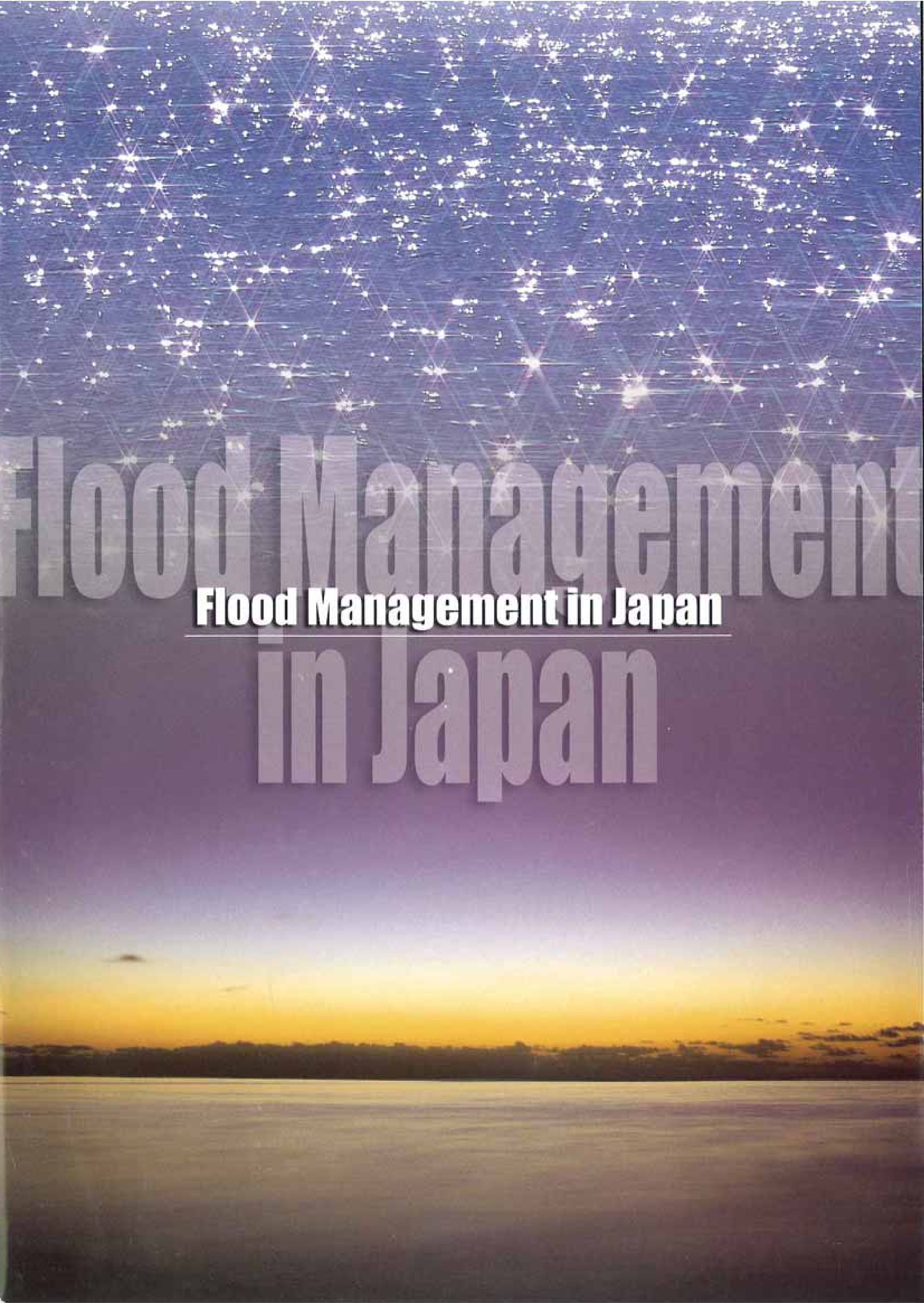
Flood Management in Japan



Flood Control in Japan

1. Natural and Social Characteristics of Japan

1.1 Natural Conditions

The islands of Japan are located between the latitudes of 20° 25' and 45° 30' in the northern hemisphere, an area known as Temperate Monsoon Asia. Seventy percent of Japan's land surface is covered by fairly steep mountains, many of which are volcanic. The landmass is geologically unstable.

Because of its location in Temperate Monsoon Asia, Japan in summer typically suffers from local downpours caused by baiu-zensen (seasonal rainfront) and typhoons, both of which are induced by southeast winds from the Pacific Ocean. In the Pacific coastal areas in particular, 50 to 60% of annual precipitation is concentrated in summer. In winter, northwestern winds blowing from the Asian continent make the coastal areas by the Sea of Japan some of the most snowed regions of the world.

Rivers are greatly affected by the topography and climate described above, and they exhibit the following characteristics as compared with other areas of the world, such as Europe.

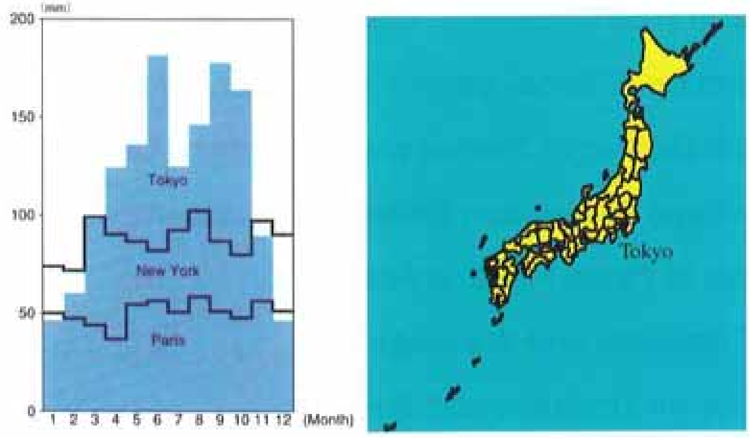


Figure 1.1 Monthly Precipitation in Tokyo, Paris, and New York

○Steep-sloped

Many of Japan's rivers have their sources in steep-sloped mountains and flow quickly over the short distances from their headwaters to the sea.

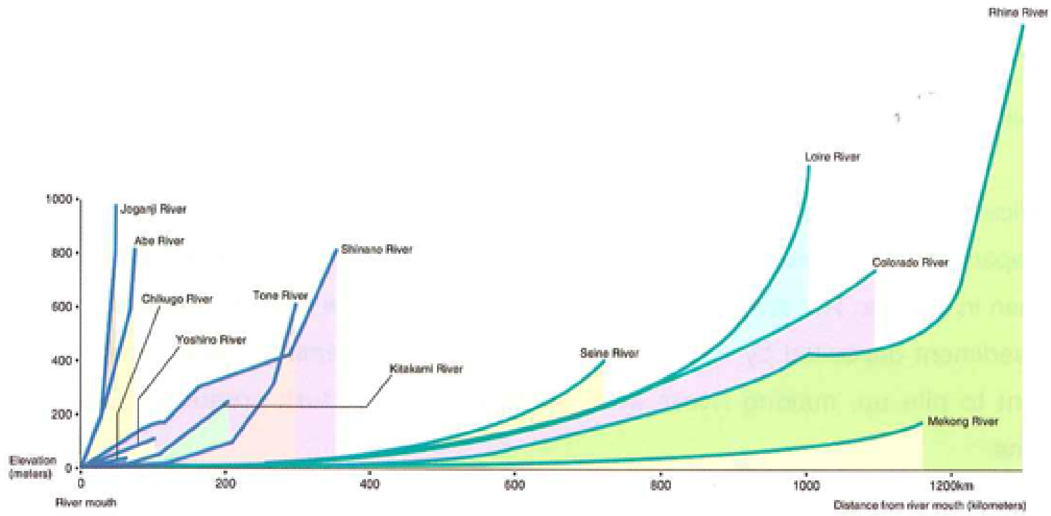


Figure 1.2 Comparison of Steepness of River Courses (Cross-Section)

○Faster rise of water levels

Japanese rivers have much smaller catchment areas compared to major European rivers. Even Japan's largest river basin, the Tone River Basin is at 16,840 km², which is only one-fifth the size of that of the Seine. Heavy local rains often cause water levels to rise rapidly in rivers with small catchment areas, as such extreme rainfalls can cover a river's entire basin. In fact, once rain falls, water levels can rise at rates of approx 20 centimeters per hour or higher.

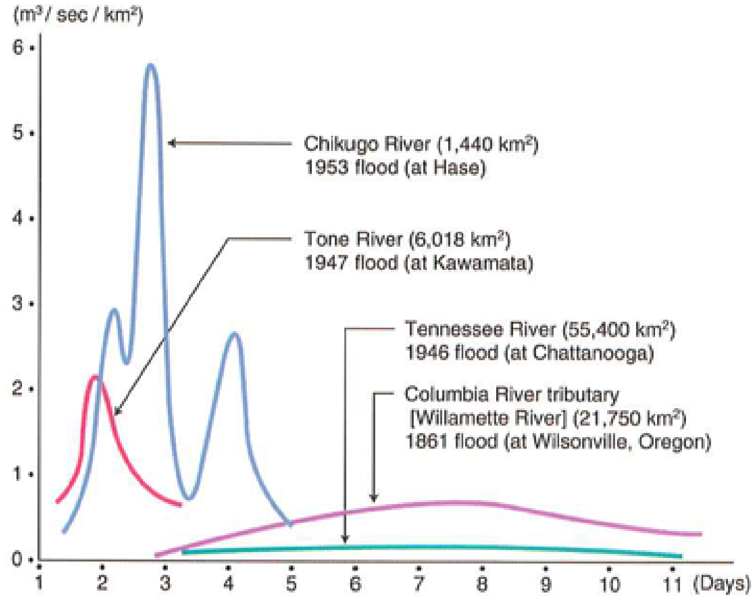


Figure 1.3 Characteristics of Floods in Japan

○Great variations in flow volumes throughout the year

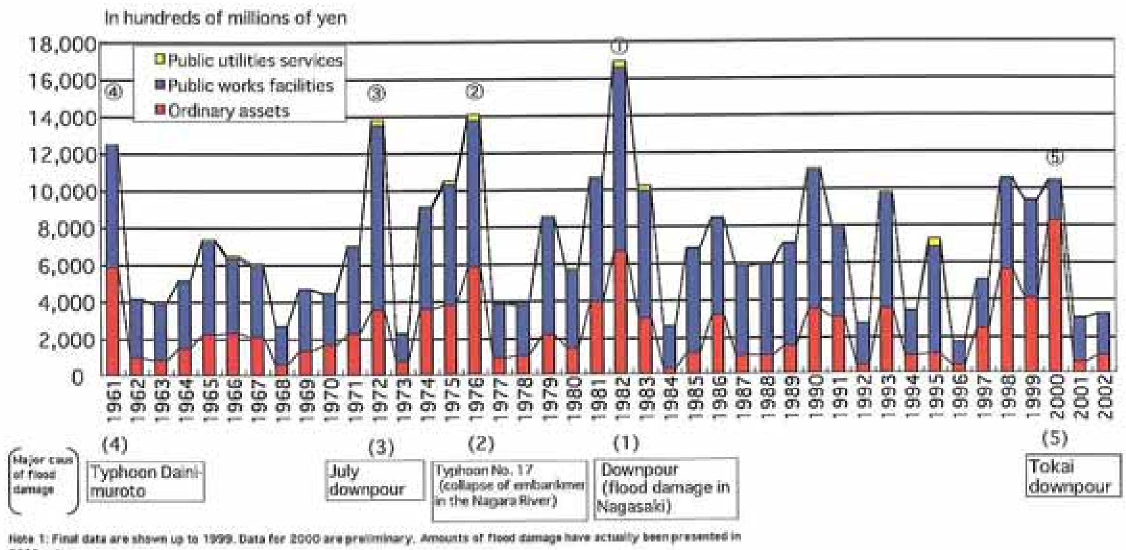
Japan's steep-sloped rivers with small catchment areas experience quick rises in water levels following heavy rainfalls but also go dry quickly during dry periods.

○Significant impact of soil influx

Since Japanese rivers flow swiftly and the soil is often loose, more sediment is carried into rivers than in Europe. The alluvial plains where many people now live were originally formed by the sediment deposited by rivers. Containing rivers within embankments soon causes sediment to pile up, making rivers even shallower, and in turn creating flood-prone conditions.

1.2 Social Conditions

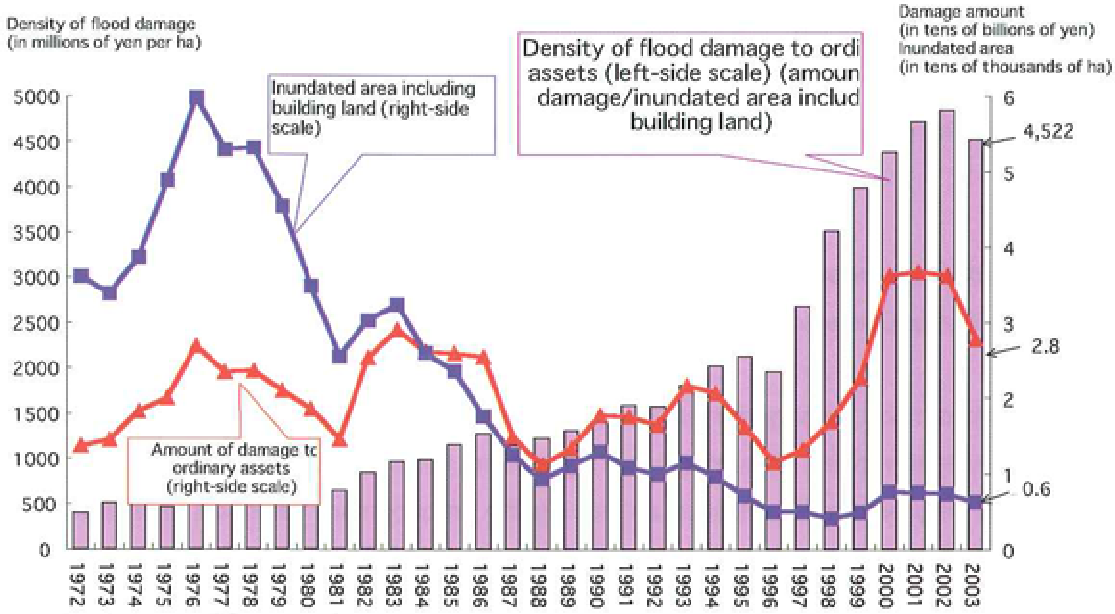
Due to the natural conditions described above, 50% of the nation's total population and 75% of its total physical assets are concentrated on the alluvial plains that account for only 10% of Japan's total land area. One single flood could therefore cause serious damage.



Note 1: Final data are shown up to 1999. Data for 2000 are preliminary. Amounts of flood damage have actually been presented in 2000 price.
Note 2: No investigations were made of the damage to public utilities services in 1961.
Note 3: Figures in the parentheses indicate the ranks in total flood damage amount (top five in the descending order). Encircled figures indicate the ranks in the amount of flood damage to ordinary assets (top five in the descending order).
Note 4: Average in the period between 1961 and 1999: 714.3 billion yen (ordinary assets: 23.1 billion yen, public works facilities: 47.2 billion yen, public utilities services: 11.3 billion yen)

Figure 1.4 Flood Damage to Physical Assets

In fact, every year, [the heavy rains during] the rainy season and typhoon-induced local downpours cause flood damage. In 2000, a heavy rainfall led to serious damage in the Tokai district centering around Nagoya; damage to houses and office buildings was noticeable and accounted for a significant share of the total loss. Although flood management projects over the years have reduced the areas suffering from inundations, the concentration of physical assets in the floodplains has increased their value per unit area. As a result, the amount of damage has hardly decreased.



Note 1: Amounts of damage to ordinary assets and densities of flood damage reflect losses due to suspension of oper
Note 2: The figure for each year is the mean value in the past six years including that particular
Note 3: Method for calculating the damage amount was partly modified in 1998.

Figure 1.5 Flood Damage to Physical Assets Per Unit Area

2. History of Flood Management in Japan

2.1 History of Flood Management in Japan

The above account described recent flood damage conditions, but since early times the Japanese have endeavored to overcome the adverse forces of nature by engaging diligently in flood management work.

