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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The MLIT uses an established set of guidelines to ensure that the series of procedures for observation and reporting are performed properly[1]. Stations are installed based on the following concepts:

- 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):

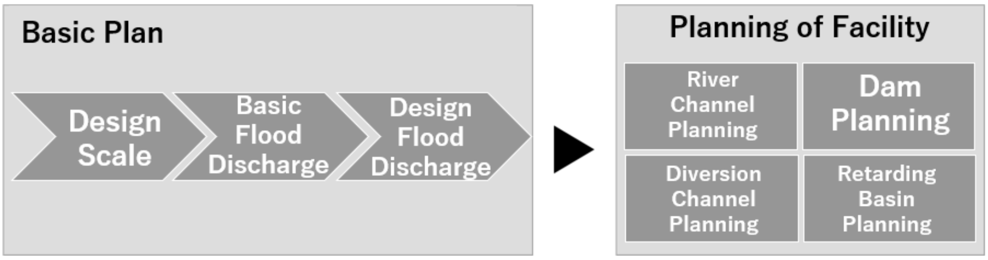
Flood protection plans should be designed in the following order: (a) design scale, (b) basic flood discharge, and (c) design flood discharge (Figure 2.2):

[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.

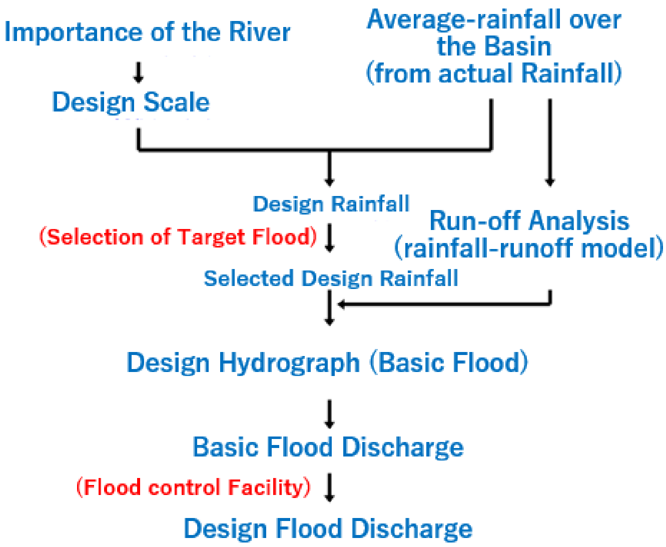
2) Basic flood discharge: Rainfall duration, rainfall pattern, and regional distribution are studied at each reference point. The rainfall patterns for multiple actual rainfall events are converted into the design scale; this is known as a hyetograph[3]. The resulting design hyetographs are input into 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

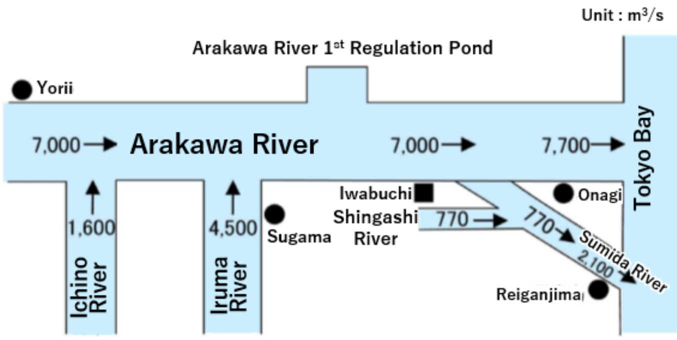
Figure 2.1 From Flood Protection Plan to Facility Planning



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

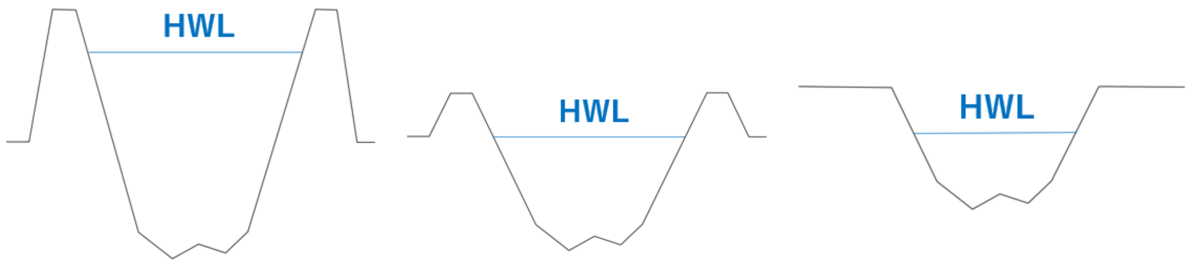
River channels are designed to discharge floodwater below the design flood discharge safely. A river channel refers to the land for river flow, usually enclosed by a levee, riverbank, or riverbed. As the alignment of the river channel usually changes with sediment transportation, it is important to fully 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

