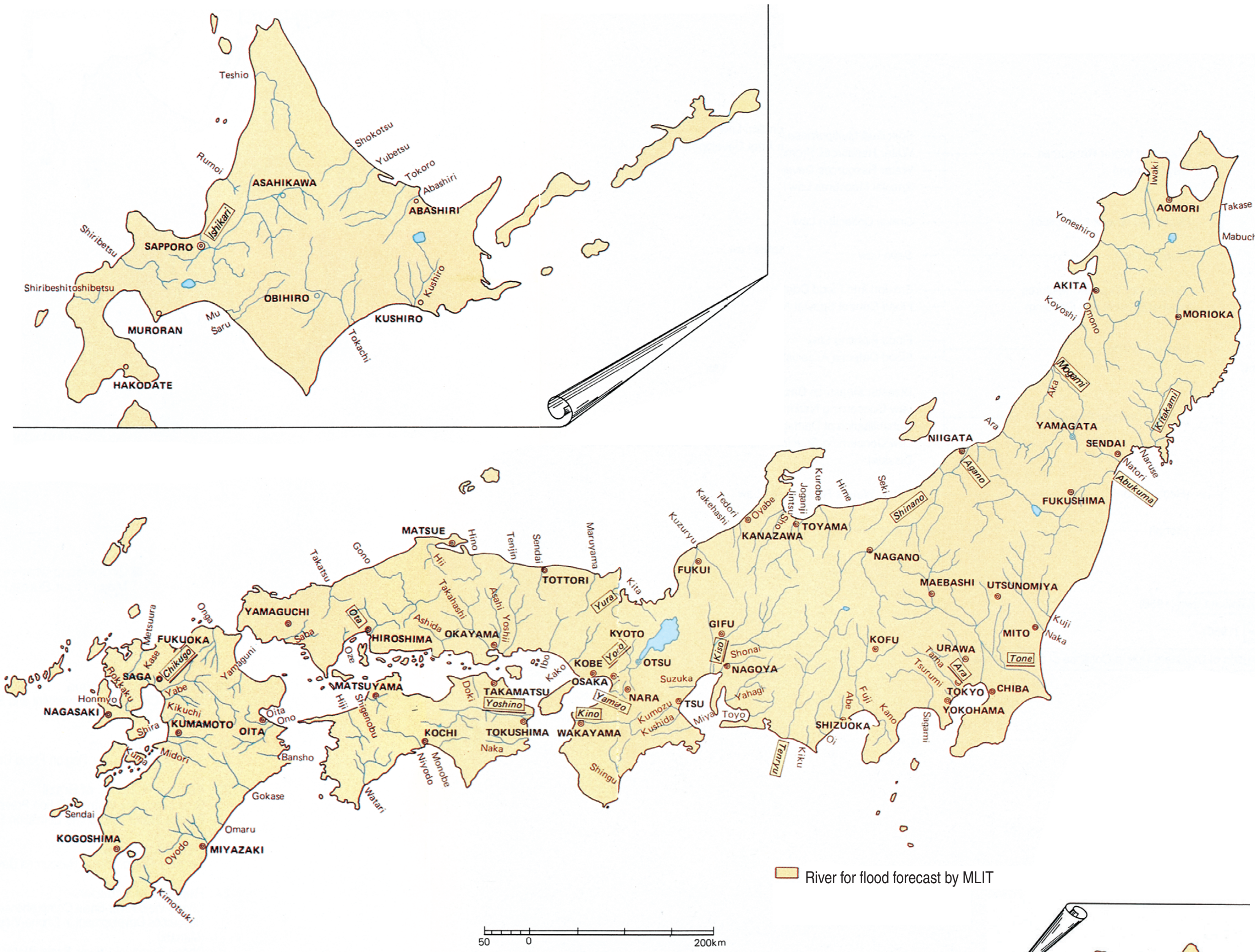
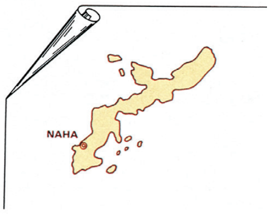
Rivers in Japan