1) Flood Management through Protection of Surrounding Areas (1850s or prior)

Japan's oldest recorded flood management project dates back to around the third century, when the Manda Levee was built on the Yodo River.

In those times, flood management methods consisted mainly of localized disaster prevention in areas along the rivers. To protect local agricultural fields and villages from flood damage, the people employed methods such as varying the embankment height on each side of the river and up and downstream, taking into consideration the priority of affected areas as well as topography and other natural characteristics.

Embankments were installed near villages instead of immediately beside the river to prevent floodwater from entering the villages. Efforts were made to diminish the force of floodwater through measures such as the creation of flood control forest belts in zones designated in advance to receive floodwater overflow. In areas subject to frequent flood damage, local residents took charge of flood management themselves by building structures with elevated floors, constructing raised mounds, and keeping evacuation boats available for emergencies.

As political power became more centralized, flood management projects figured among the most important state endeavors for administrators, not only to stabilize civil administration, but also to build up power and resources by developing new agricultural lands in flood-prone lowlands. It was believed that "he who rules the rivers rules the nation." Large-scale flood management projects began to appear in some areas, especially from the Warring States Period (late 15th-16th centuries) onward.

2) River Transportation and Low-water River Works (1860s to 1890s)

Following the Meiji Restoration in1868, the authorities encouraged the development of new industries with the aim of establishing a modern state. Because inland mass transportation of goods was heavily dependent on water transportation, rivers served as the principal economic arteries. In those times river improvement was synonymous with economic policy. In 1880, the national government implemented low-water river works in the Yodo River to accommodate water transportation. High-water works, meanwhile, were carried out mainly by local administrative agencies for flood protection, and were focused on the locality.

Nevertheless, frequent flood damage from large rivers such as the Yodo, Tone and Kiso Rivers in the 1870s and 1880s highlighted the need for radical flood management measures. This coincided with the development of railway networks, leading to a decline in river transportation and a correspondingly diminished need for low-water river works to facilitate water transportation.

Spur dike in Kitakami river

Water transportation in Kitakami River

3) Flood Management Efforts Led by the National Government (1900s to 1930s)

The River Law was established in 1896, and the Sediment Control Law and Forest Law were enacted the following year in 1897, laying the foundations for modern flood management. This River Law provided the basic principles of river administration in Japan up to the time of its amendment in 1964.

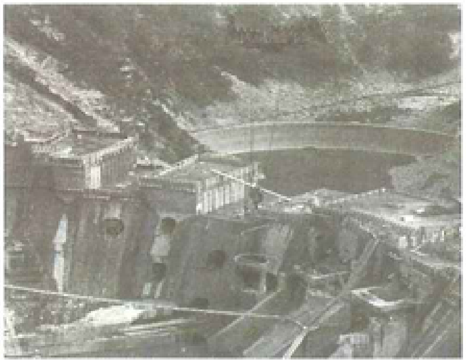
According to the River Law, rivers were considered national structures which local administrative agencies, as national institutions, were to take charge of managing. For those rivers that were considered significant to public interest, the law also eliminated private rights to river use, riverside lots, and river water. As in the past, this law held local administrative agencies primarily responsible for river works and maintenance. The national government, however, was to be directly responsible for certain types of projects, including river works affecting more than one prefecture; difficult projects requiring sophisticated technology; projects costing more than local governments could afford; and systematic improvement work based on a specific master plan.

Subsequently the flood damage that occurred on a national scale in 1910 prompted a study aimed at formulating the first national flood management plan, with deliberations concerning the selection of rivers for which improvements should be undertaken as national projects, the order of priority, time periods and costs. Based on this study, the government began to undertake flood management works with financial backing.

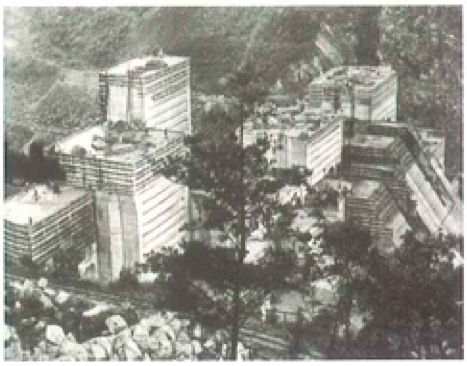
4) Infrastructure Development for Economic Growth (1940s to 1950s)

There was little progress in flood management work during the World War II. In the two decades after the war, a succession of large-scale typhoons such as Typhoon Catherine attacked areas of Japan already devastated by war, causing enormous damage. In the wake of Typhoon Ise Bay in 1959, the "Erosion and Flood Control Emergency Measures Law" and the "Flood Control Special Account Law" were passed in 1960, instituting legislation-based long-term flood management programs (ten-year or five-year plans) for the first time.

Meanwhile, economic development was leading to a rapidly growing demand for industrial and municipal water supplies. To meet these needs, water resource was developed through the construction of multipurpose dams designed for both flood management and water utilization. The construction and maintenance of these dams were integrated into the responsibility of river administrators.



Yuda dam in Kitakami River



Tase dam in Kitakami River

As a result of socio-economic development and reforms to administrative systems since the late 1950s, the River Law underwent a full revision in 1964. The reasons cited for this were as follows:

- With the establishment of the current constitution the nation's administrative system has undergone large-scale reform, making it necessary to review the existing system of fragmented river management by prefectural governors based on administrative districts
- The state of river basin development and the increased demand for various types of water use accompanying socio-economic development have heightened the need for integrated management of all river systems in place of the existing segmented river management systems.
- The progress of water use projects has necessitated improvements in regulations related to water use in order to coordinate new water use with existing water use.
- Progress in construction technology has led to the construction of numerous large-scale dams, thus necessitating regulations to prevent disasters from dam operations and so on.

Consequently, it became mandatory for river administrators to establish a "Master Plan for Project Implementation", and a dramatic shift took place from the conventional river-segment management to integrated management of river systems from the uppermost to the lowest reaches.

5) River Improvement to Meet the Needs of Rapid Urbanization (1960s)

Around the time that the new River Law was enacted, the onset of the high economic growth period gave rise to rapid development of cities and industries. At the same time, this drastic urbanization caused various river related problems, such as pollution of rivers and lakes, frequent urban flood damage due to delays in flood management measures, serious water shortages including the drought in 1964 when the Olympic Games were held in Japan, and a sharp increase in debris flow disasters.

To deal with these problems, measures to control river water pollution were promoted along with the gradual introduction of comprehensive flood management measures such as rainwater collection and permeation measures in conjunction with river improvement; improved warning and evacuation systems in conjunction with debris flow disaster prevention; and construction of dams to control droughts. "Excessive flood management measures" such as super-levees have also been introduced to prevent catastrophic damage in urban areas where assets and critical business functions are concentrated, as conventional embankments may fail in the event of large-scale flooding exceeding design flow levels.

In addition to measures related to flood management and water use, there are now many projects aimed at creating a better river environment by improving river water quality, protecting wildlife habitats and offering better public access to rivers. Examples of these are the development of water conveyance channels and natural variability-simulated river works.

The 1997 amendment to the River Law saw the addition of "improvement and preservation of river environment" as one of the objectives of the law.

The next chapter describes the role played by flood management projects, using typical examples from the Tokyo Metropolitan area.

2.2 Flood Management Projects in Tokyo Metropolitan Area

1) Eastward Relocation of Tone River (Metropolitan Flood Management Project Started at the End of the 16th Century)

(1) Outline of Eastward Relocation Project

In pre-modern times, the Tone River did not belong to the same river system as the Kinu and Kokai Rivers, but flowed in several branches over the Saitama Plains towards Tokyo Bay. After Tokugawa Ieyasu moved the government to Edo (now Tokyo) in 1590, several projects were carried out during the first 60 years of the Edo Era mainly by Ina, the governor of the Kanto region, to re-route the Tone River. This resulted in the present structure of the Tone River, which now flows into the Pacific Ocean.

The work of moving the Tone River eastward was mostly concentrated in the 60 years of river improvement that took place between the "Closing of the Kai River" in 1594 and the opening of the Akahori River in 1654.

Figure 2.1 Eastward Relocation of Tone River

There are several theories concerning the purpose of the eastward relocation of the Tone River, including "protecting Edo from floods", "developing new agricultural fields", "securing shipping channels", "military defense against the Date clan" and "road improvements." In any case, Edo could not have continued to exist without this river improvement work; and the Tone River eastward relocation project, begun more than 400 years ago, became the foundation of large-scale urban development that led to the subsequent growth of Tokyo.

(2) Effects of the Eastward Relocation on the Development of New Agricultural Lands

Moving the Tone River to the east served to integrate the courses of the Tone, Ara and other rivers that formerly had flowed turbulently over the lowlands of eastern Saitama Prefecture. The resulting improvement in drainage of marshy lands made possible the emergence of a large grain belt in the Tone River basin.

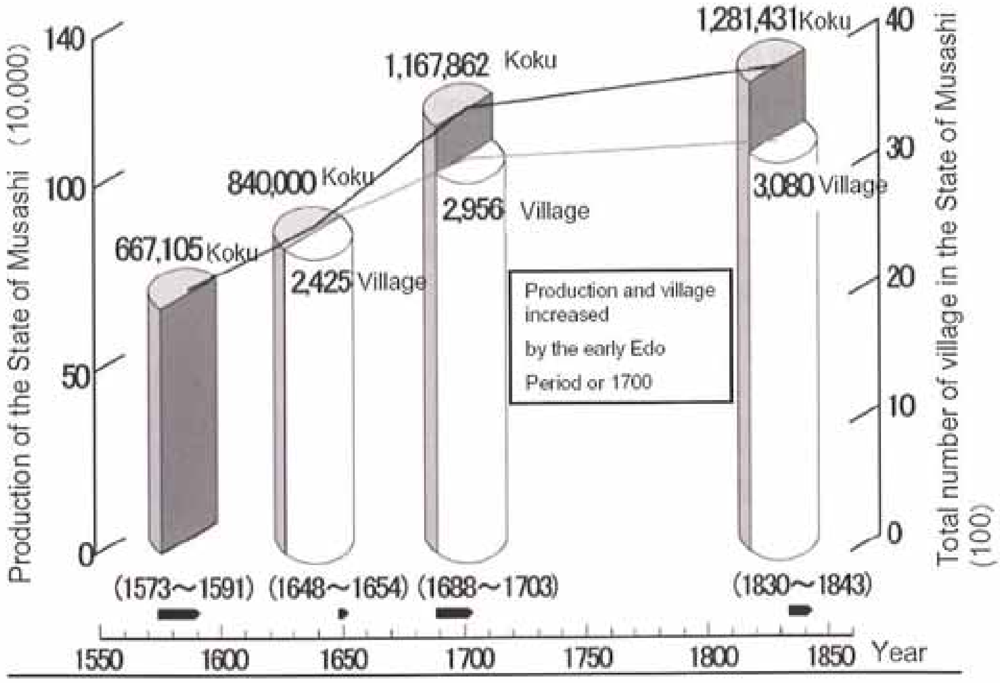


Figure 2.2 Changes in Crop Yields and Number of Villages in Musashi Province

The development of new agricultural lands increased not only crop yields but also the numbers of people and villages. The area most affected by the eastern relocation was Musashi Province, consisting of the counties of Katsushika, Saitama and Adachi. In the 100-year period beginning in 1550, this region saw a 200 percent increase in rice paddy yields, with a corresponding increase in the number of rural communities.

2) The Ara River Floodway Project (a Modern Flood Management Project Begun at the End of the 19th Century)

Flood damage that had occurred approximately once every three years since the time of the Meiji Restoration became more serious with the urbanization of Tokyo. The new Meiji Era government implemented a national policy to establish clusters of cement, shipbuilding and chemical fertilizer plants near the mouth of the Sumida River. Through the Sino-Japanese and Russo-Japanese wars the Joto district of Tokyo which was well-situated for water transport, saw its industrial area expand. In the early 1900s, thanks to the construction of the Nihon and Sumida Embankments, factories were also built all along the middle basin of the Sumida River, which until then had been only a retarding basin.

Spurred by the great flood of 1910, and in view of the need to build a port for Tokyo, construction of the Ara River floodway was begun as a critical measure to protect the downtown area of Tokyo from flood damage. The huge project to excavate the floodway, which was 22 km long and 500 m wide, was completed in 1930, 20 years after the work was begun. At the completion of the project Tokyo's economic strength surpassed that of Osaka, which till then had been the center of the Japanese economy, and the resulting growth has continued to the present day.

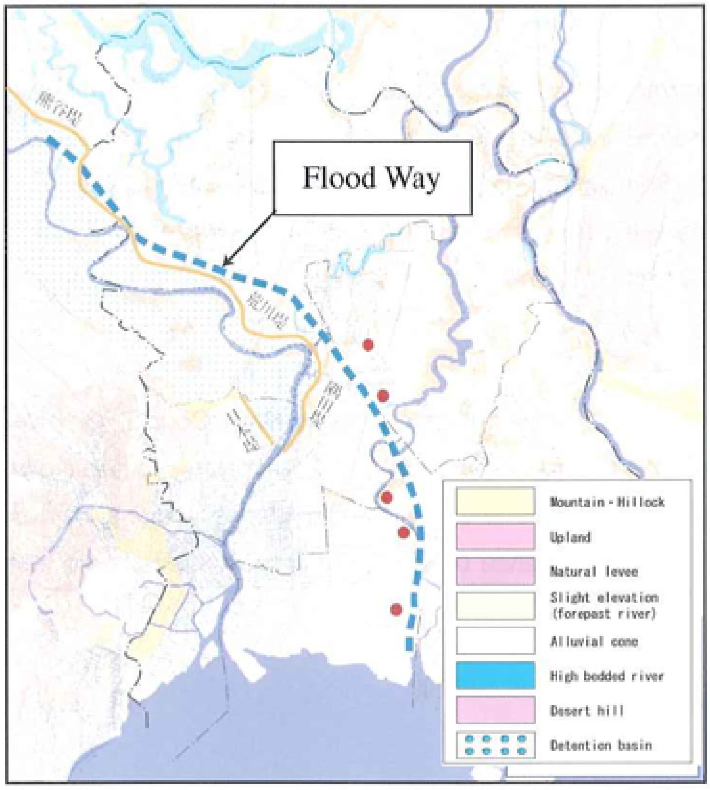


Figure 2.3 Construction of the Ara River Floodway

3. The River Law

3.1 The Formulation and History of the River Law

The modern river policies of Japan have a history of approximately 100 years, dating back to the enactment of the old River Law in 1896. The law has been revised several times up to the present to reflect changing socio-economic conditions.

Particularly noteworthy is the 1964 amendment, which established a systematic framework for "flood management" and "water use," including the introduction of an integrated system of river system management. The 1964 amendment also instituted a planning system for rivers which required river administrators to draw up a "Master Plan for Project Implementation" for each river system, in order to promote consistent and systematic improvements.

Although the Master Plan was to be drafted in consultation with the River Council, the river administrators were basically expected to formulate the plans according to their own discretion. Moreover, the plans were not required to contain detailed specifications for river improvements and thus provided no concrete sense of what river development should look like.

3.2 Amendment of the River Law

Due to subsequent socio-economic changes, the river situation has changed dramatically in recent years. Today, rivers are considered not only in terms of "flood management" and "water use", but are perceived as pleasant waterfront spaces for people to enjoy, as well as habitats for a wide range of wildlife. Because rivers are an important component of regional climate, landscape and culture, there is also a strong demand for river development that makes the most of the characteristics of each river.