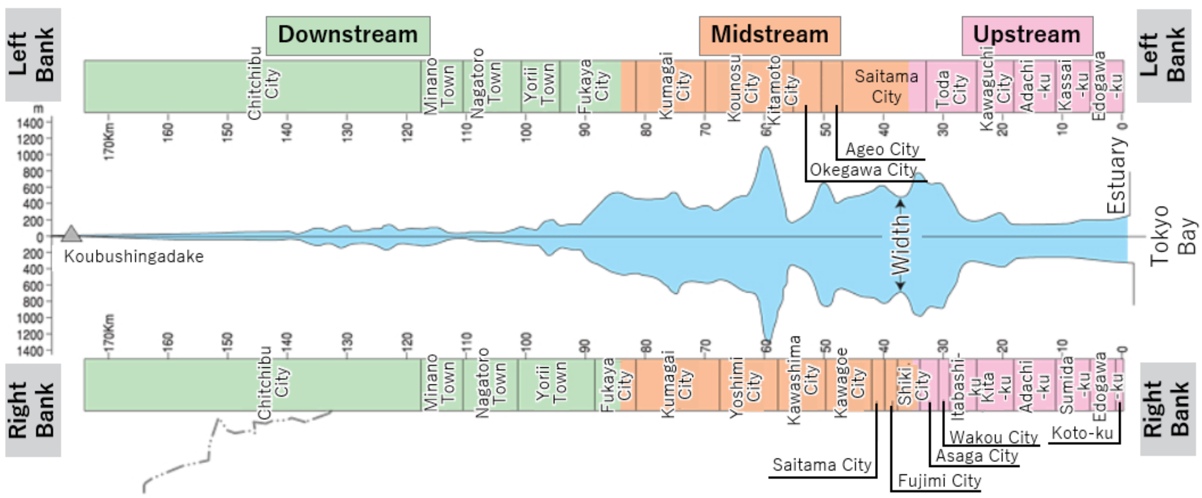
Figure 2.4 Flood Protection Plan to Facility Planning

(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

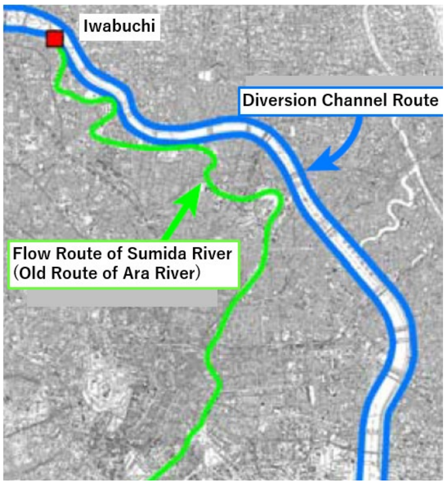
Normally, the river width is narrow in its upstream reach and wide in its downstream reach. However, for historical reasons, the Arakawa River is narrower in the downstream reach. The river area of the midstream is around 2.5 km wide, the widest river channel in Japan, while the downstream part of the 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)

