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

ABSTRACT

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

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

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

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

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

CHAPTER 1 INTRODUCTION

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

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

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

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

Relationships between Water Rights System and the SDGs:

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

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

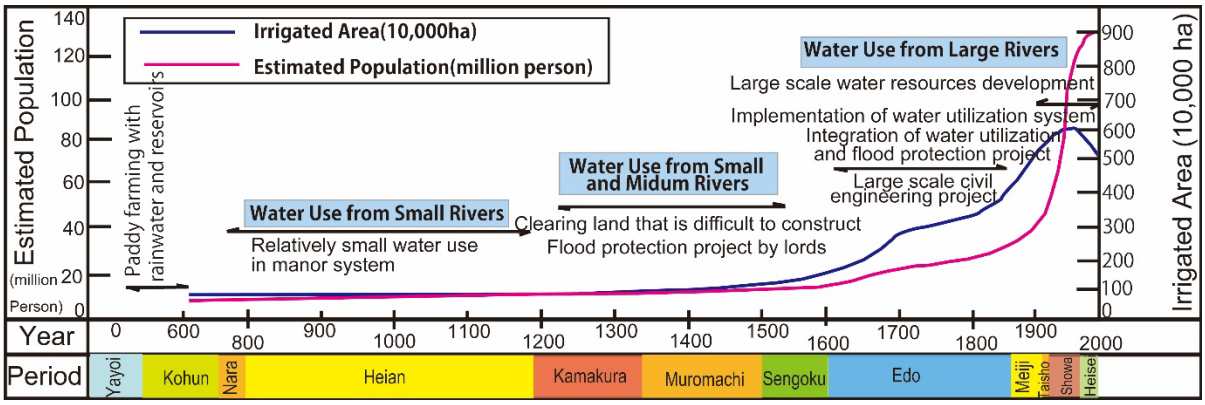
(2) Granting water rights for hydroelectric power generation, which is a renewable energy source:

SDG7 "Affordable and Clean Energy"

CHAPTER 2 THE CHANGE OF WATER USE

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

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



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

Figure 2.1 Changes in the Population and Cultivated Area

[4th century BC to 19th century AD]

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

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

[1896 to 1964]

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

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

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

[1964 to present]