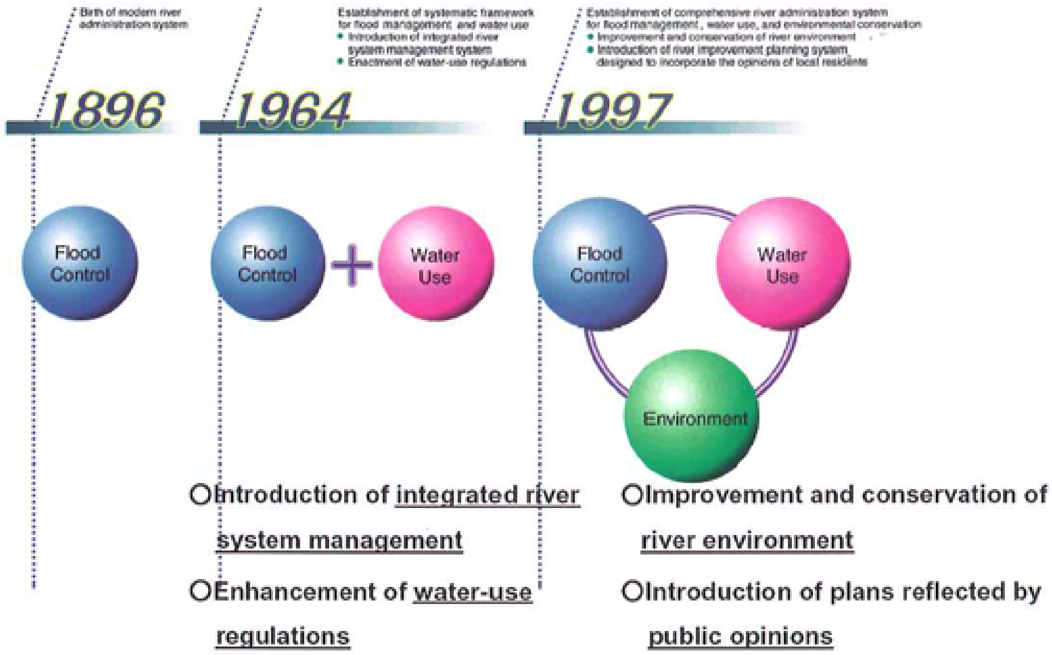


Figure 3.1 Changes in the River Law

Against this background the River Law was amended in 1997, incorporating the following items that reflect the consideration for river environment and the relationship between rivers and local residents.

○Improvement and preservation of river environment

Before the 1997 amendment, the River Law focused mainly on "flood management" and "water use"; i.e. its stated goals were "to prevent the occurrence of disasters due to flooding and storm surges, and to utilize rivers appropriately [......]. "

The 1997 amendment explicitly specifies the "improvement and preservation of river environment" as one of the objectives of the law, thus adding "river environment" to the original river management objectives of "flood management" and "water use." This applies not only to the natural environment of the river, but also to the living environment of people in relationship to the river. River management is therefore required to take an integrated approach that balances "flood management, "water use" and "river environment."

○Revising the river improvement planning system

The original Master Plan for Project Implementation is now divided into two parts: the Basic Policy for River Improvement which determines long-term policies regarding river improvement; and the River Improvement Plan dealing with the specifics of river improvements during the next 20 to 30 years. The latter includes more details than the Master Plan for Project Implementation in regard to river works and maintenance, in order to provide a concrete image of what river development should be. It also introduces procedures for incorporating the community opinions such as those from the local governments and residents in the planning.

○River development that reflects the views of community

The Basic Policy for River Improvement provides the long-term direction of improvements to river systems as a whole for river administrators to follow, including river works and maintenance, while ensuring balance on a national scale. It also specifies the fundamental parameters of river improvement, such as design flood discharge, its distribution between river channels and flood management facilities, and design high water discharge. The River Improvement Plan, covering all aspects of river improvement from river works to maintenance for a designated period of 20 to 30 years, is applicable to those sections of rivers that are subject to systematic improvement under the Basic Policy for River Improvement, with provisions for taking into consideration the feedback of local governments and residents.

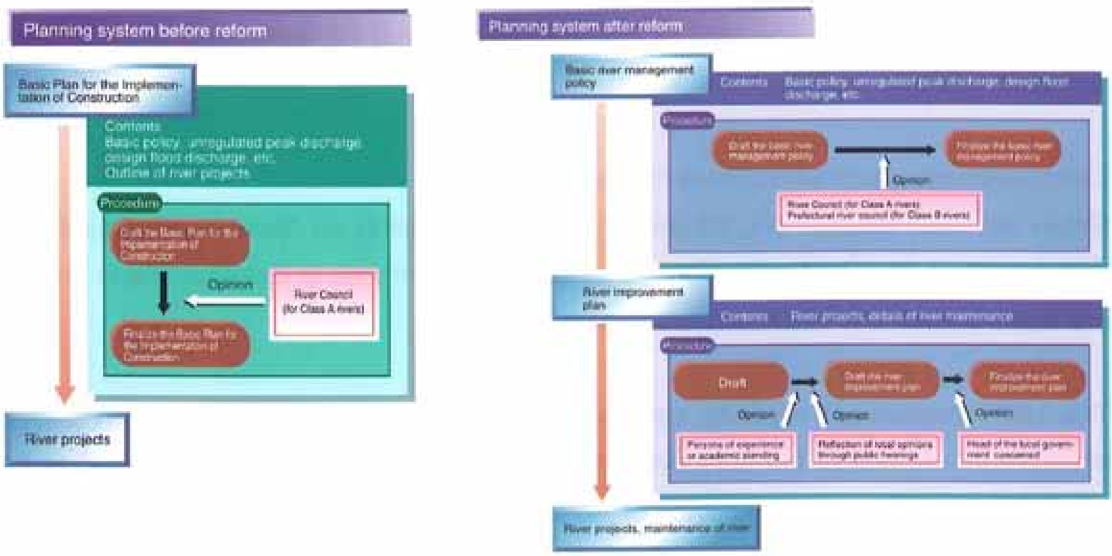


Figure 3.2 Comparison between the New and Old Planning Systems

Concerning the planning process, the 1997 amendment stipulates that "when drafting a river improvement plan, persons with academic standing and field experience concerning rivers must be consulted if deemed necessary," and "all necessary measures, such as organizing public hearings, must be taken to reflect the opinions of the local residents." In other words, it is a key feature of this revision that the input of local residents are to be sought right from the planning stages in order to reflect the wishes of the community in the river management. A wide variety of methods are employed for this purpose, including holding public hearings and information sessions, announcement and public inspections for inviting the submission of written comments, distribution of brochures, and the use of the Internet, in accordance with the specific plans on the table and/or local situations.

It should be noted that the river administrators are duty-bound to "take the necessary measures to reflect the opinions of the local residents," but are not necessarily obligated to alter the particulars of the plans based on these opinions. River administrators are expected to use their own judgment after the careful consideration of the comments from affected residents.

4. Flood Management Works in Japan

4.1 Major Flood Management Programs in Japan

Japan has a wide range of water facilities and control systems in place in order to protect her people from floods. Flood management projects have included the development of embankments, retardation basins, floodways, and other specialty projects across Japan for the protection of human life and property from water hazards.

[Widening of river channels and construction of embankments]

To limit the rise in a river's water level by enlarging its cross section and to prevent overflow during a flood by constructing embankments.

[Drainage basins]

To temporarily store overflow from the river during a flood and return it after the risk of flooding is eliminated. This will prevent the downstream water levels from rising.

[Floodways]

Artificial water channels are constructed to lead midstream or downstream water to another river or the ocean in order to decrease the water flow rate.

[Pumping stations]

Pumps are used to drain rainwater into the river in areas where the water level in the river is higher than the ground.

[Dredging]

To lower the water level in a river by dredging the river bottom.

[Shortcuts]

To shorten the length of a river channel by straightening bends so that floodwater will pass through rapidly.

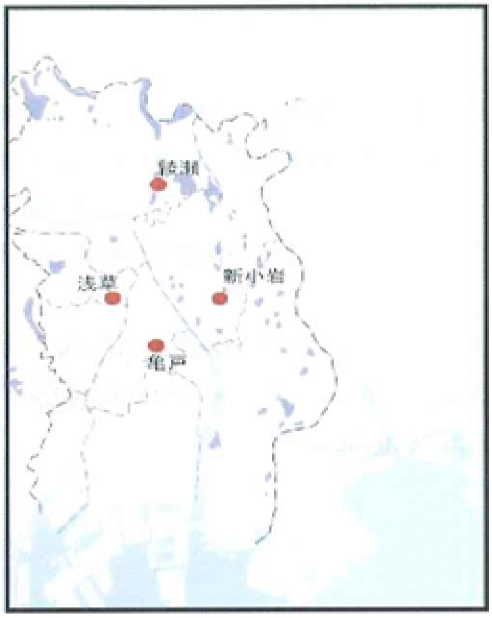
[Dams]

To control water flow from upstream at the time of a flood by building a dam or dams so that the flow rate downstream is reduced.

○Benefits from these programs

The Arakawa River, which flows through Metropolitan Tokyo, has benefited from a number of projects since World War II, including one against storm surges and another for discharge channels. These certainly have decreased the incidence of home inundations. The 1947 flood was the largest after the war in the extent of damage; yet in the 1982 flood, when the total precipitation recorded was approximately twice that during the 1947 flood, the area affected by flooding was far smaller. Further, the peak water level in the 1999 flood, which had a rainfall pattern similar to that of the 1947 flood, was nearly 2 m below that of 1947.

1947 Flood(Catherine Typhoon Total Rainfall:166.8mm



1982 Typhoon No18Total Rainfall:313.0mm

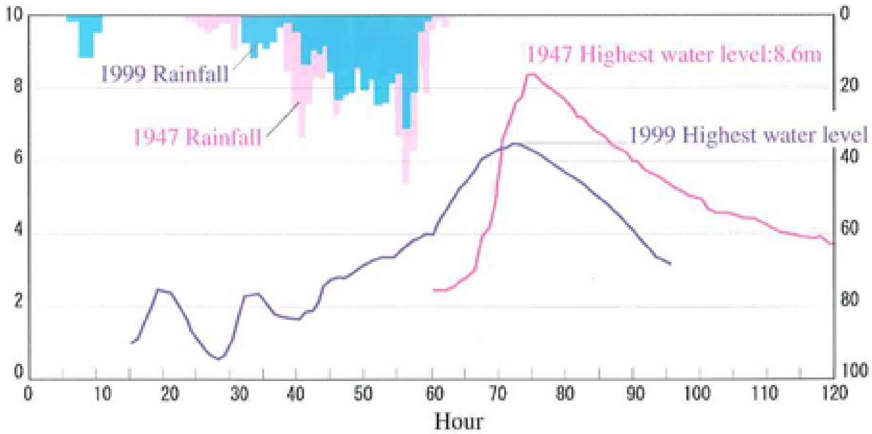


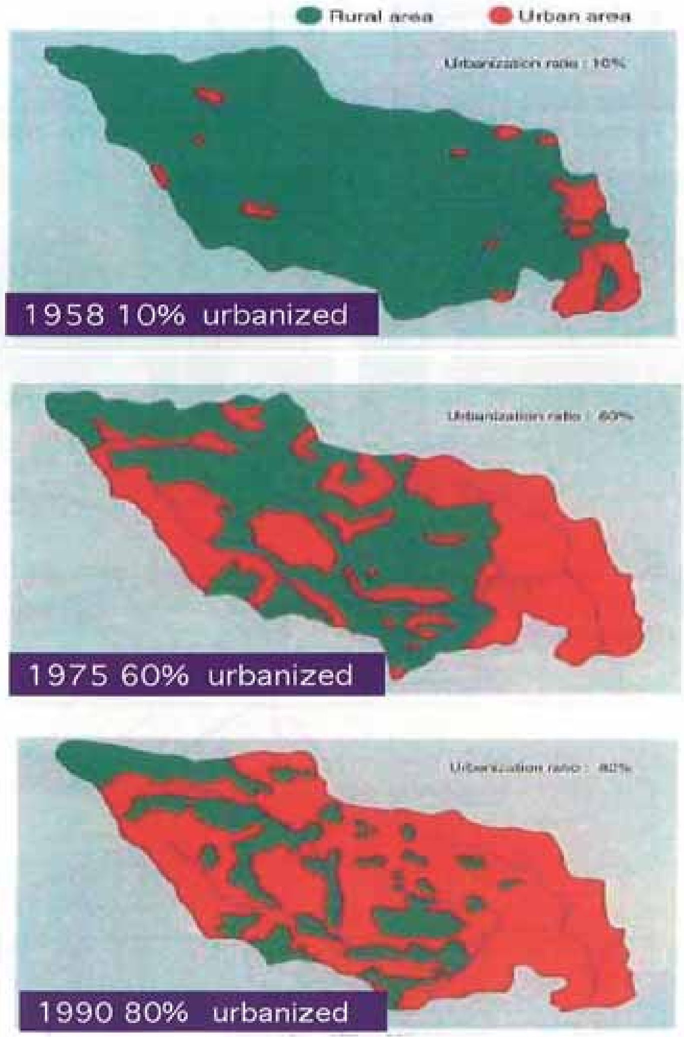
Figure 4.1 Comparison of 1947, 1982, and 1999 Floods

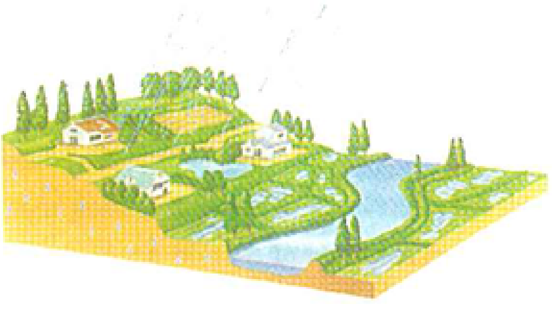
4.2 Flood Management Measures in Urban Areas

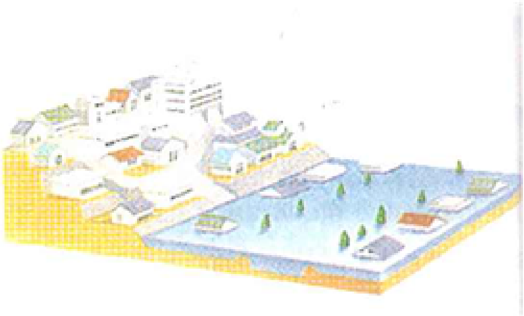
1) Urbanization and Flood Damage

Urbanization is progressing rapidly, especially in the Metropolitan Tokyo area. For instance, in 1990 only 20% of the Tsurumi Basin in Kanagawa Prefecture remained as forest or agricultural land, a huge drop from 90% in 1958.

Once the ground is covered with concrete or asphalt, rainwater no longer permeates into the ground. That is why the rainwater pours into rivers and low-lying areas during a heavy rain, increasing flood risk.







[Before development]
Most of the stormwater infiltrates into the ground or is retained on the ground surface. As a result, runoff downstream is reduced.

[After development]
Concrete, asphalt, the loss of forest, vegetation increase runoff downstream and aggravate flood damage in low-lying areas.

2) Overview of Comprehensive Flood Management Measures

In June 1977, the River Council published the Interim Report on the Facilitation of Comprehensive Flood Management Measures as a response to the increase in volume and faster pace of surface water runoff due to rapid urbanization.

The report assumed that urban floods are caused by the fact that the construction and upgrading of flood management facilities lag behind the increase in runoff that results from the accelerated buildup of cities. As a solution, it believed that the upgrading of rivers through improved flood management facilities was important. Also important were measures to improve river basins for the purpose of maintaining their water retention and drainage capacities, and damage mitigation measures by which any substantial damage will be prevented even if water penetrates buildings. The report proposed to employ these approaches as the three pillars of a future flood management policy.

In FY1977, the Ministry of Construction organized an internal Comprehensive Flood Management Council among six of its relevant bureaus, including the Secretariat, to discuss specific policies for comprehensive flood management measures. In FY1978, preparatory groups were created for six rivers, including the Tsurumi River, for the purpose of establishing comprehensive flood management councils for the respective river basin. The preparatory groups studied the basic philosophy for the comprehensive flood management measures, including issues in river basin improvement planning. Following these, Notice of the Director-General of the River Bureau and Notice of the Administrative Vice-Minister were issued to create the Comprehensive Flood Management Measures.

The Comprehensive Flood Management Measures are applicable to those rivers that are located in one of the top three urban centers or one of the major regional centers that meet the following criteria: their basin areas cover 30 to 1,000 square kilometers; their main sections have not yet been upgraded to accommodate a rainfall of 50 mm per hour; the developed portions of their areas that have been designated for urbanization or promotion thereof account for 20% or less of the basin area, which is most likely to the further developed; and the population of their basin is at least twice that in 1955 or the population density is 1,000 or more per square kilometer. In essence, they are small to mid-size rivers in rapidly growing urban areas without a sufficient level of flood management measures.