C O N T E N T S

Rivers in Japan





River system		Classification		Administrators
Class A river system (109 systems) Rivers in Japan have been classified according to the degree of importance from the viewpoint of land conservation and national economy.		Class A rivers(13.991rivers) Ministerial management sections Designated sections	Locally designated rivers Non-designated rivers	Minister for land, Infrastructure and Transport Prefectural governors Head of municipality Municipal governments
Class B river systems (2,722 systems) Prefectural governors administer river systems except class A systems as class B systems.		Class B river Locally designated rivers Non-designated rivers	(7.084rivers)	Prefectural governors Head of municipality Municipal governments
independent river systems River systems except class A and B are classified as independent systems.		Locally designated rivers Non-designated rivers		Head of municipality Municipal governments

Major Rivers in Japan (Source:River Handbook 2004)

River [1]	Catchment Area (km^2)	**Total Length of Main Stream Channel (km)	Observation Point	Catchment Area Upstream of Observation Point (km^2)	Discharge (m^3/s)			Observation Period
					Mean Annual	Maximum	Minimum	
Tone	16,845	322	Kurihashi	8,588	290	7,925	69	1938~2001
Ishikari	14,330	268	Inou	3,379	151	2,294	28	1954~2001
Shinano	11,900	367	Odiya	9,719	486	3,725	86	1951~2001
Kitakami	10,150	249	Tome	7,869	295	3,201	78	1952~2001
Kiso	9,100	229	Inuyama	4,684	162	3,393	-	1951~2001
Tokachi	9,010	156	Obihiro	2,529	99	2,110	28	1954~2001
Yodo	8,240	75	Hirakata	7,281	235	2,560	133	1952~2001
Agano	7,710	210	Maoroshi	6,997	396	1,975	70	1951~2001
Mogami	7,040	229	Takaya	6,271	405	2,459	66	1959~2001
Teshio	5,590	256	Bifukabashi	2,899	140	2,364	20	1969~2001
Abukuma	5,400	239	Akutsu	1,865	52	941	5	1963~2001
Tenryu	5,090	213	Kashima	4,880	176	3,462	56	1939~2001
Omono	4,710	133	Tsubakigawa	4,035	227	2,098	76	1938~2001
Yoneshiro	4,100	136	Takasu	2,109	99	537	24	1956~2001
Fuji	3,990	128	Shimizubata	2,179	75	2,149	21	1960~2001

Class A rivers whose catchment area is 3,000km^2, and for which continuous discharge observation date are available.
Discharge values are 2001 data.

Organization chart of Water and Disaster Management Bureau & Legal System

- Ministry of Land, Infrastructure, Transport and Tourism
  - Minister's Secretariat
  - Policy Bureau
  - National and Regional Policy Bureau
  - Land Economy and Construction and Engineering Industry Bureau
  - City Bureau
  - **Water and Disaster Management Bureau** (Director-General, Deputy Director-General)
    - General Affairs Division
    - Water Administration Division
      - Water Use Coordination Office
    - River Planning Division
      - River Planning Coordination Office
      - International Affairs Office
      - River Information Policy Planning Office
    - River Environment Division
      - Water Management Office
      - River Management Office
    - River Improvement and Management Division
      - Project Supervision Office
      - River Basin Management Office
    - Disaster Prevention and Relief Division
      - Disaster Risk Management Office
    - Water Resources Department (Director-General, Deputy Director-General)
      - Water Resources Policy Division
        - Reservoir Area Development Office
      - Water Resources Planning Division
        - Integrated Water Resources Management Strategy Office
    - Sabo (Erosion and Sediment Control) Department (Director-General)
      - Sabo (Erosion and Sediment Control) Planning Division
        - Sabo (Erosion and Sediment Control) Administration Office
        - Earthquake and Volcanic Disaster Management Office
      - Land Conservation Division
        - Seacoast Office
    - Sewerage and Wastewater Management Department (Director-General)
      - Sewerage Planning Division
        - Sewerage Management Office
      - Sewerage Works Division
  - Road Bureau
  - Housing Bureau
  - Railway Bureau
  - Road Transport Bureau
  - Maritime Bureau
  - Ports and Harbours Bureau
  - Civil Aviation Bureau
  - Hokkaido Bureau
  - Regional Bureaus(9) — Work Offices
    (Hokkaido,Tohoku, Kanto, Hokuriku, Chubu, Kinki, Chugoku, Shikoku, Kyushu)
- Cabinet Office, Prefectures (47) — Okinawa General Bureau