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

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

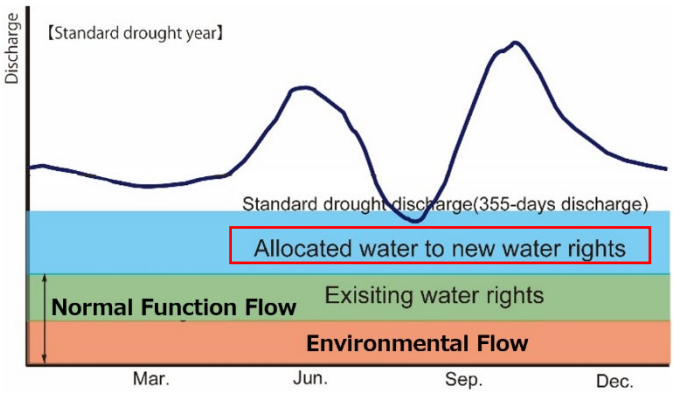
CHAPTER 3 BUILDING A WATER USE ORDER THROUGH THE WATER RIGHTS SYSTEM

3.1 Water Rights Licensing System

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

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

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



Source: Project Research Team

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

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

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

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

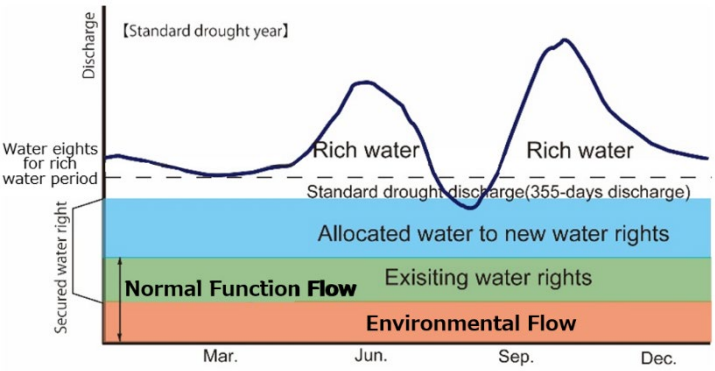
1) Stable Water Rights

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

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

2) Water Rights during Rich Water Period

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



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

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

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

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

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

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

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

3) Provisional Water Rights during Rich Water Period

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

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

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

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

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

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

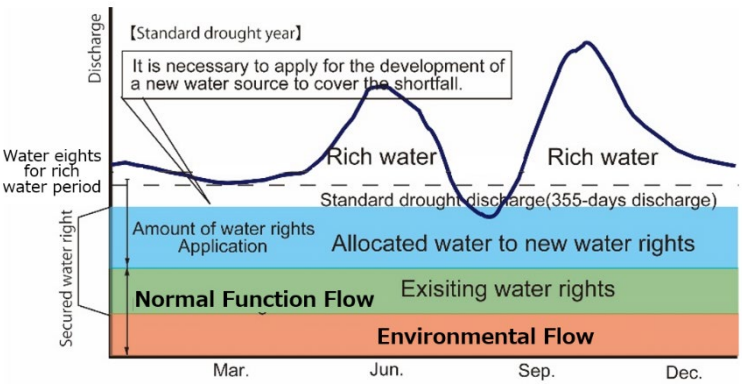
If there was no record of the actual discharge measurement for the last ten years, it was estimated using the following methods:[8]

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

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

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

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



Source: Project Research Team

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

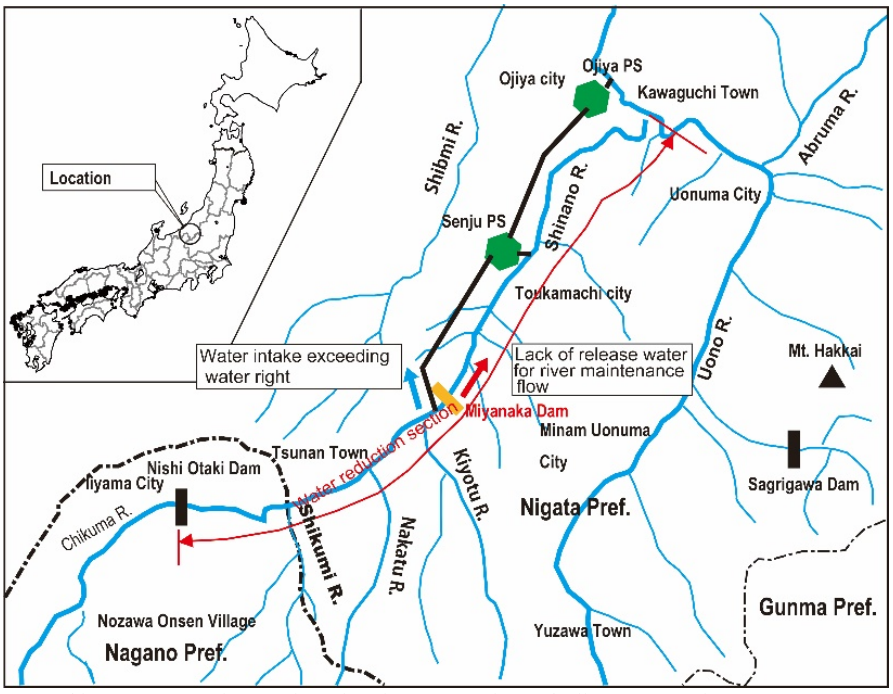
(3) Valid Period of Permission

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

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

(4) Penalties for Illegal Water Intake

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



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

Figure 3.4 Location Map of Shinano River Hydroelectric Power Station

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

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

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

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

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

3.2 Prioritized Customary Water Rights

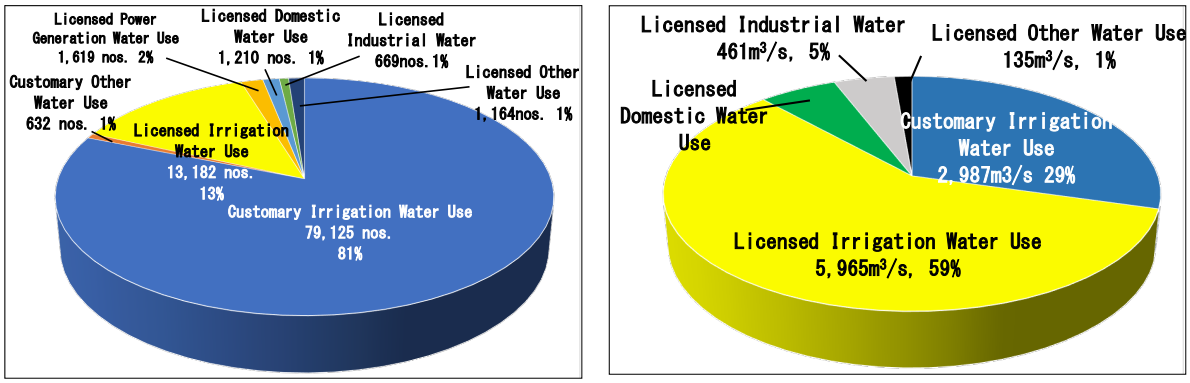
> Japan has given the customary water rights to traditional water uses made before establishing the water rights system, and the rights remain valid.