Application of the Comprehensive Flood Management Measures is the responsibility of a Council for Basin Comprehensive Flood Management Measures specific to each river. These councils consist of representatives from the regional construction bureaus of the national government, and bureaus and offices of the affected prefectures and municipalities that are responsible for the particular river, urban planning, housing, and lands. These councils are responsible for preparing Basin Improvement Plans for the approval of concerned parties; these plans will set out the sharing of work to upgrade downstream areas as well as basin areas and are to contribute to the establishment of effective programs.

The measures incorporate the three pillars proposed by the River Council and have created the Comprehensive Flood Management Programs for Designated Rivers for advancing river improvement civil works projects. The Basin Improvement Plans are to include consensus building on the required capacity of flood management reservoirs to be constructed as a part of new development proposals and the policy for any other measures mandated for large-scale development projects through the use of the Disaster Prevention/flood management Reservoir Program. For built-up areas, the plans are to include increased water storage and permeation capacities at schools and parks through the use of the Basin Water Storage and Permeation Program. Damage mitigation approaches include building regulations for districts designated as disaster prone, the promotion of water-resistant buildings, and the publication of flood histories.

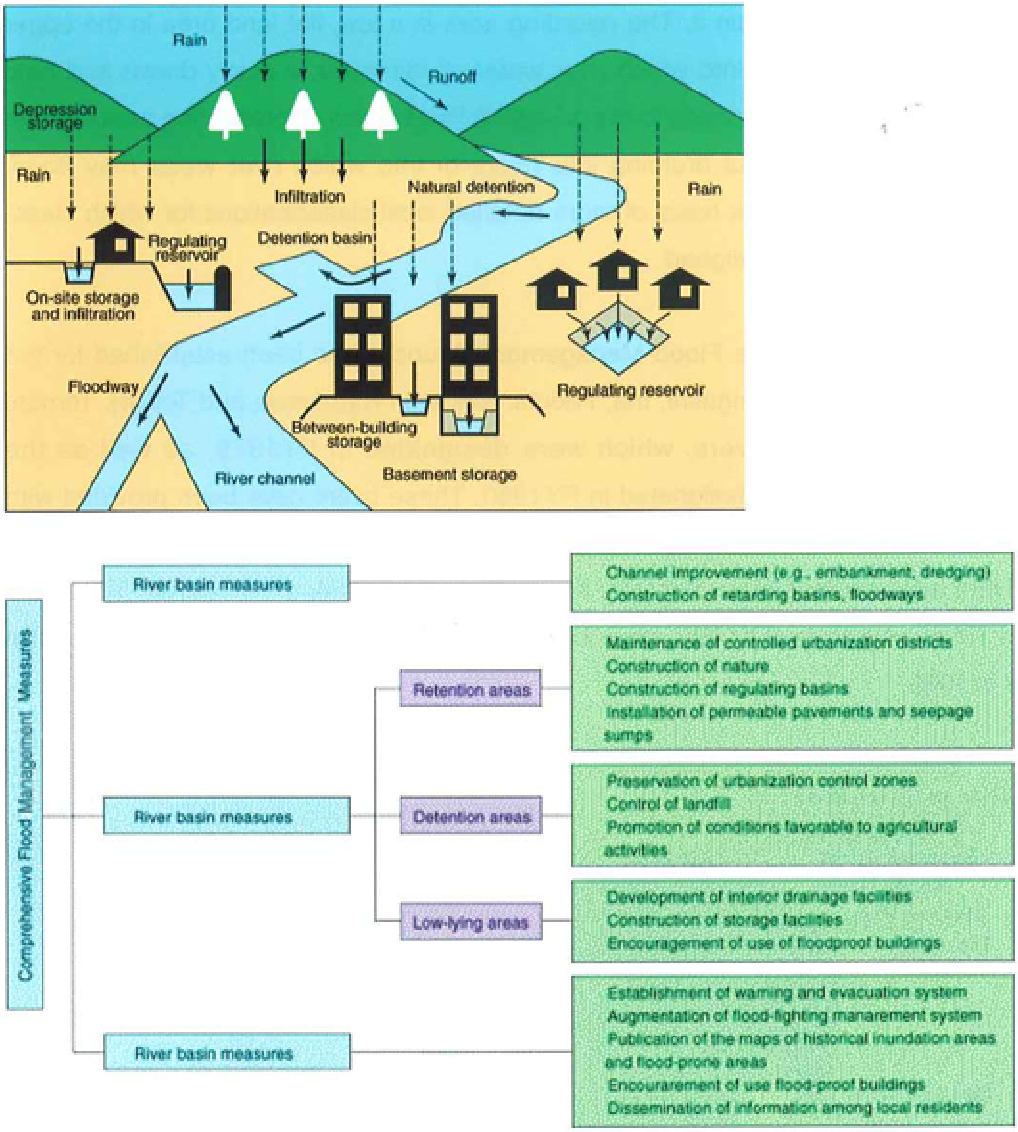


Figure 4.2 Flood Management Measures

The preparation of Basin Improvement Plans necessitates determination of the proportion of the total flow rate accounted for by each individual measure in both the river and the basin improvement programs. The amount of precipitation in the basin that flows out in accordance with the use of the land is called the "design flood discharge." The portion of the discharge to be absorbed by basin measures is called the "basin discharge load," while the water discharged into the river to be reduced or to flow away in the river is called the "river discharge load." The basin discharge load is further broken down and assigned to different areas in the basin in accordance with their respective functions: namely, the retention area, the retarding area, and the lowland. The retention area corresponds to the so-called watershed, including mountains and hills, whose main function is to temporarily permeate water into the ground or to retain it. The retarding area is a low, flat land area in the upper and middle reaches of a river into which river water or rainwater is easily drawn and held temporarily. The lowland corresponds to the so-called flood plains, representing areas where local precipitation stays without draining into rivers or into which river water may flood. These three categories form the basis of more detailed local classifications for which class-specific basin measures are designed.

By 1980, Basin Comprehensive Flood Management Councils had been established for ten rivers in total: the Tsurumi, Shingashi, Ina, Hikichi, Sakai (in Kanagawa and Tokyo), Tomoe, Mama, Shin, and Fukoshi rivers, which were designated in FY1979, as well as the Naka/Ayase River, which was designated in FY1980. These rivers have been provided with their respective basin improvement plans in due course. In addition, the Zanbori and the Mekujiri rivers were designated in FY1981, the northern tributaries of the Yamato River and the Sakai River (Aichi) in FY1982, and the Sakai River (Gifu) was introduced to the measures in 1988.

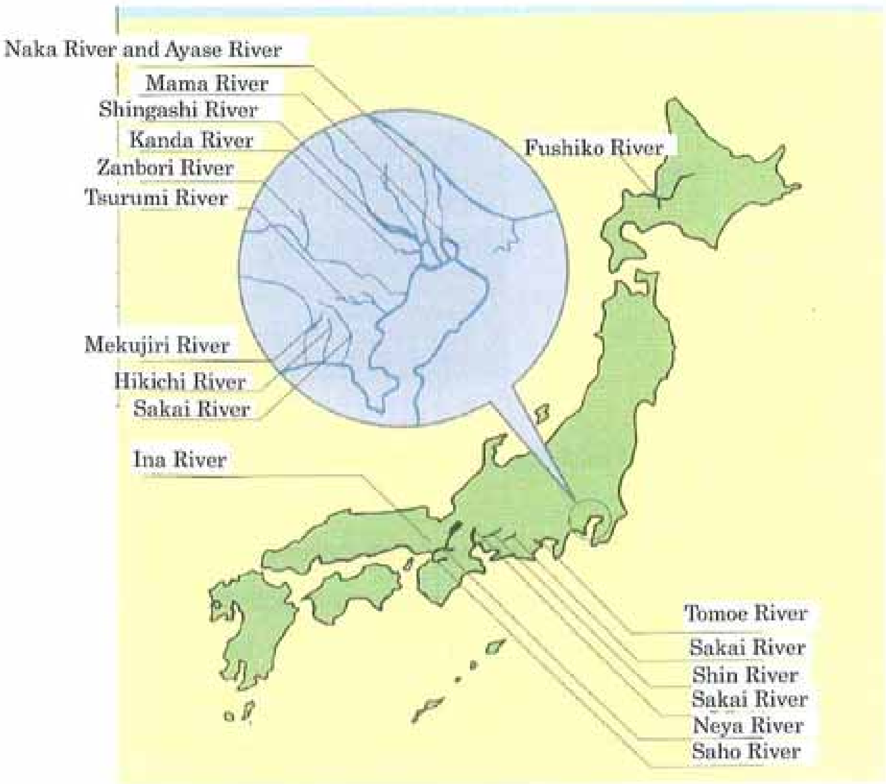


Figure 4.3 17 Rivers Subject to Comprehensive Flood Management Measures

3) Comprehensive Flood Management Measures on the Tsurumi River

(1) Pioneering Comprehensive Flood Control: Flood Disaster Defense Planning Committee

For the Tsurumi River, the Flood Disaster Defense Planning Committee, consisting of people with field experience or academic standing, municipalities in the river basin, and river administrators, was established in July 1976. The committee had met seven times by October 1977, and provided many proposals concerning flood management measures for the Tsurumi River basin, including the Interim Report submitted in June 1977. The activities of the Flood Disaster Defense Planning Committee were ahead of the rest of the country, and it is no exaggeration to say that the committee was the initiator of Japan's comprehensive flood management measures.

(2) Activities of the Council for Tsurumi River Basin Comprehensive Flood management Measures

The Council for Tsurumi River Basin Comprehensive Flood Management Measures received its mandate through notification issued by the Administrative Vice-Minister of Construction in May 1980 and was established in September of that year. The council proceeded with the study and discussion of specific control measures pertaining to the river and river basin. In April 1981, the Basin Improvement Plan for the Tsurumi River was completed and published along with the Inundation History Map. This Basin Improvement Plan was reviewed in FY1985, since its original term expired in that year. Incorporating new ways of thinking, the New Basin Improvement Plan was prepared in May 1989 and published along with Anticipated Inundation Zone Maps.

Since the introduction of the Basin Improvement Plan for the Tsurumi River, the Tsurumi River Council for Comprehensive Flood Management Measures has been implementing comprehensive flood management measures, but there still remain many issues, including:

- Further development of the river basin is expected to continue into the future.
- The conventional approach of improving flood management facilities is not sufficient by itself to raise the level of flood safety rapidly.
- The progress of water retention measures for the Basin Improvement Plan is behind.
- Discharges into the river have increased due to pump installations in the lowland area.
- Grade raising is still going on in the retarding area.
- The time to flood arrival has decreased.

In order to solve these problems, the Tsurumi River Basin Council for Comprehensive Flood Management Measures studied new comprehensive flood management measures that would integrate river and river basin strategies with a long-term view, and the Tsurumi River New Basin Improvement Plan was formulated in May 1989. A new feature of this plan was that it had long-term maintenance targets, which were missing in the old plan, to the beginning of the 21st century, and it called for different measures to be employed to reach the targets. Based on past development patterns, 90 to 95% of the land in the basin will be urbanized by the beginning of the 21st century, and the council is working on possible measures to meet this eventuality.

(3) Formulation of New Basin Improvement Plan

Improvement of River and Sewerage

○Basic Approach of the Provisional Plan

For the area around the river's upper reaches (above the Ochiai Bridge), the plan calls for improvements enabling the accommodation of 50 mm/hr of rainfall when combined with the basin measures. For the area around the lower reaches, the goal is to accommodate the largest rainfall observed in the post–World War II period.

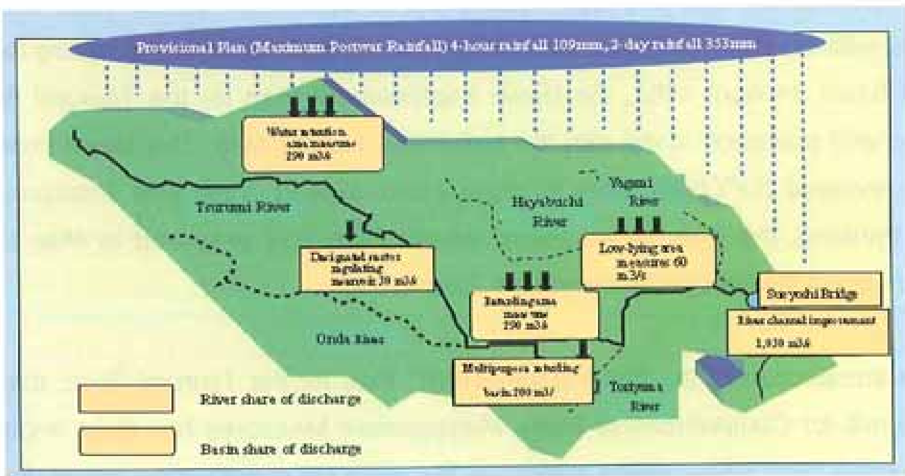


Figure 4.4 Provisional Plan

○Long-Term Targets for Improvement

Proceed with the construction or improvement of flood management facilities to prevent flooding with the probability of 1 in 150 per year. In the mid to lower reaches of the Tsurumi River, be prepared for drainage flooding on a scale that may occur every forty years or so by the use of water retention facilities such as the river, streams, and sewerage systems.

Basin Improvements

○Special Designation of Areas for Flood Management

The three classifications of river basins by flood management function (retention, retarding, and lowland) are further categorized into six zones by local characteristics. The implementation of such river basin measures tailored to meet the needs of each zone enhances the effectiveness of the Comprehensive Flood Management Measures.

○Allocation of Precipitation

The precipitation load is appropriately shared among the river, the sewer system, as well as facilities and measures for securing water retention and/or retardation in the basin, such as disaster prevention/control reservoirs and rainfall retention facilities.

○Permanent Improvement of Disaster Prevention/Control Reservoirs

To date most disaster prevention/control reservoirs have been constructed as temporary facilities to be used until the relevant river improvements are completed. The New Comprehensive Flood Management Measures instead expect such reservoirs to continue to provide their discharge regulating function into the future and also serve as multipurpose facilities based on local need.

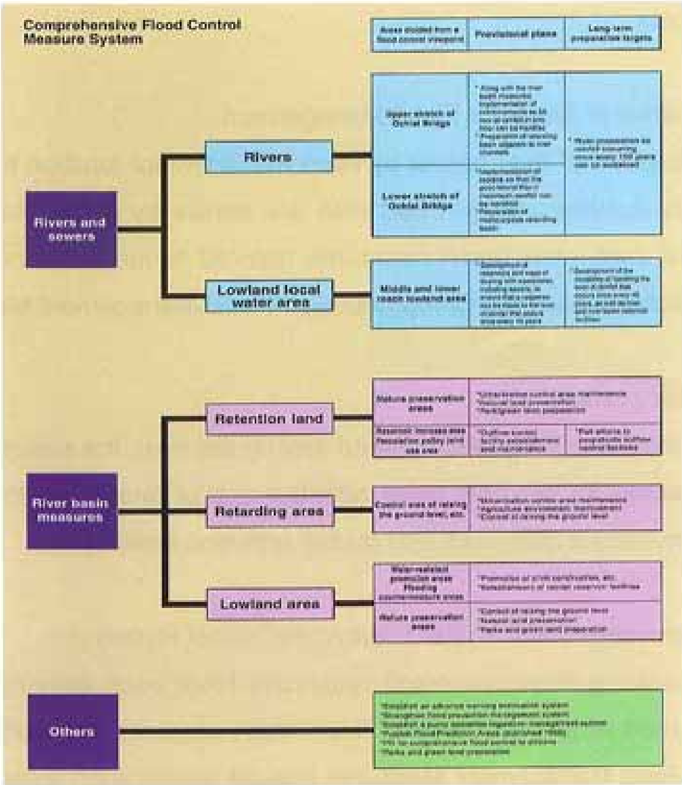


Figure 4.5 Overview of Comprehensive Flood Management Measures for Tsurumi River

(4) Specific Comprehensive Flood Management Measures

○River improvement

The Tsurumi River has benefited from large public works projects for embankment construction and/or dredging. The total volume of soil and sand removed from the river bed to expand the cross-section of the river channel is equivalent to three to four times the volume of Tokyo Dome.

Thanks to such improvements, the flow capacity of the Tsurumi River is now double that of 1975, when the Comprehensive Flood Management Measures were launched. River improvement work continues today.