- River Law (1964 Enactment)
  - (Dam and Water Resources Development)
    - Specified-Multipurpose Dam Law
    - Water Resources Development Promotion Law
    - Water Resources Development Public Corporation Law
    - Act on Special Measures for the Reservoir Area Development
  - (Sand and Gravel Extraction)
    - Gravel Collection Law
  - (Sabo (Erosion control)Works)
    - Sabo Law
  - (Emergency Countermeasures against Erosion and Flooding)
    - Erosion and Flood Control Emergency Measures Law
    - Flood Control Special Account Law
    - Act for Promoting Prevention Measures against Sediment Disasters
    - Landslide Prevention Law
  - (Flood Fighting)
  - (Natural Disaster Prevention)
    - Disaster Measures Basic Law
    - Law Concerning National Treasury Share of Expenses for Rehabilitation of Damage to Public Works Facilities
    - Law Concerning Special Financial Aid etc. in Case of Severe Disaster
  - (Reclamation)
    - Public Waters Reclamation Law
  - (Canal)
    - Seacoast Law

- Flood Fighting Law
- Canal Law
- Law for Prevention of Disasters Due to Collapse of Steep Slopes (1969)
- Environment Basic Law (1994)
- Water Pollution Prevention Law (1970)
- Environmental Impact Assessment Law (1997)

I

The River Law

Concept of the River Law during 100-years

Providing a framework for comprehensive river improvement encompassing flood control, water use and environmental conservation for the new century

The river administration system has been revised several times since the enactment of the so-called "Old River Law" in 1896. Under the "new River Law" enacted in 1964, the institutional framework for flood control and water use was improved systematically by, for example, introducing an integrated river system management system. The River Law of 1964, therefore, has played an important role in forming river administration today.

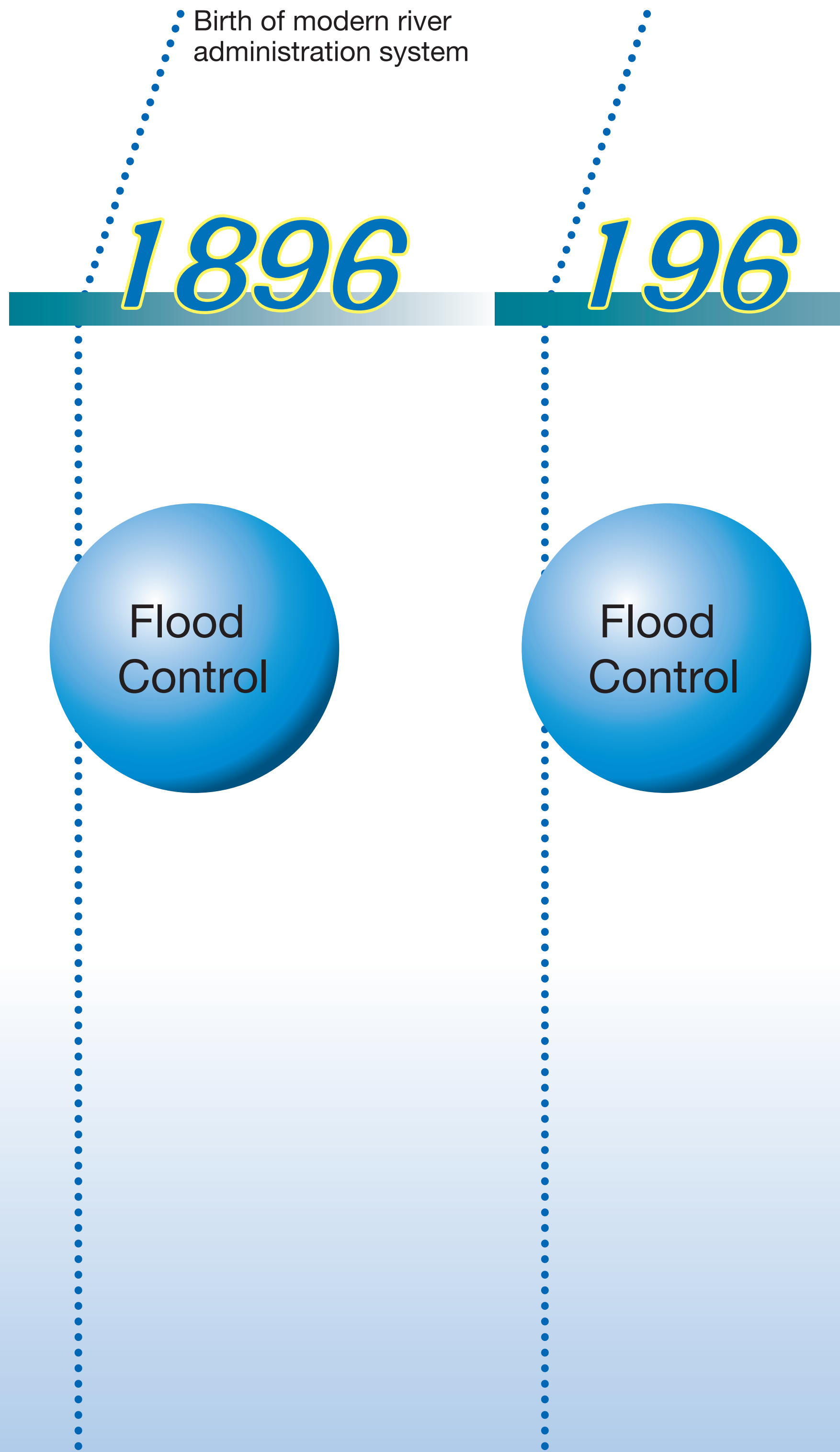
However, as the economic and social conditions have changed in the subsequent years, the conditions surrounding the river administration system have changed dramatically. Today, Projects are expected not only to perform flood control and water use functions but also to provide an attractive waterside space and habitat for diverse plants and animals. There is also a growing demand for creative efforts to make effective use of rivers as an important component of the regional climate, landscape, and culture.