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

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

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

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



Total Number of Water Rights **Maximum Intake Water Discharge**

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

Figure 3.5 Customary and Licensed Water Rights

3.3 Water Right Fee

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

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

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

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

Table 3.1 Examples of Water Right Fee for Industrial Water

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

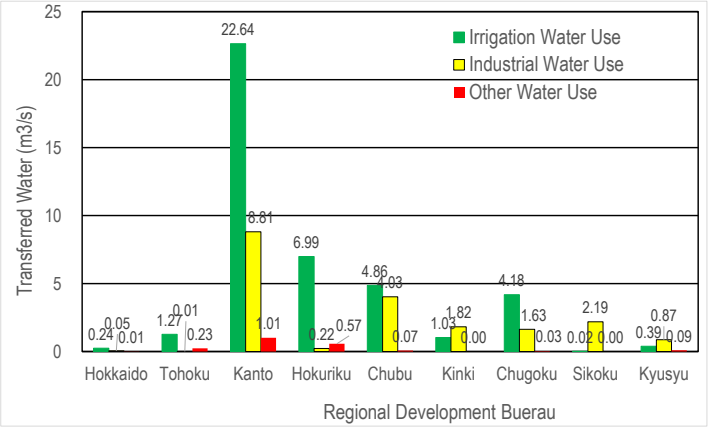
Source: The River Law Enforcement Ordinance at each prefecture

3.4 Transfer and Trade of Water Rights

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

(1) Transfer of Water Rights

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



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

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

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

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

Irrigation Water Rationalization Projects in Saitama Prefecture[10]

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

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

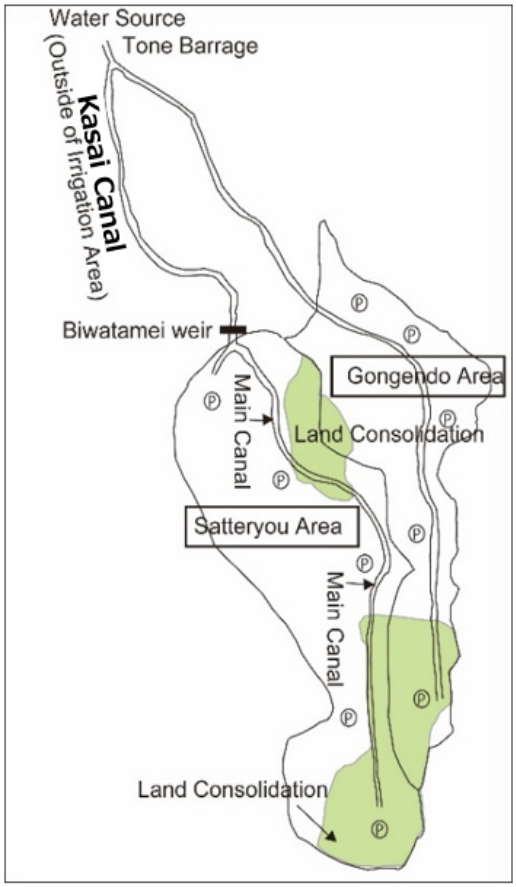
Table 3.2 Irrigation Water Rationalization Projects in Saitama Prefecture