Before improvement

After improvement

○Multipurpose Retarding Basin

[Overview of Retarding Basin Project]

The Tsurumi River Multipurpose Retarding Basin is located in Kozukue/Toriyamachisaki in Yokohama's Kouhoku Ward, where the Tsurumi River and the Toriyama River merge. The master plan ultimately aims to divert a volume of 800 m^3/s (out of the peak design discharge rate of 2,600 m^3/s at the Sueyoshi Bridge) through the retarding basin and the control reservoirs in the mid and upper reaches of the river.

The immediate goal is the capability to divert 200 m^3/s in order to safeguard against a flood on the scale of the 1958 Kano River Typhoon, which recorded the largest rainfall since the World War II.

[The Yokohama International Sports Stadium]

The Yokohama International Sports Stadium was built in the Yokohama General Athletic Park located in the Retarding Basin. It is one of the largest sports stadiums in Japan, with a capacity of 70,000 people and a total floor area of 166,000 m^2. The final match of the 2002 World Cup soccer tournament was held here.

In order to avoid compromising flood management capacity, the Yokohama International Sports Stadium employs a pilloti (raised floor) construction.

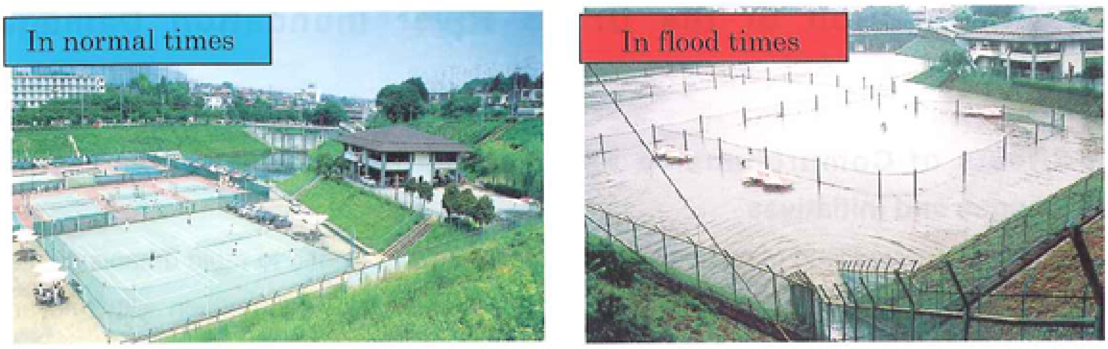
Multipurpose Retarding Basin for Tsurumi River

○Sewerage Improvement (water retention in sewer lines)

In order to prevent flooding following a heavy rainfall, rainwater is temporarily stored in the sewer lines.

○Discharge Control Facilities

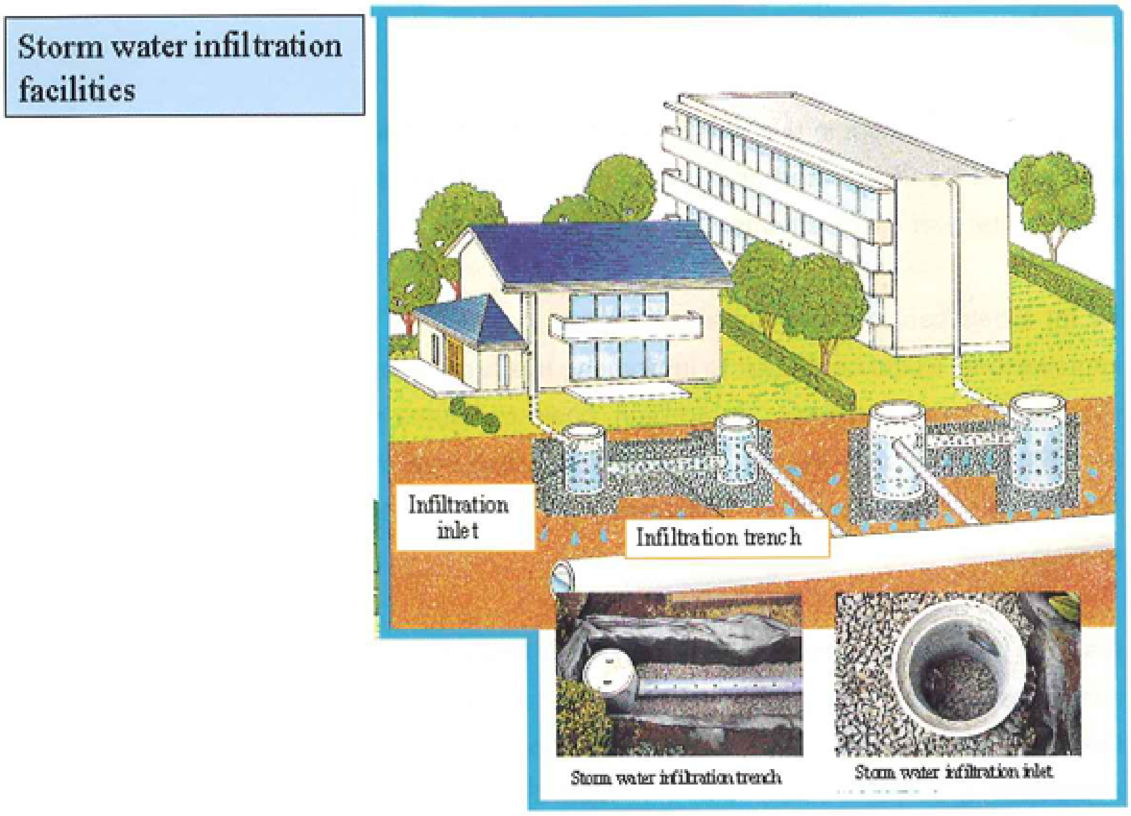
Facilities designed to temporarily hold rainwater in order to prevent flashing into the river are called discharge control facilities. There are currently approximately 3,000 facilities (with a storage capacity of approximately 2.77 million m^3) installed in the Tsurumi River Basin.



Kirigaoka Regulating Pond (Tsurumi River)

○Rainwater permeation facilities/permeable pavement

Sub-grade permeation facilities include permeable sumps, drainage trenches, and drainage wells.



4.3 Introduction of the Urban River Inundation Damage Countermeasure Act

1) Effects of Comprehensive Flood Management Measures, Future Challenges and Initiatives

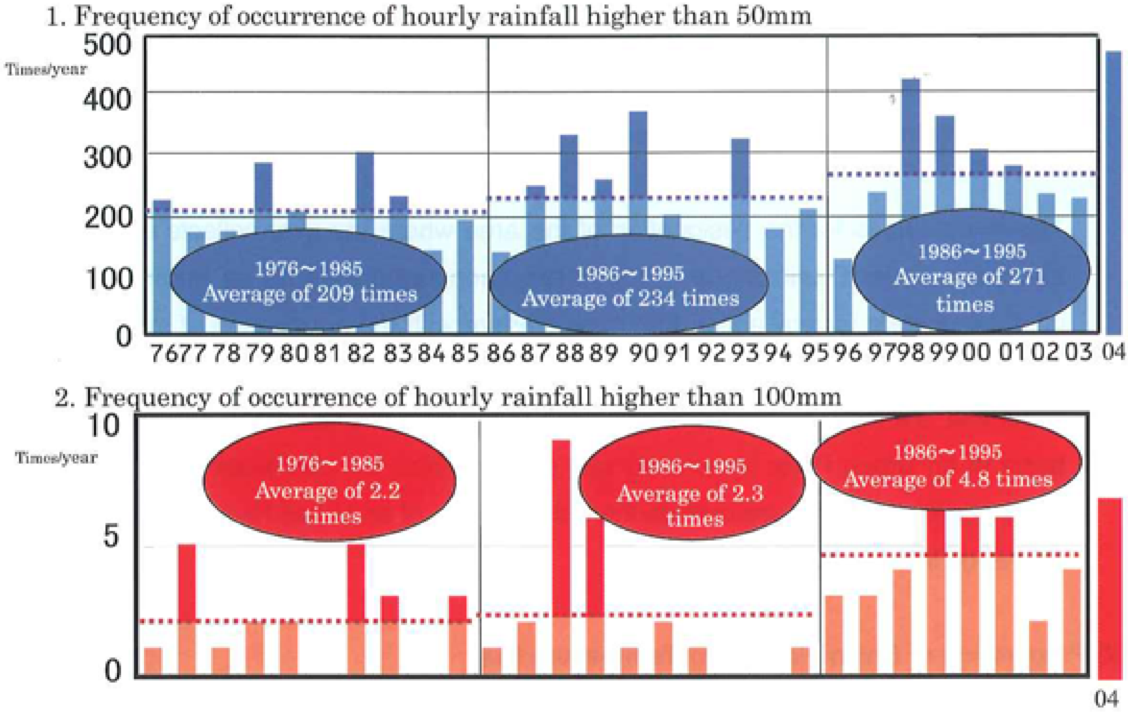
The Comprehensive Flood Management Measures have responded to rapid urbanization to a certain degree by deploying basin improvement measures in cooperation with relevant municipalities despite the fact that this planning is voluntary rather than mandated.

Generally, a mismatch is found between the river improvement ratio and the corresponding basin improvement ratio. This is likely because some rivers located in built-up areas are difficult to improve due to the limited availability of land for river channel expansion. As well, the commitment of those working to implement the measures and the understanding and support of the community differ from river to river because of the fact that the measures are voluntary.

Recently, development in river basins has slowed down, indicating that it is time to migrate the current flood management measures to more permanent ones in the scale of fundamental river improvements.

As for those basins where urbanization has progressed so far and conventional river improvements would be difficult to implement, river administrators need to participate in the planning of basin measures. In addition, basin measures need to be strengthened while introducing rules and sharing responsibilities between the river administrator and its counterpart in sewerage administration as well as between the prefecture and its municipalities.

It should be also noted that a prolonged loss of urban functions such as transportation and communication received a great deal of public attention in the urban flooding seen in the Fukuoka Flood of June 1999 and the Tokai Flood of September 2000. Data encompassing approximately 30 years collected at the AMeDAS stations across Japan (1300 sites) shows that the incidence of heavy rainfalls exceeding 100 mm per hour is increasing: There were 22 in the first ten years of observation, 23 in the next ten years, and 34 in the seven years to date.



※Number of hourly rainfalls observed in a year (based on data obtained through Automated Meteorological Data Acquisition System (AMeDAS) installed at 1300 locations throughout Japan)

Figure 4.5 Changes in Rainfall per Hour over Years

With this background, it was believed that comprehensive measures coordinated by river administrators, sewerage administrators, and regional authorities as a group would be more effective for urban floods than the conventional approach of instituting measures under separate laws such as the River Law, the Sewerage Law, and the Flood Fighting Law. The Urban River Inundation Damage Countermeasure Act was therefore enacted in June 2003 and came into effect in May 2004.

2) Overview of the Urban River Inundation Damage Countermeasure Act

(1) Designation of Urban Rivers and Urban River Basins

There are three criteria for designation as an urban river: 1. The river flows through an urban area; 2. It has a history of significant inundation damage or risk thereof; 3. It is difficult to eliminate the risk of inundation through conventional river improvements such as changing its course and constructing dams or retardation basins.

It is possible for a portion or portions of a river system to be designated as an Urban

River if they are contiguous. The authority for designation lies with the Minister of Land, Infrastructure, and Transport for the rivers partially or wholly under the ministry's jurisdiction, and with the governor of the relevant prefecture for the others. The consent of the minister is required for the designation by a governor.

The law provides for the designation of the area where the river collects rainwater as an Urban River Basin since it stipulates such requirements as implementing a countermeasure for any action that may interfere with the permeation of rainwater into the ground in the basin of an Urban River. Normally, the word "basin" refers to a river basin that is a topographical drainage area at the time of a flood, but since most of the basin of an Urban River is serviced with sewage lines, the designation includes those sewerage districts that are outside the natural basin of an Urban River but nonetheless discharge into the river.

(2) Preparation of Basin Flood Countermeasure Plan

Once the designation of Urban River is received, four parties, namely, the river administrator, the sewerage administrator, the prefectural governor, and the municipal mayor, must jointly prepare a Basin Flood Countermeasure Plan in order to prevent inundation damage.

The plan defines the sharing of responsibilities among the four parties for specific improvement and damage mitigation measures for preventing inundation in the basin.

The law calls for mid-term planning over roughly 20 to 30 years to complete the following:

- Basic policy for inundation countermeasures in the Urban River Basin
- Design precipitation for the prevention of urban flooding or inundation
- Specific improvements to be made by the river administrator for rainwater permeation facilities and by the sewerage administrator for sewer lines
- Specific items for municipalities in rainwater permeation and/or retention
- Specific items for the operation and control of sewer pumping stations

This system of joint planning and implementation under shared and defined responsibilities is a new approach for such legislated programs. The parties directly involved in the planning are required to provide their best efforts in the execution of the plan and to request the cooperation and support of residents and businesses in the basin.

One of the damage mitigation methods stipulated in the law is the establishment of pump operation rules. In lowlands, pumps, including those at sewer pumping stations, are used to drain rainwater into rivers. Although pumping will solve the problem of drainage flooding, it may contribute to flooding downstream; the suspension of the pumping operation, on the other hand, may aggravate the drainage flooding in the vicinity of the pumping station. If the embankment fails, the resulting flood will be fast in its spread and inundation, typically presenting a high risk of major disaster. Yet stopping the operation of a pumping station will have a significant impact on the residents in the vicinity. It is necessary to create appropriate rules for pumping operations to minimize the potential for damage and to implement physical countermeasures such as the installation of retention piping around the pumping station. The understanding of the residents of the need for such rules is a prerequisite of their success; it is therefore vital to work toward the dissemination of information and consensus building.

(3) Actions Based on the Basin Flood Countermeasure Plan

The law stipulates that the following items be provided in order to advance Basin Flood Damage Countermeasure Plans:

○Construction and improvement of rainwater storage/permeation facilities by river administrators

Urban Rivers are waterways for which traditional flood-proofing measures are difficult to implement due to a high level of development; the law empowers river administrators to take new approaches beyond the conventional ones, including constructing/improving rainwater storage/permeation facilities in the basin area.

These facilities to be initiated by river administrators as part of the Basin Flood Damage Countermeasures will be deemed to be river management facilities for the purpose of the River Law; their construction will be treated as regular river improvement projects.

○Cost sharing by other municipalities

When a rainwater drainage plan is prepared by a sewerage administrator and municipalities, the lack of a cost-sharing provision may become a stumbling block in the effective facility planning encompassing the entire river basin. The law provides for cost sharing by allowing the organizing municipality to make the other benefiting municipalities contribute financially.

○Special provision for technical criteria in the drainage facility

The Sewerage Law requires the discharge water from residential lands to be connected to a sewerage service; the basic rule is for any drainage system to feed runoff into a public sewage line since Japan employs a combined sewer system. In some areas it is encouraged and subsidized to separate rainwater, for example, from roofs to a permeable sump or to a storage facility; the law allows municipalities to require it in their bylaws.

(4) Regulations for Rainwater Discharge in Urban Basins

○Permit requirement for actions blocking rainwater permeation

Since it is not easy to protect Urban Rivers with regular river improvements alone, the increase of discharge from urban development was to be controlled by legislation. Any action in non-residential lands such as agricultural land or woodland that would block rainwater permeation above a certain level requires a permit from the relevant governor; the permit will require a countermeasure such as a disaster prevention/control reservoir or a drainage trench. If any plan is made for a project that may impede the functionality of a rainwater retention/permeation facility that was constructed as a prerequisite for the permit, a new permit will be required.

Since the law covers any action that will disturb the permeating function, projects such as the conversion of agricultural land to parking lots are now regulated; they were previously not sufficiently controlled since they were not subject to the Residential Land Development Guidelines. In addition, the law focuses on the actions rather than on the acting parties; any actions taken by a public authority will be subject to the provision as well.

