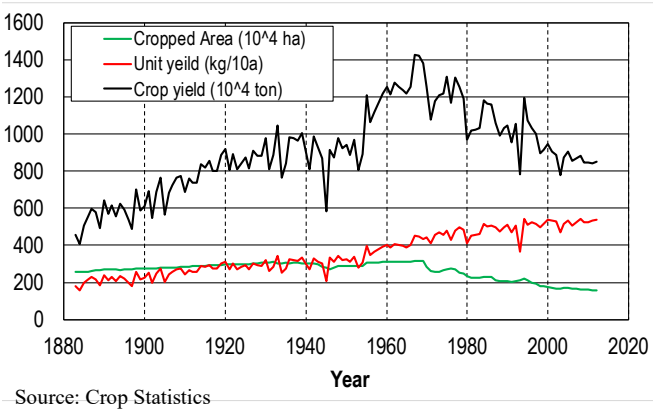


Source: Preparation based on "History and significance of hydropower generation in Japan and international activities under the IEA Implementation Agreement for Hydropower Technologies and Programmes," Akiyama Takashi, New Energy Foundation, July 31, 2015, the Japan Electric Power Industry History Database."

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.

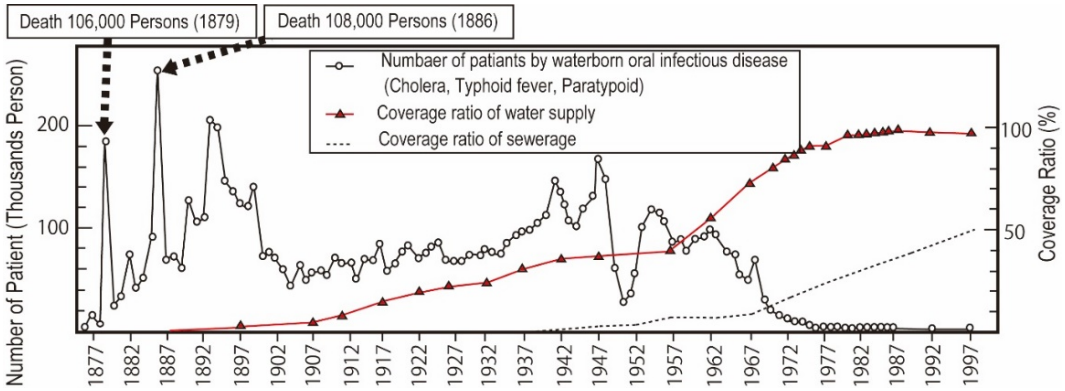


Source: Crop Statistics

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).



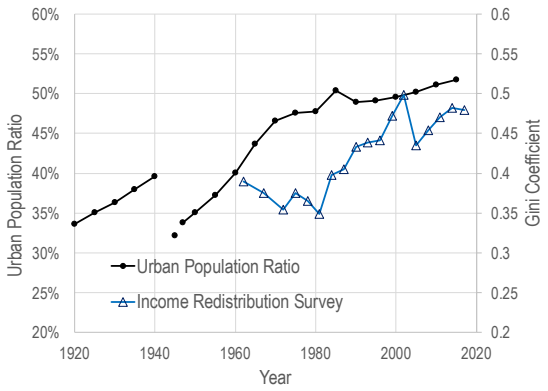
Source: "Urban Development and Public Health" Nakatsuji Hideji WHO insight No.44(2010)

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

(3) Reduction of Disparity and Poverty

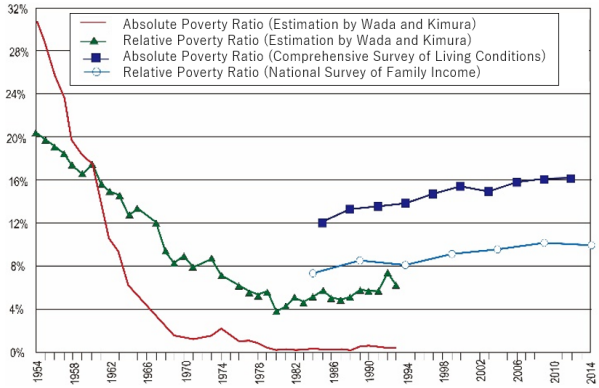
During the high economic growth, the social structure of Japan changed dramatically as the population moved from rural areas to cities. Along with industrialization and urbanization, the water demand in urban areas increased. Developing water resources can reduce income disparities and poverty. This 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

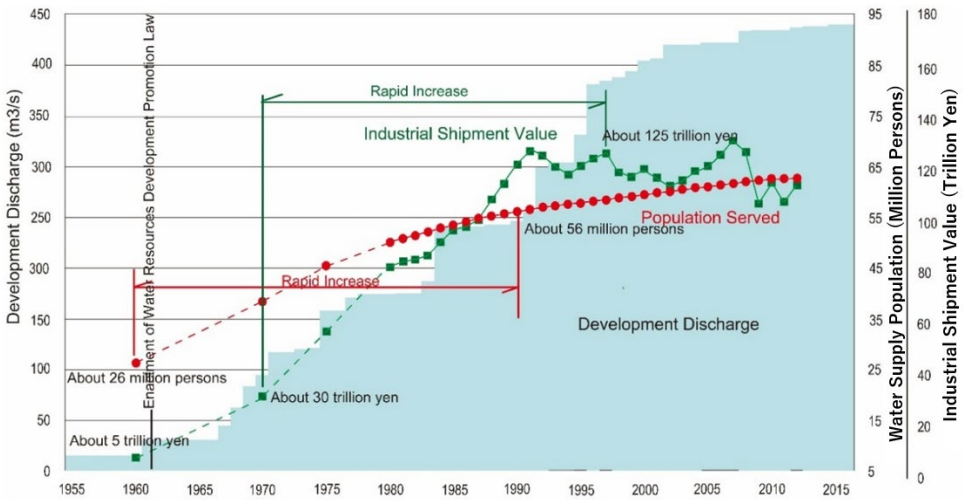


Note: Wada-Kimura's estimation set the poverty line at the average consumption per member of the welfare-recipient households in 1960 (about 40% of that of general households). The "Comprehensive Survey of Living Conditions" and "National Survey of Family Income and Expenditure" set the poverty line 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.