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

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

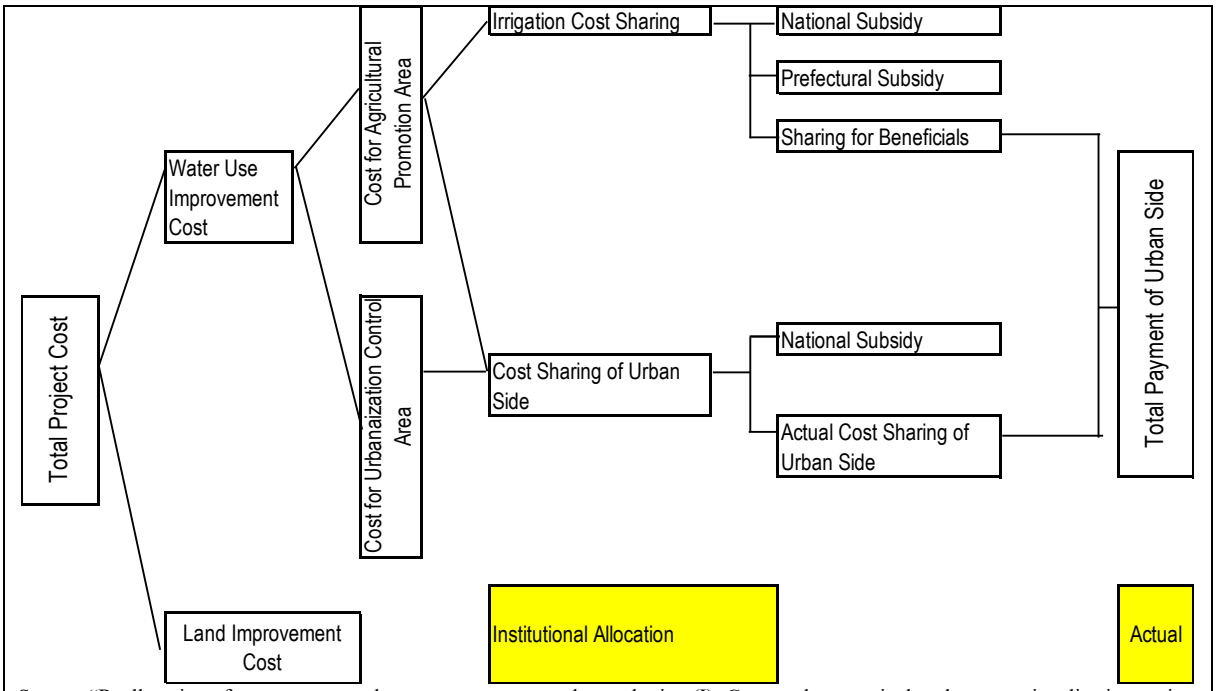
In order to generate excess water by renovating the irrigation facilities in the Gongendo-Satteryou area, the project installed a pumping station and pipelined the irrigation canal. MAFF subsidized this irrigation rationalization project. Part of the generated excess water can be transferred because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