○Reporting of actions pertaining to flood control reservoirs-to-be-maintained

Disaster prevention/control reservoirs have been constructed so far under the Residential Land Development Guidelines and others, but it has been found that some of them were reclaimed or otherwise compromised, warranting some kind of action to remedy the situation. The existing disaster prevention/control reservoirs were, however, built as voluntary measures, and there were no requirements in place for the maintenance of their function. For this reason, the law provides that governor shall designate such reservoirs of a certain minimum size as regulating reservoirs to be maintained so that any actions on the reservoirs that may threaten the flood control feature must be reported. The governor may also offer advice or make recommendations, including a construction method (such as a pilloti design) that will not impede the functionality of the reservoir in question.

○Management agreement regarding control reservoirs-to-be-maintained

It is important to have solid management in place for reservoirs-to-be-maintained to properly function. The reservoirs are managed either by respective local public agencies with the assignment of rights, by the private sector themselves, or by respective local public authorities through mutual agreements with the respective owners. If a reservoir is managed by a municipal authority under such an agreement, the law provides that the agreement be binding on the assignees of the title to the reservoir, ensuring the reservoir's continuous and smooth management.

(5) Designation of Anticipated Urban Flood Zone and Anticipated Urban Inundation Zone

It is important for an anti-flood program to ensure that damage mitigation measures such as evacuation planning are on-going in parallel to the steadfast progress in the facility improvements in the rivers and sewer system.

The law stipulates that the areas subject to inundation and their estimated depths of water with the current flood management facilities in place be published as the anticipated urban flood zone map for flooding of rivers (river water) and the anticipated urban inundation zone map for inundation due to the shortage of sewer line capacity (drainage water). Since a flooding due to iradequate urban drainage could cause significant damage in an urban area, this is the first law in which anticipated inundation zone maps based on drainage flooding are required to be published. If an Urban River is also a Flood Forecasting River, then its anticipated inundation zones is to be used instead of the flood zones.

This law expects these published data to be utilized to assist smooth evacuation in the inter- or intra-municipal planning for disaster prevention, including the method of communicating inundation information and the designation of evacuation sites.

An emerging issue on the Urban Rivers is the inundation prevention measures for underground facilities, as shown in the Fukuoka Flood and the water damage seen in Shimoochiai, Shinjuku, Tokyo in 1999. The law requires the municipal disaster prevention plan to establish a communication channel to the administrators of underground facilities. It also sets out the responsibility of such managers to prepare inundation countermeasure plans.

4.4 Construction of Super Levees (High Standard Embankments)

Super levees (high standard embankments) are thicker embankments that will not fail (break) even in a flood larger than any historically recorded. The construction of such embankments is currently under way for six rivers that run in the metropolitan areas such as Tokyo and Osaka with high concentrations of population and properties; approximately 800 km in aggregate has been specified as river channels where high standard embankments are applicable. The Super Levees Construction Project features the following:

○Essential prevention measure against major flood events in urban areas

It is anticipated that a failure in the embankments of a river in a metropolitan area due to a flood larger than the designed size will be devastating and cause irrecoverable damage. Japan's rivers are, in particular, naturally prone to flooding, and many of the major cities are located on low-lying land adjacent to a river. The Super Levees Construction Project aims to prevent destruction by a flood in urban areas, where populations and properties are highly concentrated.

○Ensuring safety by failure-proof embankments

The super levees are thick embankments made of earth fill. Water may go over a levee in a flood exceeding the designed maximum in the plan, but super levees will not fail and will prevent any devastating damage from occurring through a failure in the embankments. They will be also safe against earthquakes since they are seismically designed as well.

○Program with no need of land acquisition

The super levees are built on the assumption that the space along their tops will be utilized as regular land; therefore no acquisition of land is necessary since the land is available for use after completion. The title holders have no need to sell.

○Contribution to the community with water and green space

Traditionally, river embankments have acted as major blind walls between a river and the urban area. Upgrading such river embankments to super levees will open up the view and improve access to the waterfront, creating a new riparian space that provides the enjoyment of water and greenery.

○Integration with urban planning

By proceeding with flood control and urban improvement works simultaneously, it will be possible to practice urban planning endowed with both functionality and safety. In addition, integrated project management offers an opportunity to reduce cost.

○Efficient utilization of land

The land traditionally used for embankments alone will be available for use as parks, green spaces, or roads, as well as for emergency evacuation sites in the event of an earthquake or fire.

○Efficient utilization of excavated soil from urban development

Disposal of soil excavated during the construction of large buildings or underground facilities in large urban centers has become a major concern. It can be utilized in the construction of the super levees.

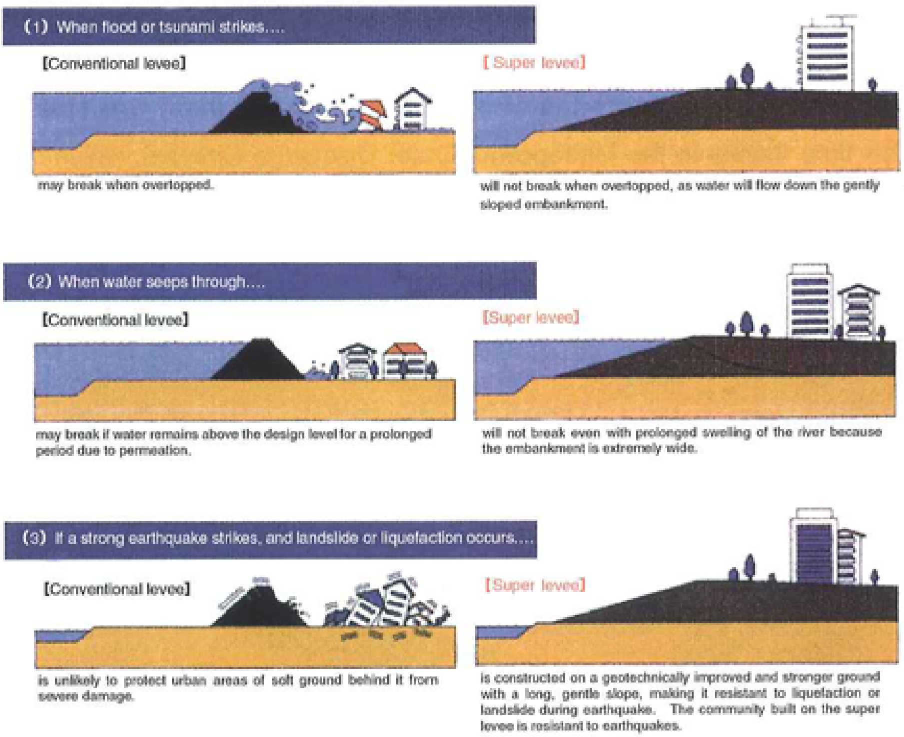


Figure 4.6 Comparison of Conventional Embankments and Super Levees

4.5 Sub-grade Discharge Channels and Underground Control Reservoirs

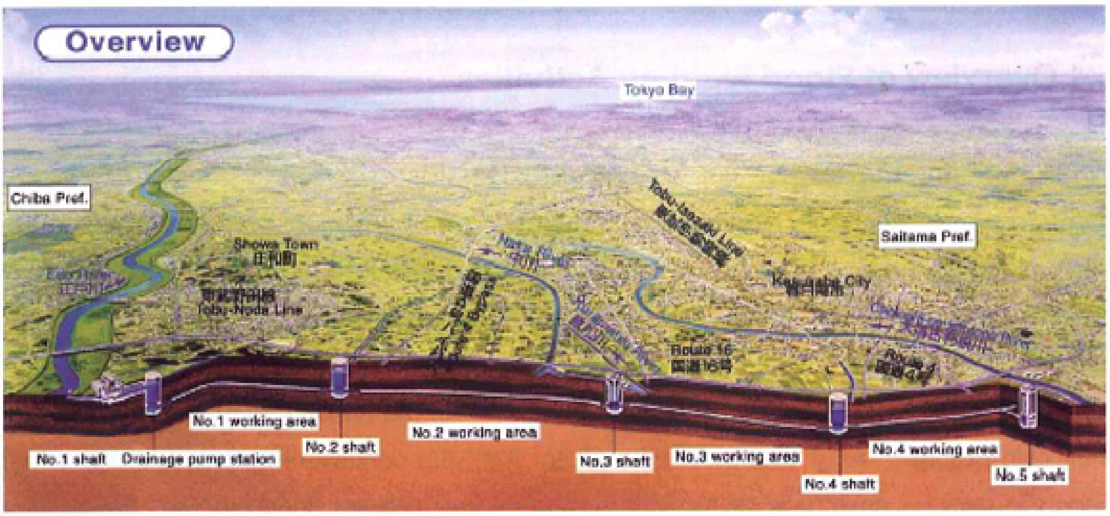
It is increasingly becoming difficult to widen rivers or construct new on-grade discharge channels. That is why sub-grade discharge channels and underground control reservoirs have been introduced to protect cities against flood events by constructing water channels or ponds underground.

■ Construction of underground floodways and underground regulating reservoirs is an effective means of solving the problem of urban flooding.

○Effect of discharge channel construction

A flood occurred in the Metropolitan Tokyo region during the typhoon of July 2002. The rainfall caused by this typhoon was larger than that observed in the typhoon of July 2000 in which 236 houses were inundated in an area of 113 ha, but there was little inundation damage this time thanks to the Metropolitan Outer Discharge Channel, which had been in pilot operation since June 2002.

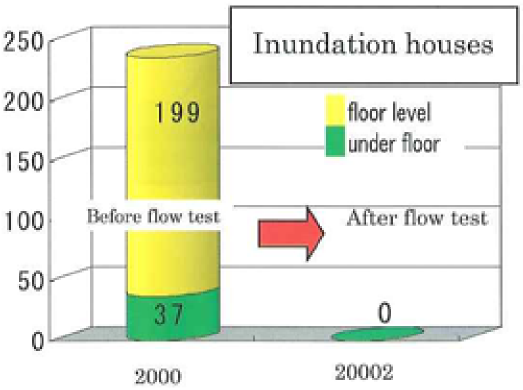
Location of Metropolitan Outer Discharge Channel



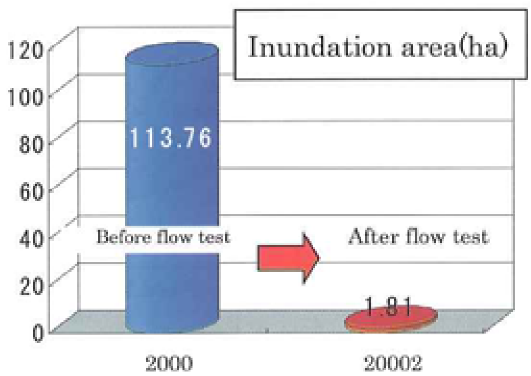
Overview Metropolitan Outer Discharge Channel

	Cumulative rainfall (mm)		
	Habu	Sugito	Shoubu
July 2002 (Typhoon No 6)	173	196	338
July 2000 (Typhoon No 3)	114	158	130

Comparison of 2000(Typhoon No.3), 2002(Typhoon No.6) rainfall



Comparison of inundation houses before and after the test



Comparison of inundation area before and after the test

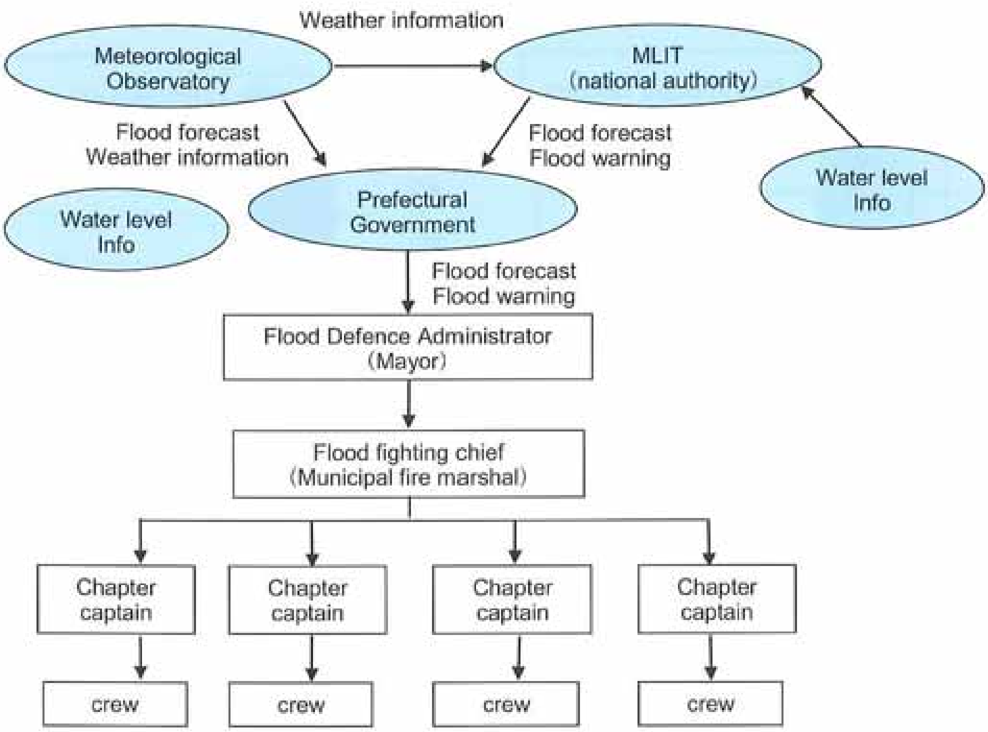
5. Flood Damage Prevention Measures in Japan

5.1 Overview of Flood Fighting Activities

When river water levels rise due to heavy rainfall, it is essential to prevent or mitigate damage before occuring. This involves inspecting embankment conditions and, if any dangerous spots are identified, enforcing the embankment by driving in piles or sandbagging them before they break. Activities of this nature, such as inspecting rivers and sandbagging, are called flood fighting activities.

Flood fighting activities in Japan evolved naturally out of the notion that people must protect their own property, but it was presumably from the 16th century onward that these efforts began to take on an organized form. It is thought that present flood-proofing construction techniques were mostly developed experientially during the Edo Period (1700-1867) and applied throughout Japan. Today, flood fighting activities are implemented in accordance with the Flood Fighting Law.

The figure below shows the progression of flood fighting activities. When there is danger of flooding due to heavy rainfall, the first steps are to broadcast forecasts about the flooding, promote flood fighting activities, and provide information to residents near the river. Then, if the threat of imminent flood damage necessitates the implementation of flood fighting activities, the authorities will issue a flood warning, activate the flood fighting system, and continue to provide information to the residents near the river.



▼ Design high-water level

expected to withstand in the standard for levee construction **▼ Warning water level**	**Action**: Patrol and inspect vulnerable parts of levee. Closely communicate and exchange information. Implement flood fighting work if necessary.	
The level at which flood-control crews are dispatched in preparation for a flood event. **▼ Designated (Alert) water level**	**Deployment**: When the water level has reached the Warning level, and it may continue to rise, the crew will be deployed to take flood-fighting action.	**Cancellation**: When the water level has fallen below the Warning level, and the possibility of flood or need for flood-fighting action has subsided, the flood warning is cancelled.
The level at which flood-fighting organizations begin to prepare for deployment.	**Alert/Preparation**: When heavy rain warning and other information indicate a potential for flood, the flood-fighting crew will be alerted. When the water level has reached the Alert level and continues to rise, the crew will prepare to be dispatched.	

Figure 5.1 Progression of Flood Fighting Activities

According to the Flood Fighting Law, the responsibility for flood fighting lies with the municipalities, which are referred to collectively as flood fighting organizations. There are approximately 3,200 flood fighting organizations in Japan. In addition to establishing flood fighting teams, these organizations can enlist the services of regular fire departments for flood fighting activities under their direct control. Meanwhile, governments at the prefectural level are responsible for ensuring that the flood fighting organizations can carry out adequate flood fighting activities. This involves formulating flood fighting plans that enable flood fighting organizations to prevent floods effectively. Other responsibilities of the prefectural governments include issuing flood forecasts and flood warnings, notification, providing directives for emergency evacuations, subsidizing flood fighting budgets and so on.

Prefectural governors and administrators of flood fighting organizations must establish flood fighting plans incorporating the various elements necessary for flood fighting, such as observation, precaution, communication, contact, transportation logistics, and operating logistics of relevant facilities, as well as cooperation and mutual support among flood fighting organizations.