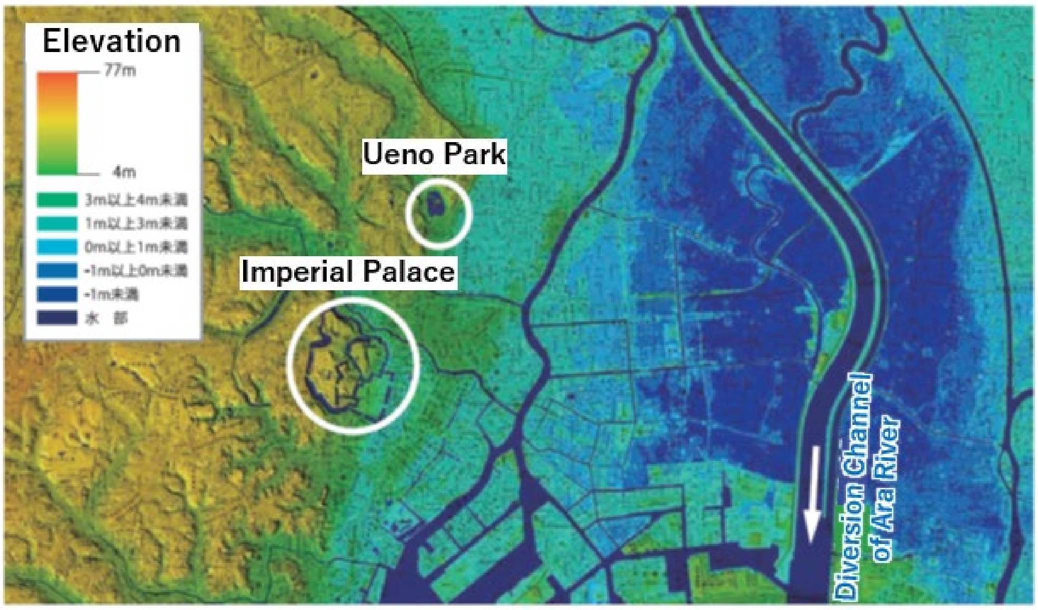
2) Development and Ground Subsidence in the Downstream Area of the Arakawa River

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".

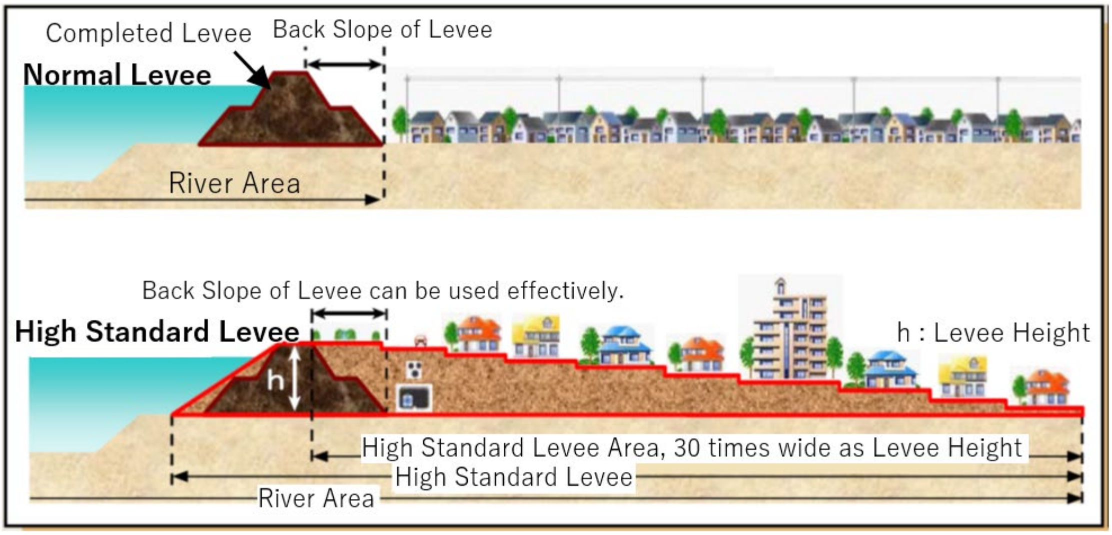
increased below the high-tide level, in the so-called zero-meter zone (Figure 2.8). The ground level along the diversion channel was lowered by a maximum of 4 m in the 1920s. The levees also subsided, and the embankment heightened.

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.