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



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

Figure 3.7 Location Map of Second Rationalization Project



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

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

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

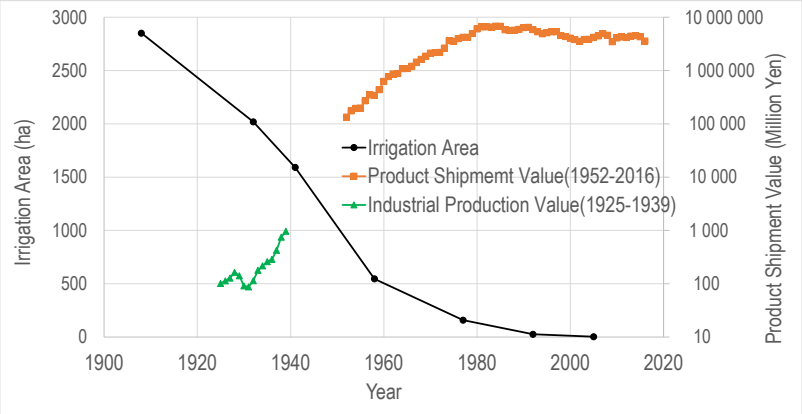
1) Developed as an Irrigation Canal

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

2) Used for Urban Use to Support Industrial Development

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

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



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

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

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

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

3) Nikaryou Canal Provides a Valuable Environment for the Community

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

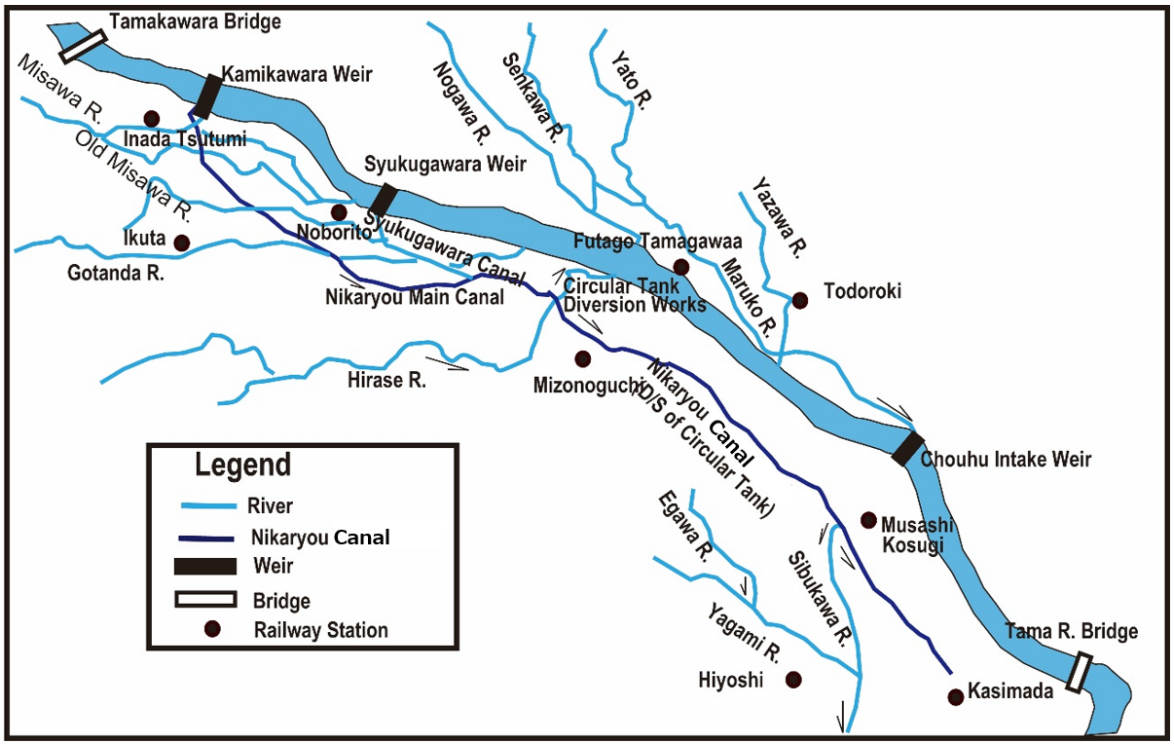
drainage for houses and factories. The water quality deteriorated to 20 ppm in BOD with dark color and bad odor.

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

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

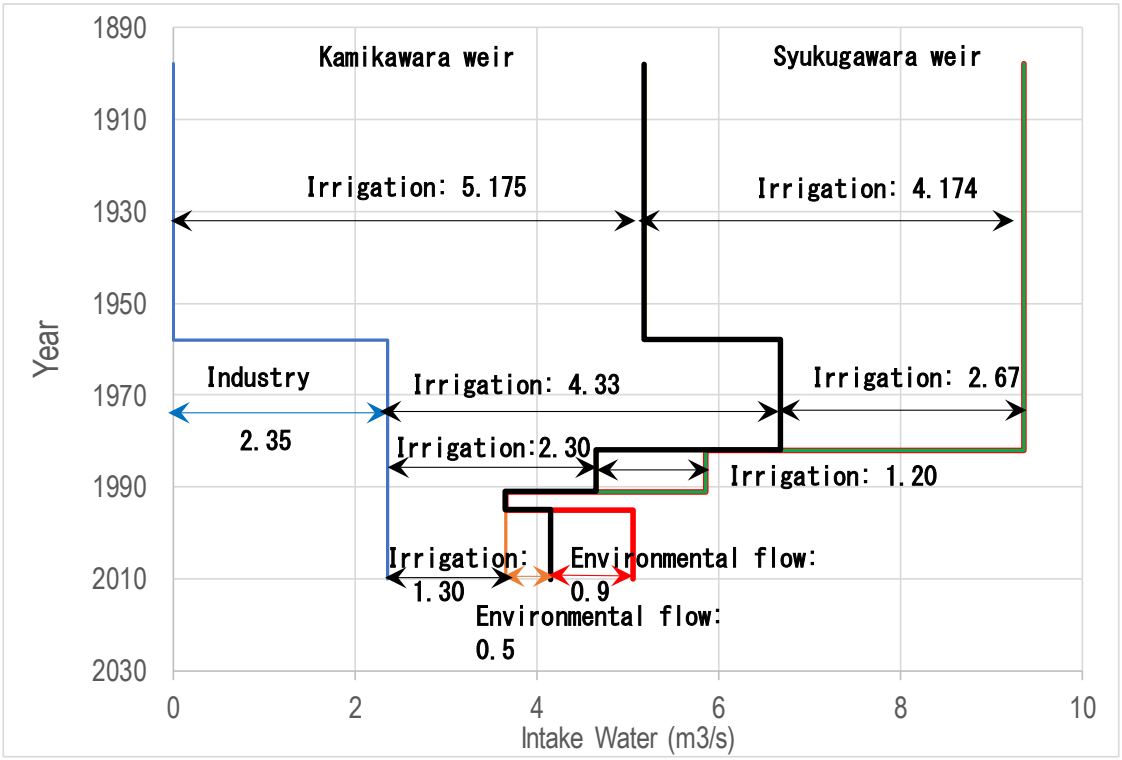
Figure 3.10 Cherry Blossom along the Nikaryou Canal