During emergencies, flood fighting agencies are granted the necessary powers for carrying out flood fighting activities, such as priority roadway passage and establishing hazard zones. At the same time, the Minister of Land, Infrastructure and Transport and the prefectural governors have the authority to direct flood fighting administrators and flood fighting teams. Prefectural governors have the additional option of requesting the dispatch of Self-Defense Forces.

5.2 Flood Forecasts and Warnings

In June 2001 the Flood Fighting Law was amended to reduce and mitigate flood damage in the light of recent flood damage conditions, the Tokai Region torrential rains and so on. The objectives of the amendments were to expand and improve flood forecast rivers, designate and announce anticipated inundation zones, and ensure smooth and prompt evacuations in such areas when necessary. Efforts are now underway to publicize and promote the amended Act.

1) Flood Forecast Transmission System

In Japan, rivers that threaten to cause significant flooding damage are designated as "flood forecast rivers" by the Minister of Land, Infrastructure and Transportation and respective prefectural governors, who implement flood forecasts in cooperation with the Japan Meteorological Agency.

Flood warnings also provide guidelines for the flood fighting activities of flood fighting organizations. They are implemented specifically for rivers, lakes or seacoasts.

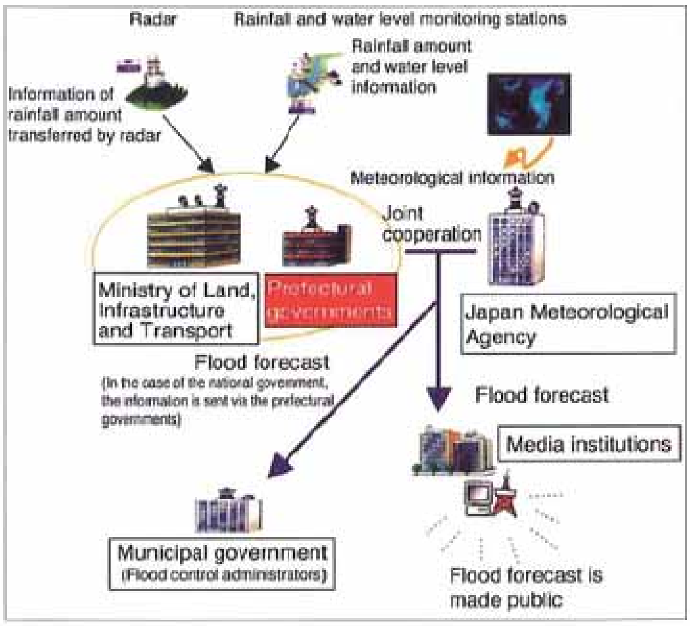


Figure 5.2 Flood Forecast Transmission Flow Chart

2) Announcement of Anticipated Inundation Zones and Flood Hazard Maps

In order to facilitate prompt and smooth evacuation of residents during disasters and to raise disaster prevention awareness, municipalities are encouraged to prepare and publish easily understandable "flood hazard maps" showing anticipated inundation zones and evacuation sites.

(1)Public Announcement of Anticipated Inundation Zones

The Minister of Land, Infrastructure and Transportation or respective prefectural governors designate anticipated inundation zones, which are areas where flooding is anticipated when the flood forecast rivers overflow. As shown below, these authorities also announce the anticipated inundation zones and the estimated water depth in the event of flooding, and notify affected municipalities.

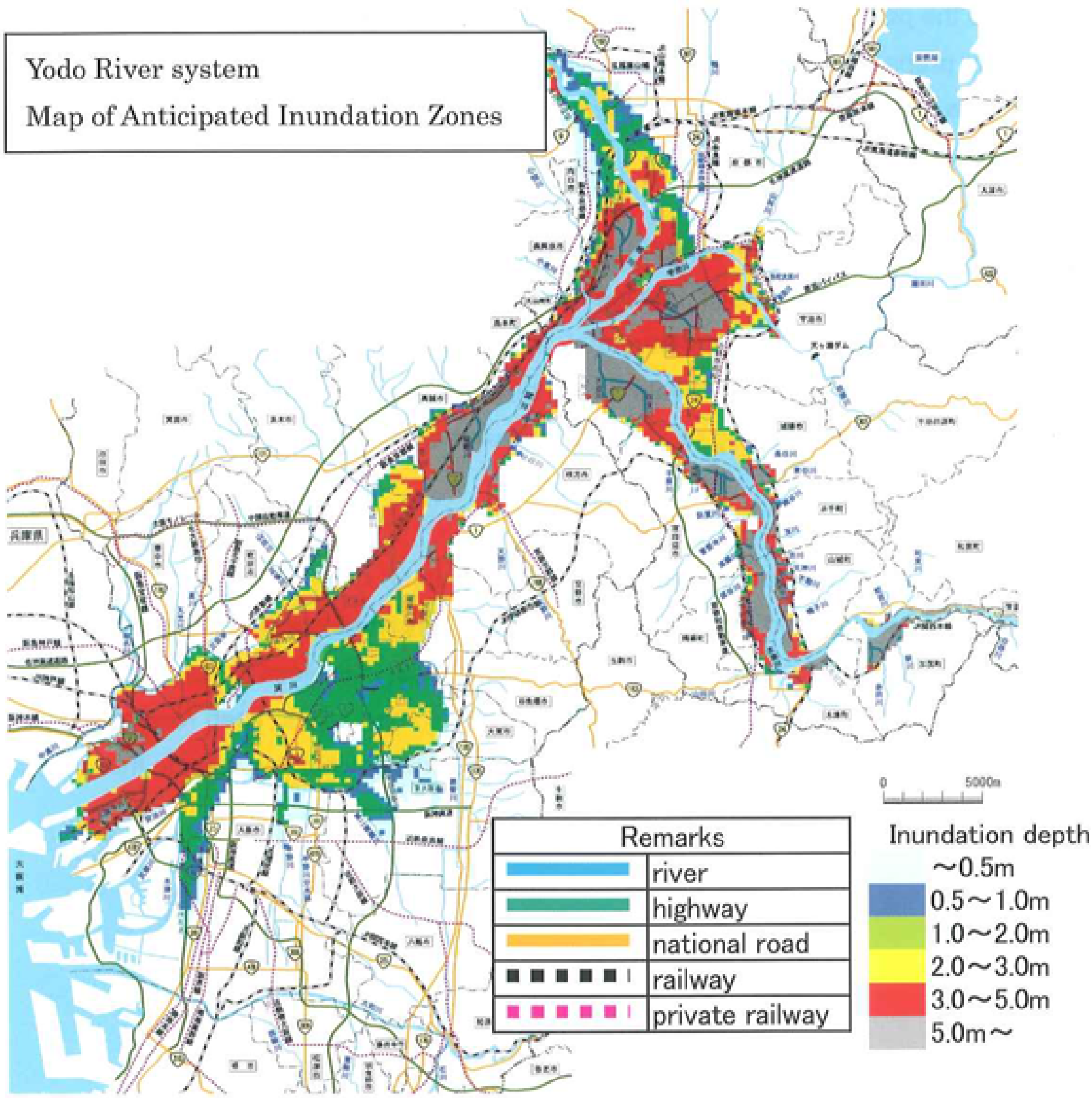


Figure 5.3 Typical Example of Anticipated Inundation Zones

(2)Publishing Flood Hazard Maps

Flood hazard maps are maps based on anticipated inundation zone charts published by the national or prefectural governments. As shown above, flood hazard maps provide flood information such as the area and depth of anticipated inundation, as well as evacuation information such as evacuation routes, evacuation sites, and methods of flood forecast transmission. They are useful for facilitating prompt and smooth evacuation activities and raising disaster prevention awareness.

(3)Functions of the Flood Hazard Map

○Advance preparation

It is essential to anticipate what may happen if flooding occurs, and to ensure that in the event of emergency residents can carry out evacuation activities themselves. Flood hazard maps serve the purpose of providing residents with information beforehand so that they can be mentally prepared for voluntary evacuation. Disaster prevention officials also find that preparing the maps is useful in relation to carrying out disaster prevention measures and drills in normal times

○Minimizing damage in the event of a disaster

Unlike earthquakes, flood disaster damage can be minimized through everyday preparations and accurate information during emergency situations. Lives can be saved by providing information about rainfall and river water levels that change over time, as well as evacuation information, and thereby allowing residents to evacuate with more than enough time.

○Raising disaster prevention awareness

In areas where flooding has decreased or there has been no flooding damage in recent years due to well-maintained embankments, people are inclined to assume that flooding will not occur, and the sense of impending danger tends to fade. Needless to say, since flooding is a natural phenomenon that could occur any time, it is important to keep residents aware of the dangerous nature of flood in the residential areas, thus motivating them to think ahead and be prepared for possible emergencies.

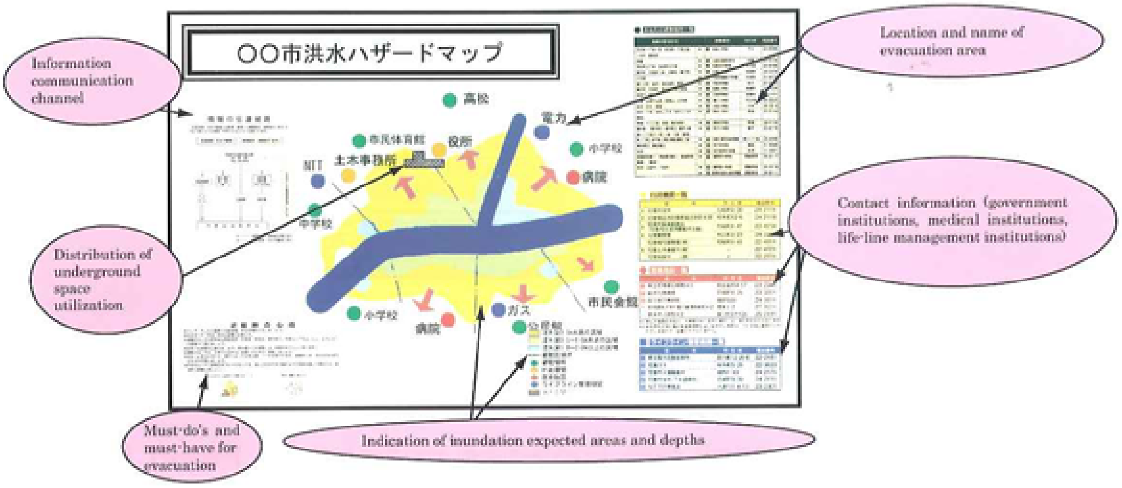


Figure 5.4 Example of Flood Hazard Map

5.3 Measures for Underground Spaces

Underground spaces such as underground shopping centers and parking lots are highly hazardous in times of flooding, since the submersion rate is several times faster than above ground. The Flood Fighting Law was therefore amended with provisions for facilities that are located underground and utilized by large and unspecified groups of people. As shown in figure 5.5, when such facilities exist in a flood anticipated zone, the amendment requires municipal disaster prevention plans to stipulate how flood forecasts will be transmitted to the facilities. The amendment also provides guidance for creating underground flooding countermeasure guidelines and for implementing measures such as equipping the entrances with water barrier boards, as shown in figure 5.5.

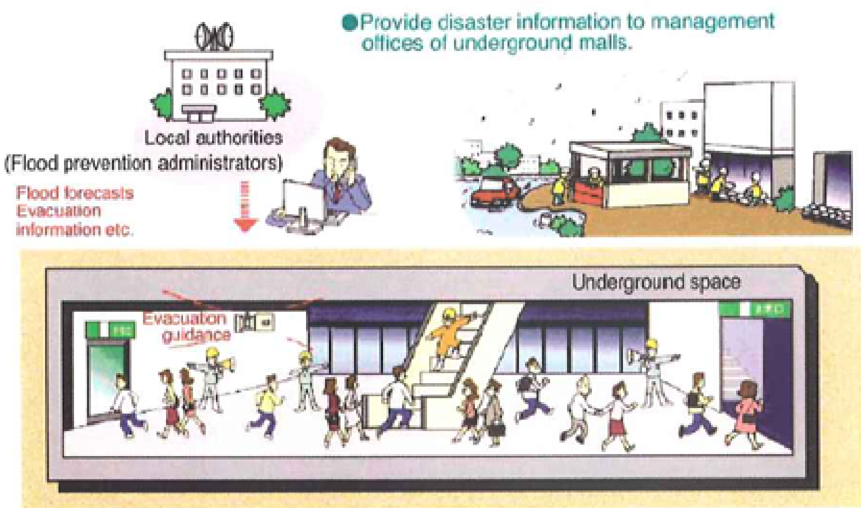


Figure 5.5 Providing Disaster Information to Users of Underground Spaces

Figure 5.6 Installation of Flood Control Device (Water Barrier Boards)

5.4 Improving Equipment and Facilities to Enhance Flood Damage Prevention

Another important aspect of flood damage prevention is the provision and maintenance of appropriate facilities and equipment. This involves maintaining the functions of flood fighting depots established by flood fighting administrators; maintaining facilities such as river disaster prevention stations and other regional flood fighting hubs, as well as drainage pump vehicles for pumping out inside water as shown in figure 5.7; and installing CCTVs for quick assessment of river flooding conditions and information outlets, and networking them with fiber optics, as shown in figure 5.8.

Figure 5.7 River Disaster Prevention Stations and Drainage Pump Vehicles

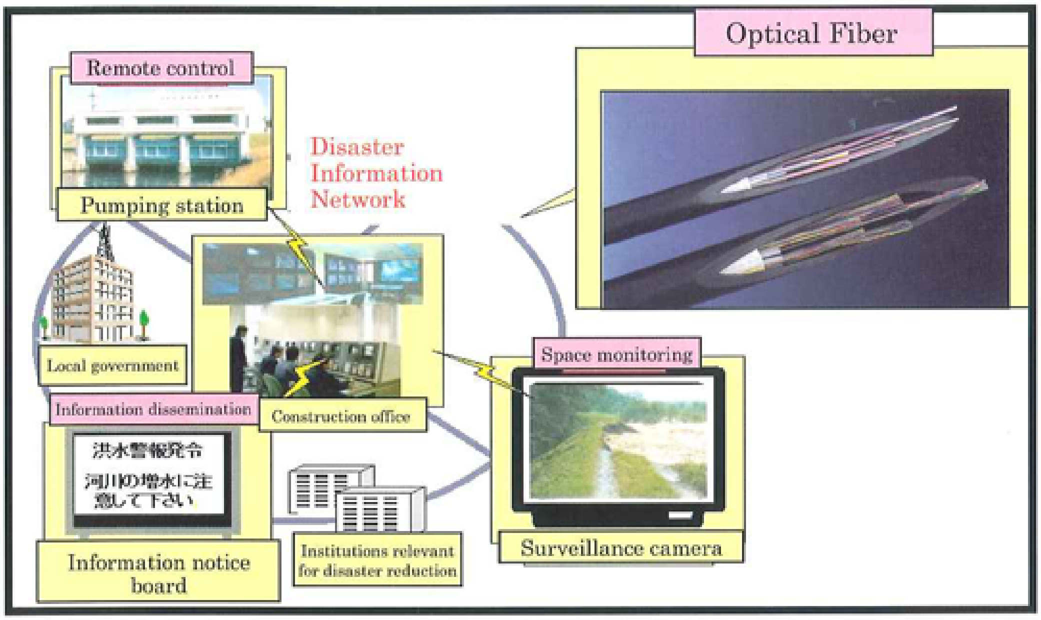
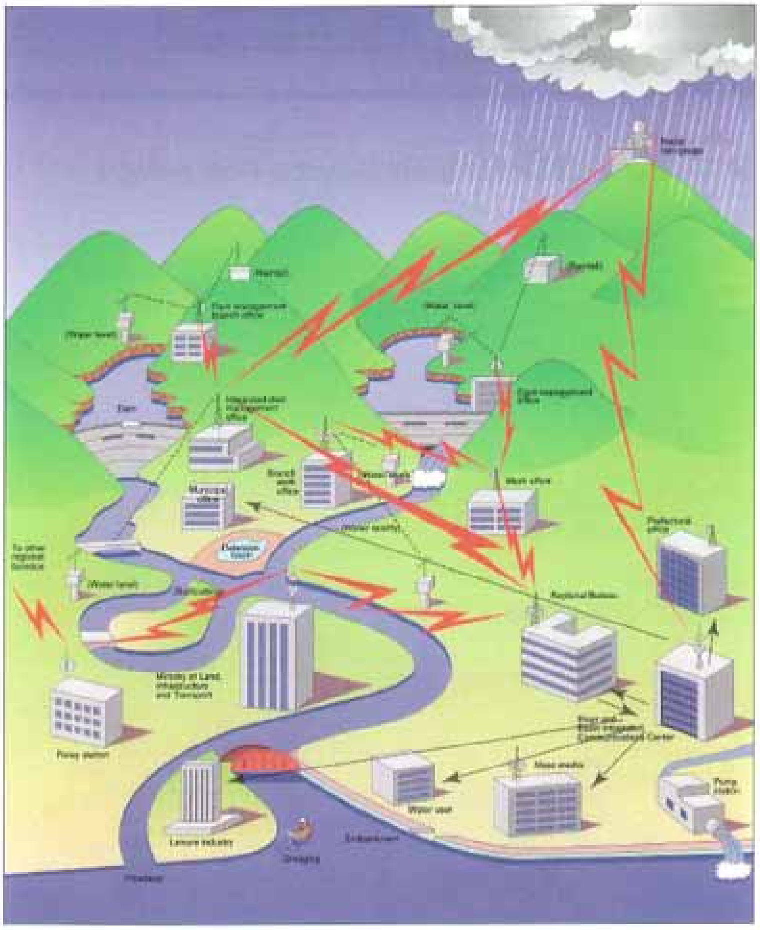


Figure 5.8 Development of Optical Fiber Network

6. River Information System in Japan

6.1 General

Water and mud disasters caused by rainfall account for a significant portion of the total number of natural disasters in Japan. In order to prevent disasters from occurring or to minimize their damage, it is necessary not only to upgrade infrastructure and facilities but also to work out a combination of better land use planning and information provision. Particularly in emergencies when river embankments must be protected or residents evacuated, the delivery of real-time data minute by minute will be of utmost importance.