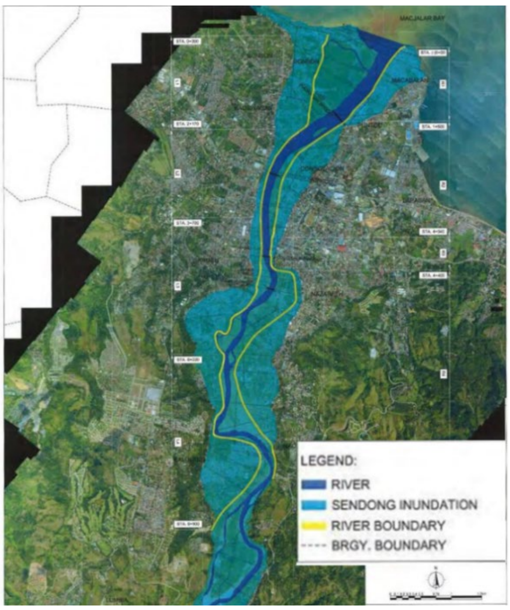
Source: Geographical Survey Institute

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

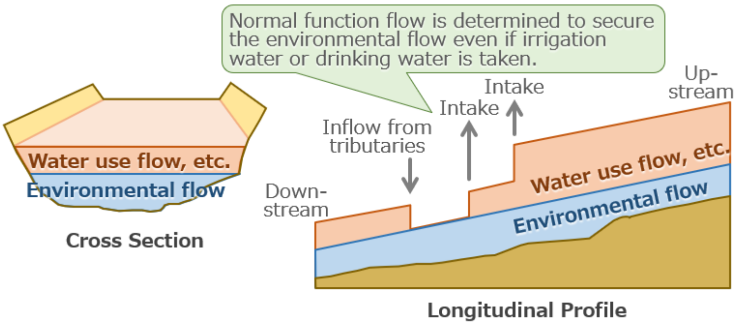
Figure 2.12 A Submerged Levee Protects Rice from Flooding (Haor District, Bangladesh)

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).



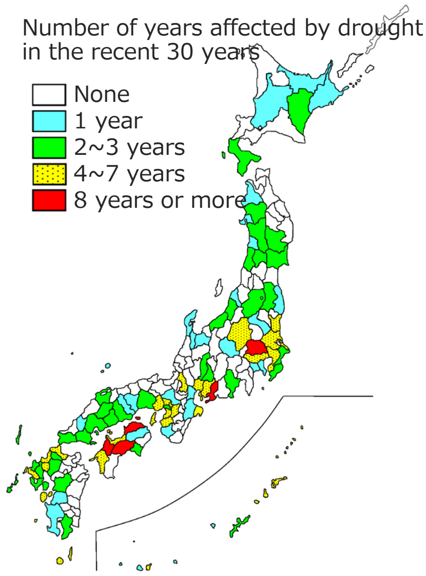
Source: Preparation of Project Research Team based on Hyogo Prefecture website

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

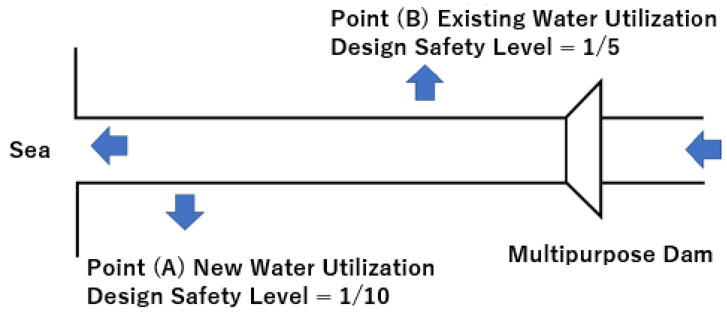
Figure 2.14 Impacts of Droughts in the Last 30 Years

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.