In addition, in keeping pace with the improvement of socioeconomic status and lifestyles, social impact of drought has become much more serious than before, and there is a pressing need for measures to ensure a smooth coordination of water use during periods of drought.

In view of these changes, in December 1996 the River Council made "recommendations on the reform of the river administration system for meeting the change of social and economic needs."

In response to these recommendations, the Ministry of Construction drafted a River Law amendment bill and submitted it to the 140th session of the Diet in 1997. The bill was adopted on May 28 during the same Diet session, and proclaimed on June 5, 1997. This bill was effective in December, 1997.

Process of amendment of the River Law



Establishment of systematic framework for flood control and water use

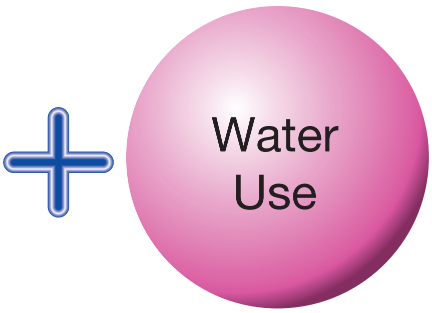
- Introduction of integrated river system management system
- Enactment of water-use regulations

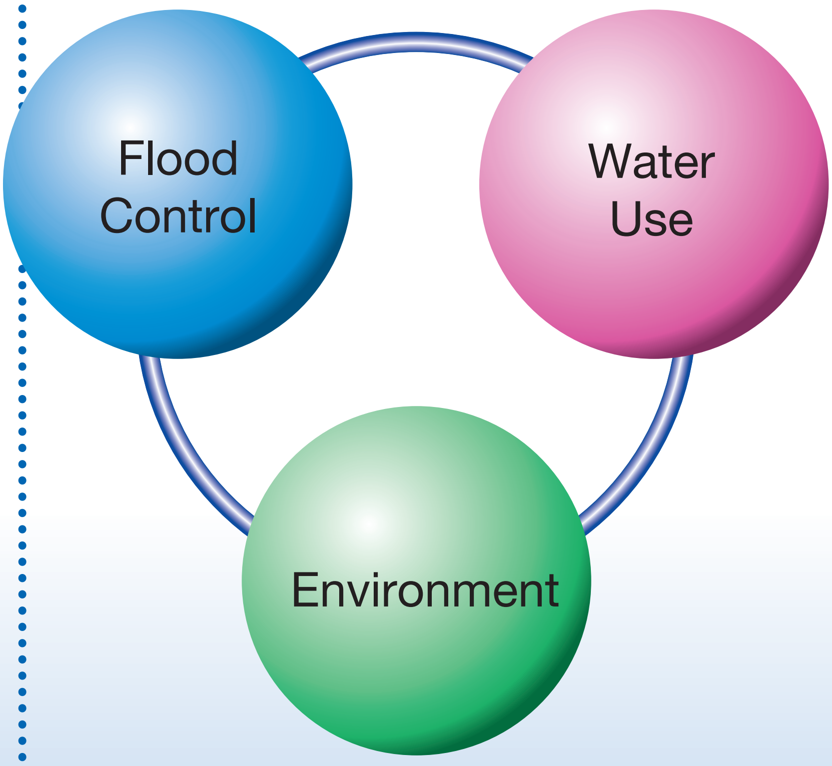
Establishment of comprehensive river administration system for flood control, water use, and environmental conservation