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



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

Figure 3.11 Location Map of Nikaryou Canal



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

Figure 3.12 Chronology of Water Right for Nikaryou Canal

4) Lessons Learned

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

(2) Trade of Water Rights

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

Table 3.3 Comparison of Water Markets in Each Country

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

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

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

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

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

4.1 Drought Coordinating Committee

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

4.2 Examples of Drought Adjustment

(1) Drought Adjustment in 1994[12]

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

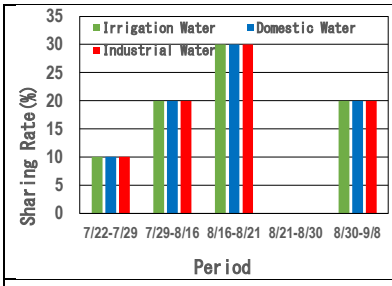
(a) All water users reduce intake water discharge at a constant rate

(b) There is a difference in the water-saving rate among water users, and the different rates remain almost constant as the drought becomes more severe.

(c) There is a difference in the water saving rate among users, and the different rates change depending on the drought stage.

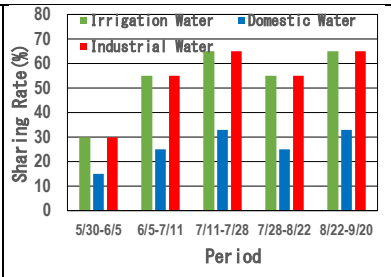
[11] It is common for river administrators to call the committee for basins with water storage facilities, such as dams.

[12] Source: "Agricultural Water Management during Abnormal Drought, especially the Actual Condition of Water Distribution-Case of Drought in Western Japan in 1994" Nakagiri Takao, Ando Taichi, Hirayama Syusaku, Ishikawa Sigeo, Mauyama Syoich, Journal of Japan Society of Hydrology and Water Resources Vol. 12, No. 3(1999) pp . 242-249



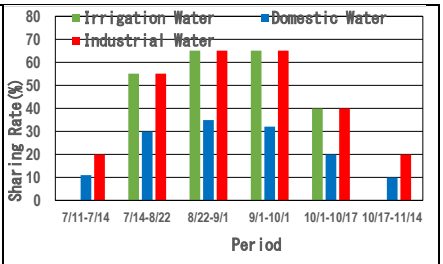
Constant rate of water saving

Dams in Tone River System



Fixing priority of water supply
1. Domestic water, 2. Irrigation and Industrial water with the same water saving rate

Yahagi Dam



Changing priority of water supply
First step: Priority to irrigation water
Next step: Prioritizing 1. domestic water, 2. irrigation and industrial water with the same water saving rate

Akigawa Dam

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

Figure 4.1 Examples of Water Saving Rate for Each Pattern

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

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

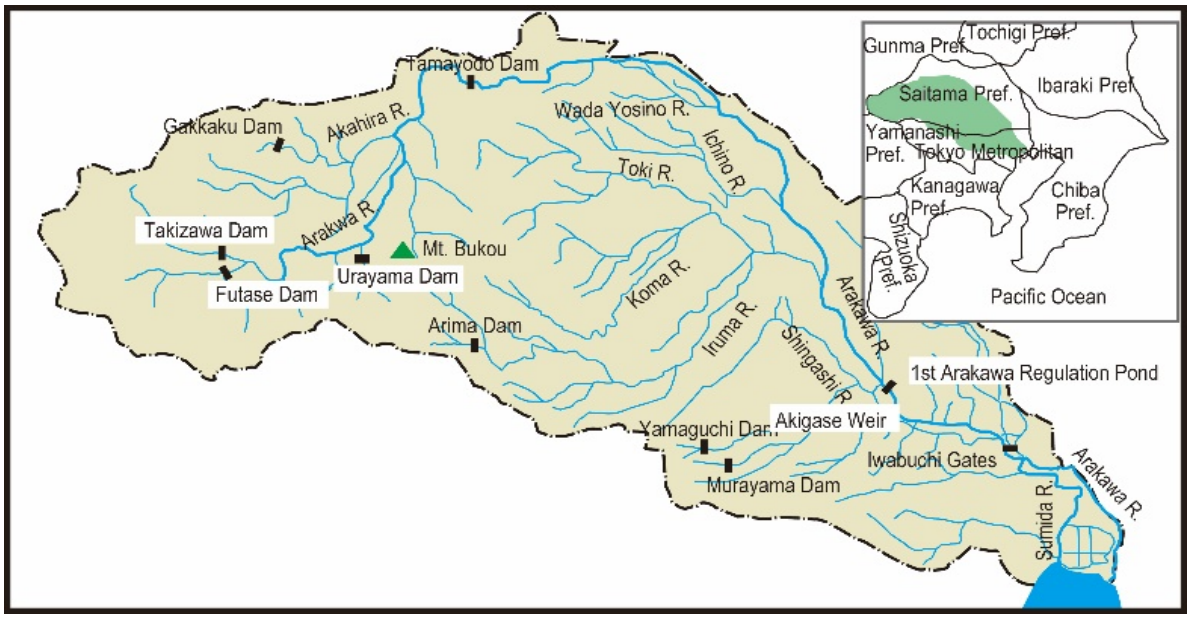
Drought Index	Content/ Degree of Drought	Countermeasures against Drought	Drought Damage	Affected District
1 (Minor)	・Normal water management	・Public relations of water saving	・None	・Isikari River system
2 (Impact: small)	・Adjustment of water supply and distribution throughout irrigation area.	・Adjustment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