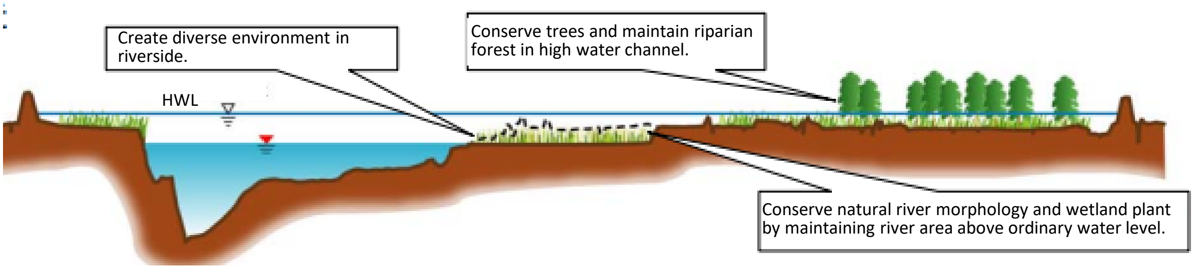
Source: MLIT Website

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

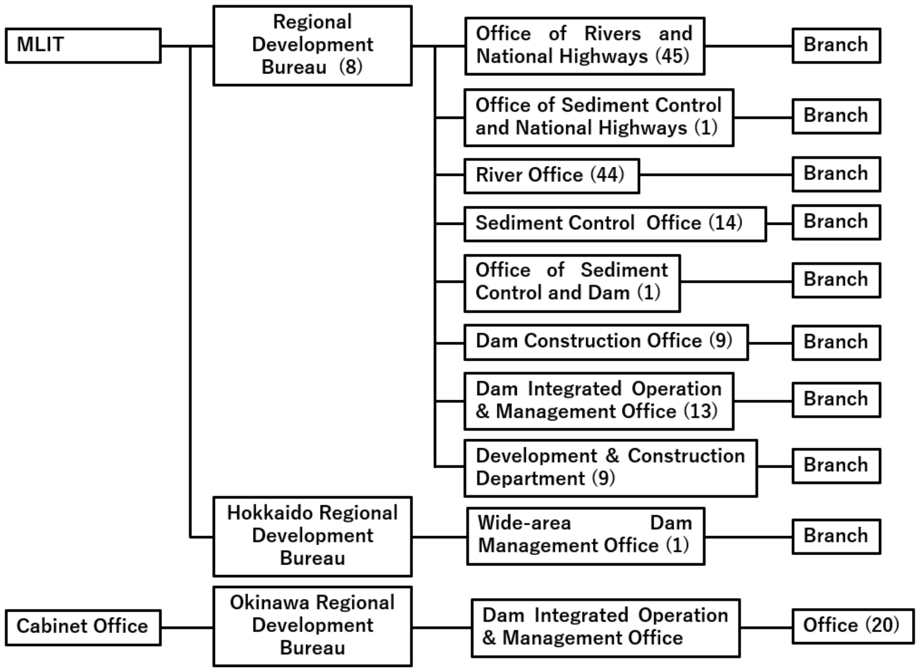
2.6 Institutional Arrangement

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.

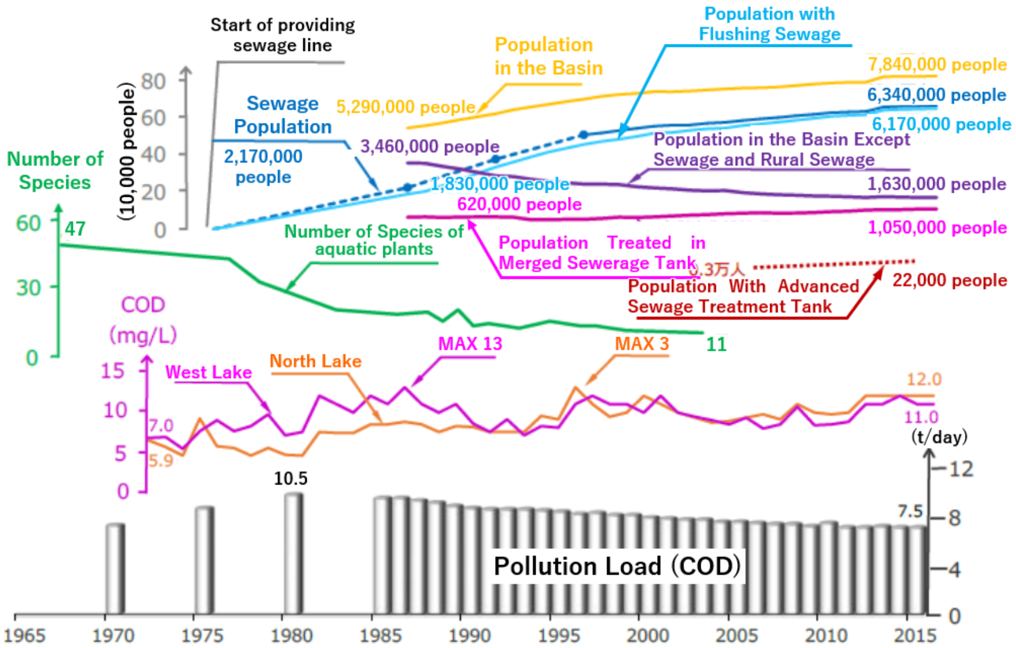
3) Purification of inflowing river water by nature-friendly river works, river cleaning, and channel dredging.

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

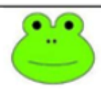
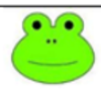
Figure 3.3 Basic Concepts and Goals of a Healthy Water Cycle Plan in the Lake Inba Basin

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

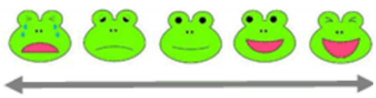
Figure 3.4 Activity of Lake Inba Basin Healthy Water Cycle (Removal of Alien Species)

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

<Legend>

- 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.