- Improvement and conservation of river environment
- Introduction of river improvement planning system designed to incorporate the opinions of local residents

4

1997





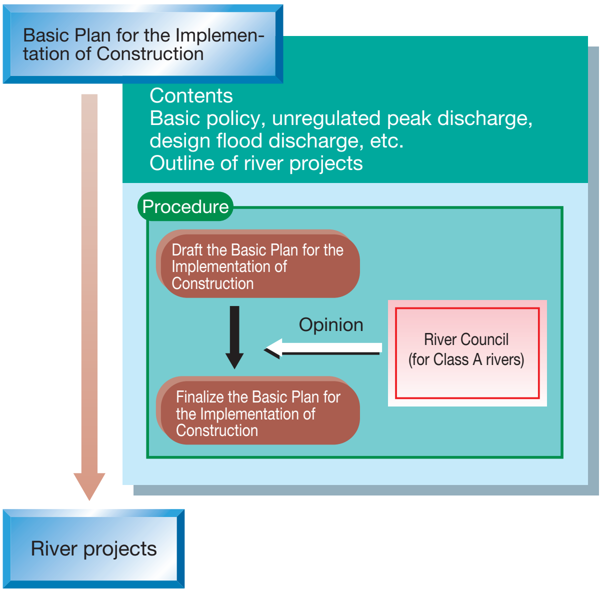
Planning system for river improvement

Promoting river improvement incorporating local opinion

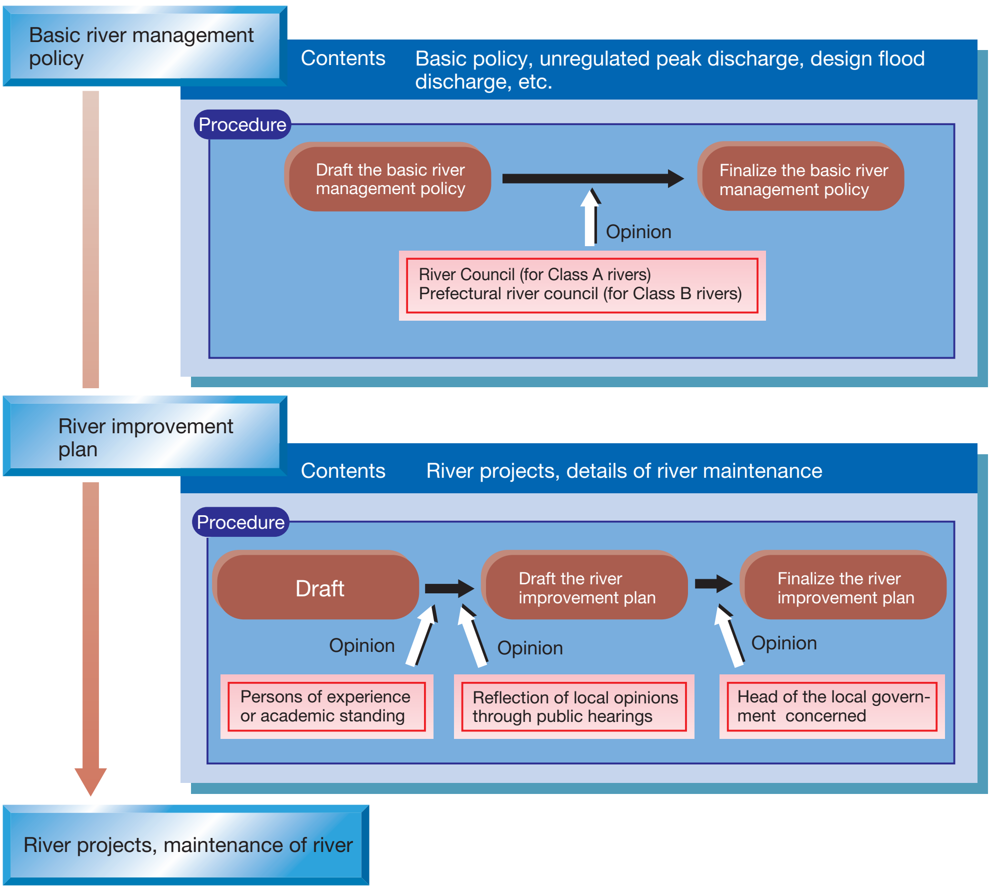
In order to satisfy the needs of the people for improvement and conservation of the river environment and to design river improvement according to the characteristics of the river and regional characteristics such as climate, landscape and culture, it is essential to cooperate closely with the local community.