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

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

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

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

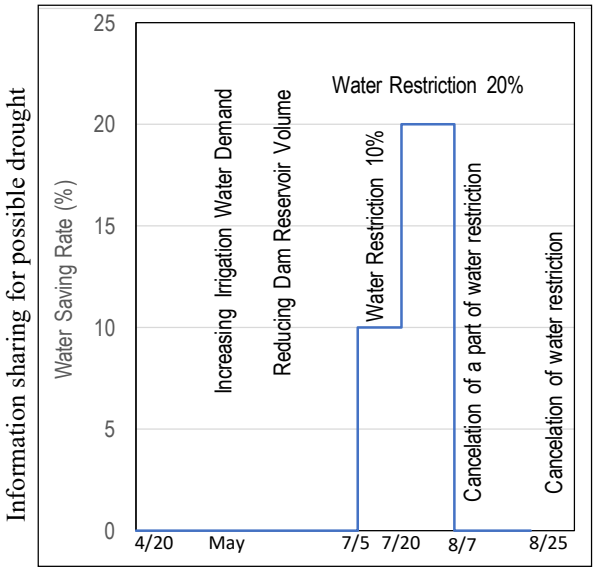


Source: Prepared from"Outline of Arakawa River Basin and Rivers," MLIT

Figure 4.2 Arakawa River Basin Map

1) Drought Adjustment

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

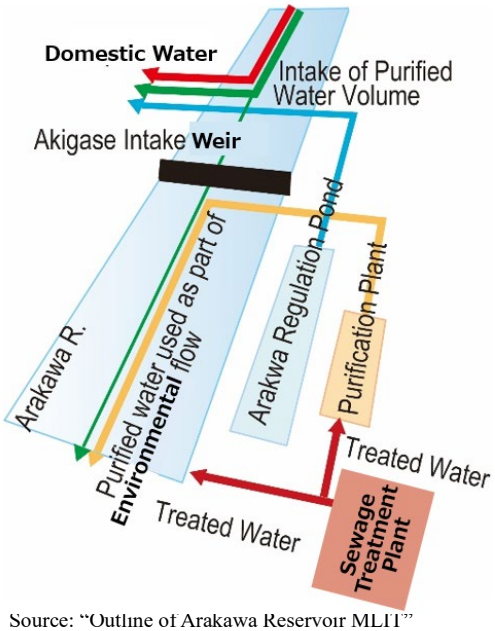


Source: Prepared based on "2017 Drought Summary: MLIT"

Figure 4.3 Status of Drought Adjustment

2) Countermeasure for Drought

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



Source: "Outline of Arakawa Reservoir MLIT"

Figure 4.4 Operation of Purification Facility

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

3) Extensive Public Relations to Promote Water Saving

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

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

Distribution of Dam Card[16](Drought Version)

PR of Saving Water with Posters (Dam Card)

Wakaba Station, Tobu Tojyo Line (Saitama Prefecture) (Arakawa River Basin)
PR by poster of "Water is in a pinch! Please cooperate in saving water"

PR to Saving Water in Cooperation with Transportation

"Please cooperate in saving water" is displayed on the Arakawabashi Dam discharge warning display board.