It has been some time since the Ministry of Land, Infrastructure, and Transport (MLIT) as well as prefectures started to implement telemeter systems for monitoring precipitation and water levels, and today these systems provide very accurate information. Now radar rain gauge systems are being installed for further refined spatial and chronological measurements; 26 units have already been completed and are operating across Japan.

In addition, the transmission of moving images of observed sites over fiber optic cables has started in recent years. In line with such developments in information collection systems, it has become easier to accumulate information in databases for sophisticated applications thanks to faster and higher capacity computers.

6.2 Particulars of River Information Systems

MLIT has, as the specific initiative for providing and sharing surface water-related information, established a data management center with the clearing-house function of tracking the location of specific data, as well as a help-desk function; this acts as the contact point for disseminating information to citizens. It is also developing and implementing software that will enable the general public to access scalable maps on its website via high-speed Internet connections. This will allow anyone to search and view information (e.g., present or past observed data such as precipitation, water levels, and water quality; water levels of dams; rivers' surroundings; ecosystems; etc.). It is also creating a database of high-quality basic data that the Japanese public needs through referencing and verification processes. It is systematically working to construct the infrastructure needed to provide all necessary information to Japanese citizens.

(1) Installation of Fiber Optic Networks with Super High Speed and Capacity

In conjunction with the roadway fiber optic networking project, fiber optic networks are being constructed that have super high speed and capacity for river management; the aim is for early deployment. These will connect MLIT's River Bureau, its regional bureaus, their site or rep offices, and the Meteorological Agency, prefectural governments, relevant municipalities, and news agencies and other organizations concerned with disaster prevention. The use of a super high speed network is expected to foster the sharing of disaster management information and the mutual utilization of the latest data. In disaster situations, these networks are expected to facilitate the coordination of efficient and prompt responses by related agencies.

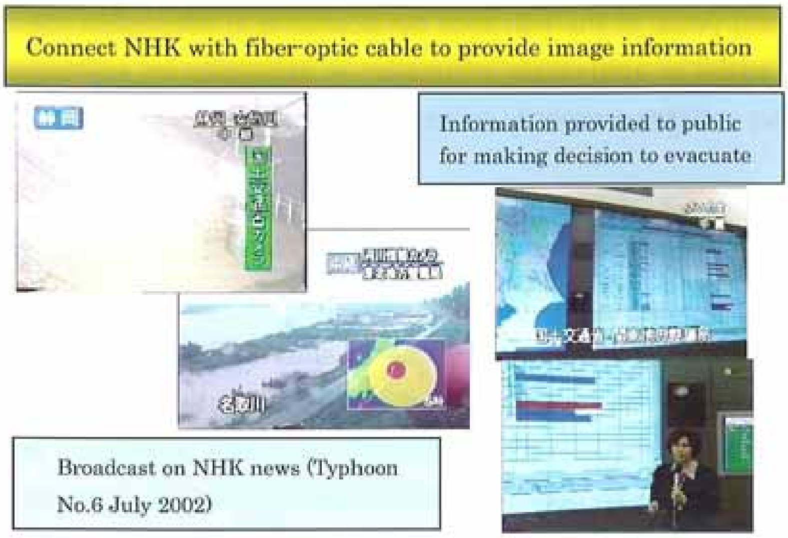


Figure 6.1 Motion Image Transmission through Optic Fiber Network

(2) Installation of CCTVs and Sensors

Along the rivers directly managed by the ministry, CCTVs have been installed in the areas that experienced frequent flood events in recent years or need concentrated flood management efforts.

CCTVs are installed, for example, in narrow valleys where it would take time for a warning vehicle to verify the safety of the river channel at the time of a dam discharge and where blind spots tend to occur. In public spaces such as heavily used campsites and riverfront parks, highly visible information boards are installed to notify river users.

(3) Installation of River GIS

The River GIS infrastructure is currently being installed in order to enable data management by the National Land with Water Information Data Management Center (the Center). Please note that the development of master GIS software for public access as well as an integrated search and view function has been centralized for the following data types:

○Hydrology/Water Quality Data

Work is underway to allow real-time data (flash reports) and finalized data (after verification by a quality-control organization) to be compared and displayed with the historical data on the GIS screen.

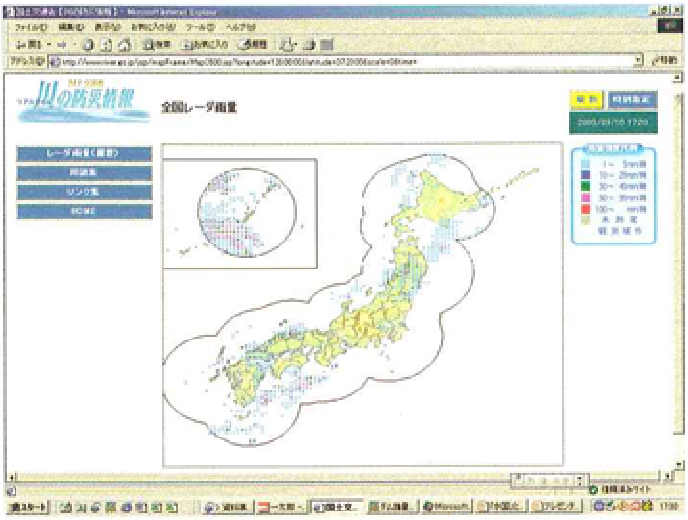


Figure 6.2 Precipitation Data from Radar Observation

○Volumetric, Hydrologic, and Environmental Data on Dams

Work is underway to allow GIS screens to display comparisons of historical data on individual dams with volumetric data such as water storage volume and discharge rates, as well as hydrologic and environmental information.

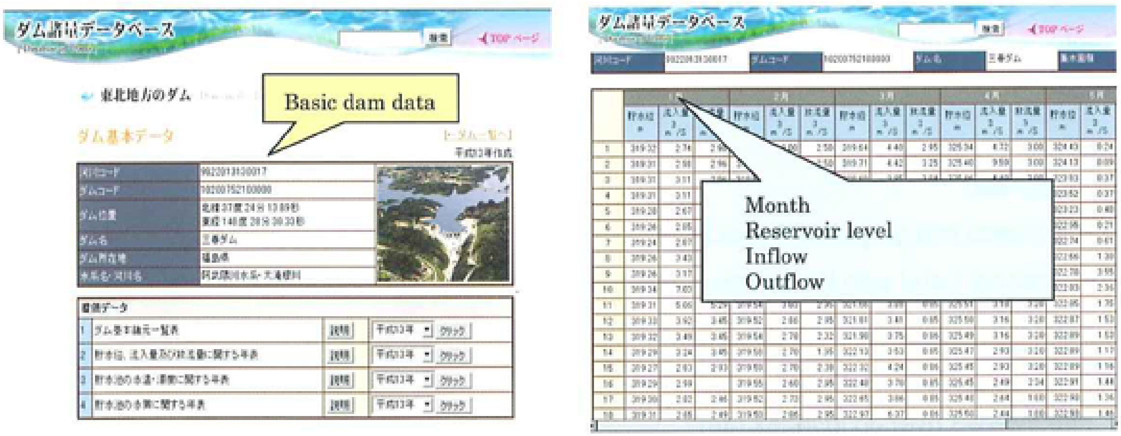


Figure 6.3 Volumetric Data on Dams

(4) Operation of the Center

December 2, 2002, marked the provisional opening of the Center and the commencement of the operation of a river environment database designed to provide the Census Data on Rivers and Riverfronts.

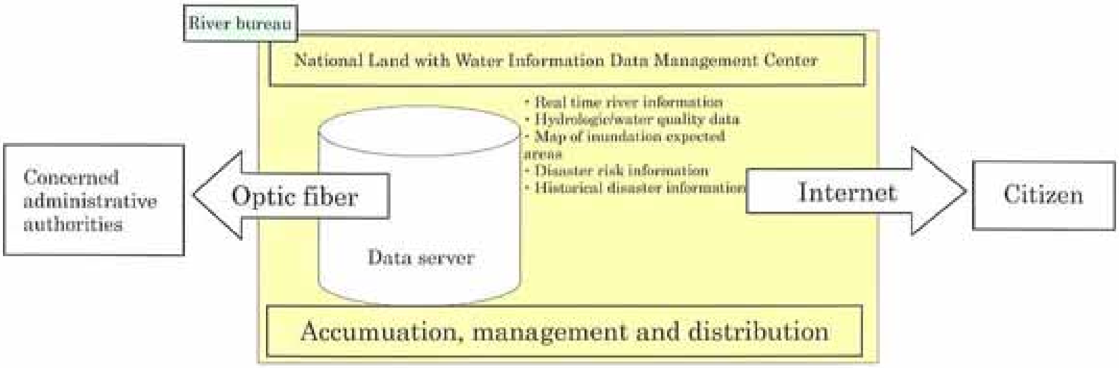


Figure 6.4 National Land with Water Information Data Management Center

The River Environment Database allows users to search and download information via the Internet from the Census Data on Rivers and Riverfronts. This function facilitates environmental studies by researchers and students.

The Center aims to present layered data, but the actual implementation of this feature still requires more work; meanwhile, the Center started operations on a provisional basis with the three databases offered independently from each other coupled with simple clearing-house and helpdesk functions.

The Center has a banner on the top page of the River Bureau Website. Please access the Center's homepage from the banner or by pointing your browser to the address indicated below:

River Bureau

http://www.mlit.go.jp/river/index.html

The National Land with Water Information Data Management Center (Japanese only)

http://www.mlit.go.jp/river/IDC/index.html

River Environment Database

http://www3.river.go.jp/index.htm

The Center is to accumulate the data acquired by the River Bureau and act as the portal for the distribution of water information to relevant administrative agencies and the public. Features include the display of multiple layered data such as hydrological, water quality, and river environment data on the GIS screen, integrated data search and retrieval, inquiry handling, and automatic update of data.

(5) Opening of Disaster Prevention Information Center

The Ministry of Land, Infrastructure, and Transport opened the Disaster Prevention

Information Center on June 12, 2003, to collect and disseminate disaster prevention information located within the ministry. (URL: http//www.bosaijoho.go.jp)

The Center allows users to find the location of or contact for disaster prevention information held by the ministry's bureaus. It also aims to offer public access via the Internet to such data as Real-Time Rainfall Information and Real-Time Radar Information in a layered format. The Center also ensures that it acts as the central portal for disaster prevention information by providing links to the disaster prevention sites administered by the ministry's individual bureaus.

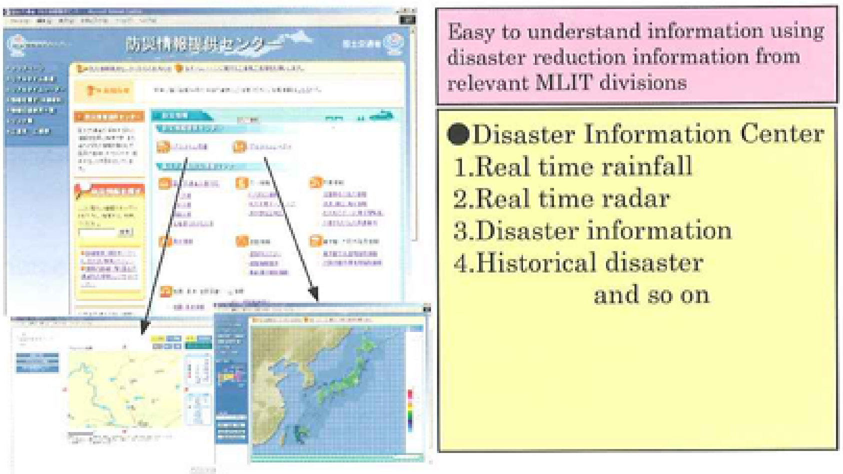


Figure 6.5 Disaster Information Center

(6) Information Provision via Cellphones

In addition to the Internet, cellphone networks are utilized to provide such real-time information as rainfall or water levels during a heavy rain or storm. Using cellphones as an information channel that anybody can use anywhere makes river information far more accessible than previously, when it was available only at fixed locations. The aim is to reduce water disaster damages through the availability of information.

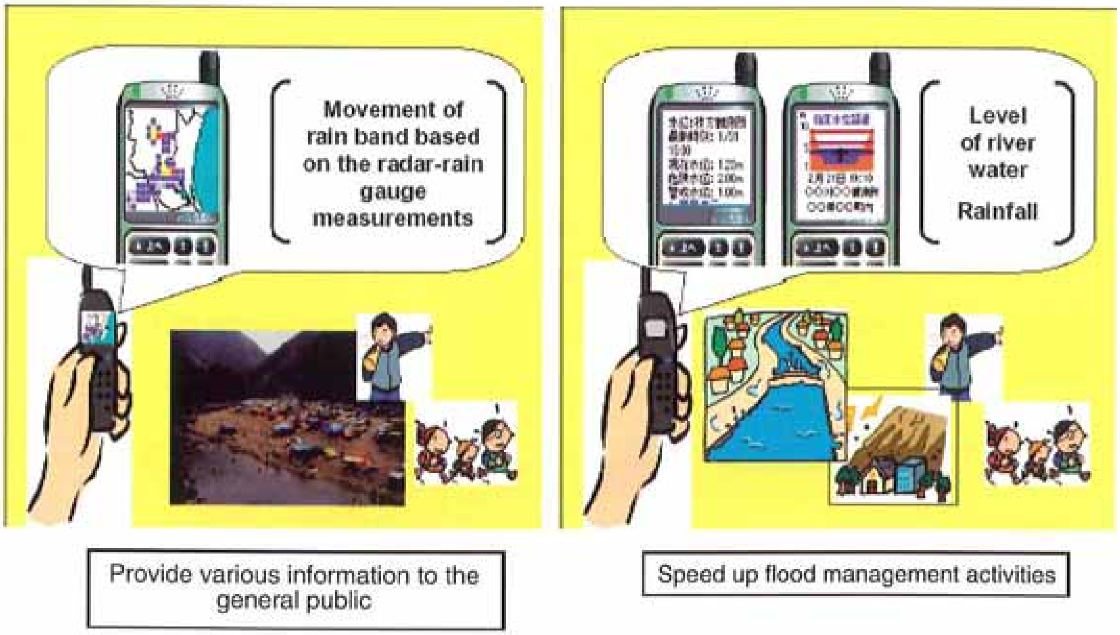


Figure 6.6 River Information through the Cellphone Version of Disaster Prevention Information on Rivers

Flood Management in Japan

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