Water-saving PR by Information Bulletin Board

River patrol vehicle
Attach a magnet sheet such as "Please cooperate in saving water"

Water-saving PR by Public Car

(Tokorozawa City)
Banner of "Please cooperate in saving water"

Water-saving PR for Local Government Building Visitors and Passers-by

NHK "Ohayo Nippon"（Arakawa Futase Dam）

Explanation / Call When Appearing on TV

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

Figure 4.5　Various Public Relation Methods during Drought

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

CHAPTER 5 OPERATION AND MAINTENANCE OF IRRIGATION FACILITY

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

5.1 History of Irrigation Water Management

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

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

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

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

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

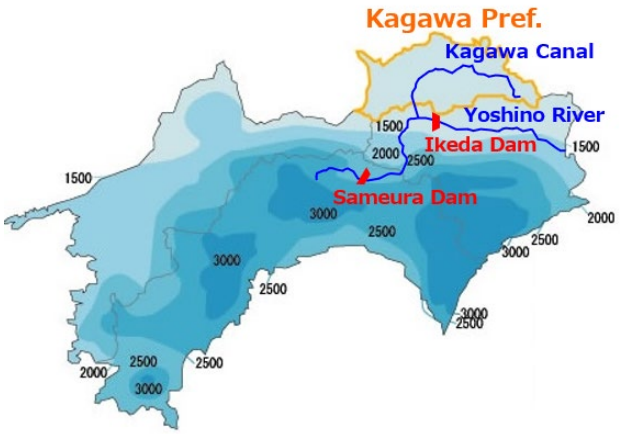
At irrigation facilities managed by the Japan Water Agency (JWA), farmers make water distribution rules and monitor operations, while the JWA operates facilities. Farmers are more satisfied if they

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

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

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

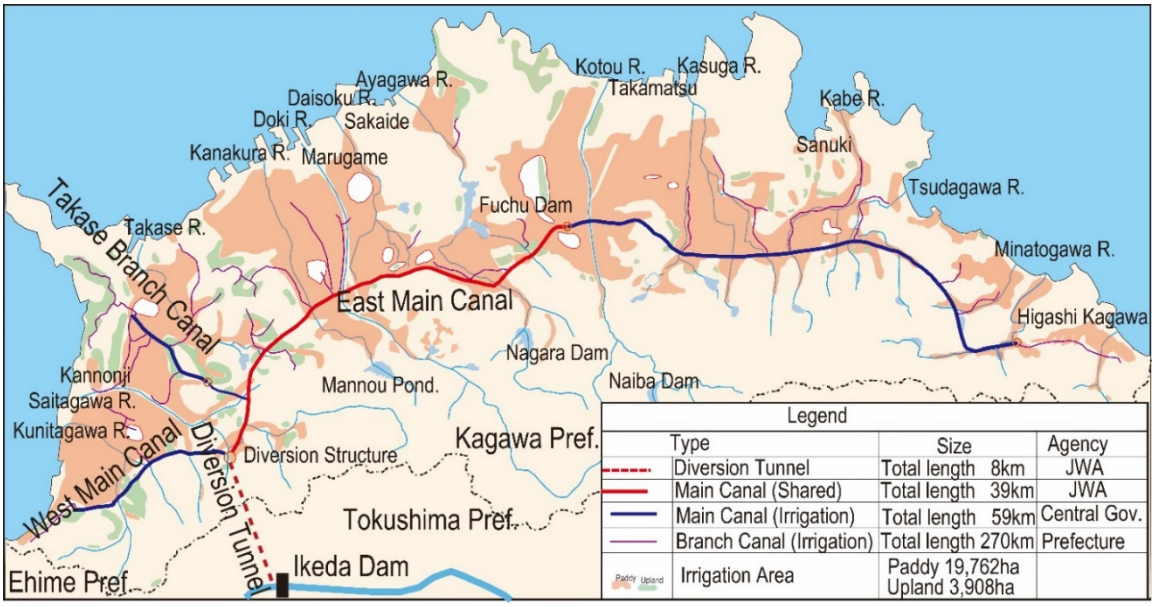
Kagawa Prefecture with little rainfall and no large rivers suffered from drought historically (Figure 5.1). Farmers tried to secure water from ponds, but could not solve the water shortage. As proposed in the Yoshino River Comprehensive Development Plan, the Sameura Dam (Kochi Prefecture), the Ikeda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



Source: MAFF, Chugoku-Shikoku Agricultural Administration Bureau

Figure 5.1 Isohyetograph in Shikoku

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



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

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

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

CHAPTER 6 LESSONS LEARNED

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

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

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

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

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

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

REFERENCES

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

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

Classification by Water Intake Scale

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

Source: Excerpt from the River Law Enforcement Ordinance