To this end, the river improvement plan is divided into two parts: one dealing with matters thought of as the basis for river improvement (Basic river management policy) and the other dealing with specifics concerning river improvement (River improvement plan). The new planning system includes procedures for incorporating the opinions of the head of the local government and the local residents.

Planning system before reform



Planning system after reform



II

Geographical Characteristics

The Land and it's River

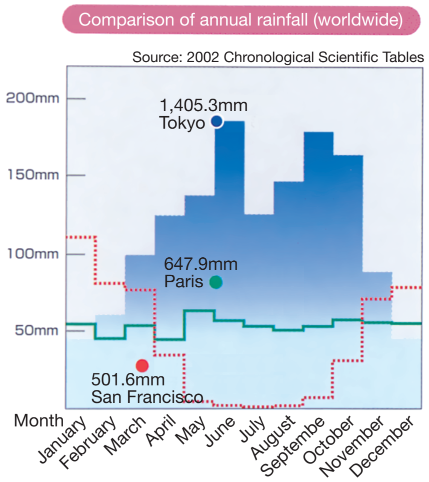
Rivers in Japan are short and steep and flow rapidly and violently. Moreover, the ratio between the normal volume of flow and that during a storm is extremely great.

Seeing the Joganji River in Toyama prefecture, Johannes de Rijke exclaimed, "Rivers in Japan are like waterfalls."

A Dutch engineer hired during the Meiji Era (1868~1911), de Rijke contributed substantially to flood control projects in major rivers in Japan, such as the Kiso, the Nagara, and the Ibi Rivers, known as the "three rivers of Kiso".

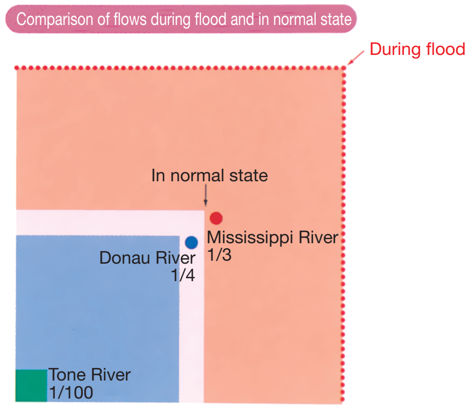
De Rijke's statement is an apt description. Rivers in Japan characteristically flow directly from mountain to sea. A great amount of rain falls on the Japanese archipelago during the rainy season (heavy rains of June and July) and typhoon seasons; and during periods of intensive rainfall, even a small stream that usually runs low may become a raging torrent.

■ Precipitation of large cities in other countries.



Japan has twice precipitation as much as world average precipitation.

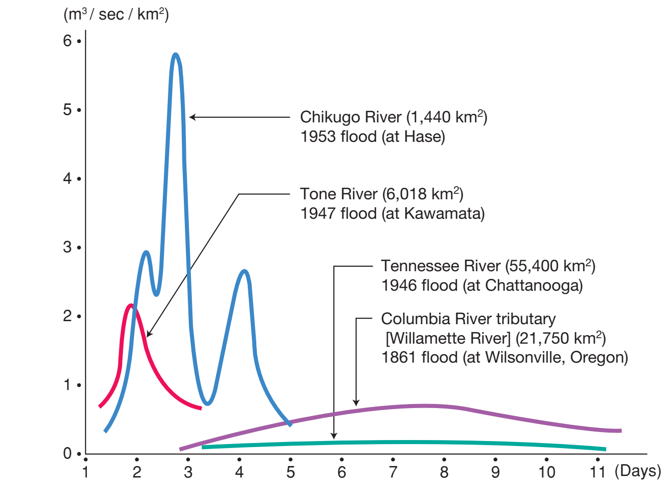
■ Minimum discharge vs maximum discharge



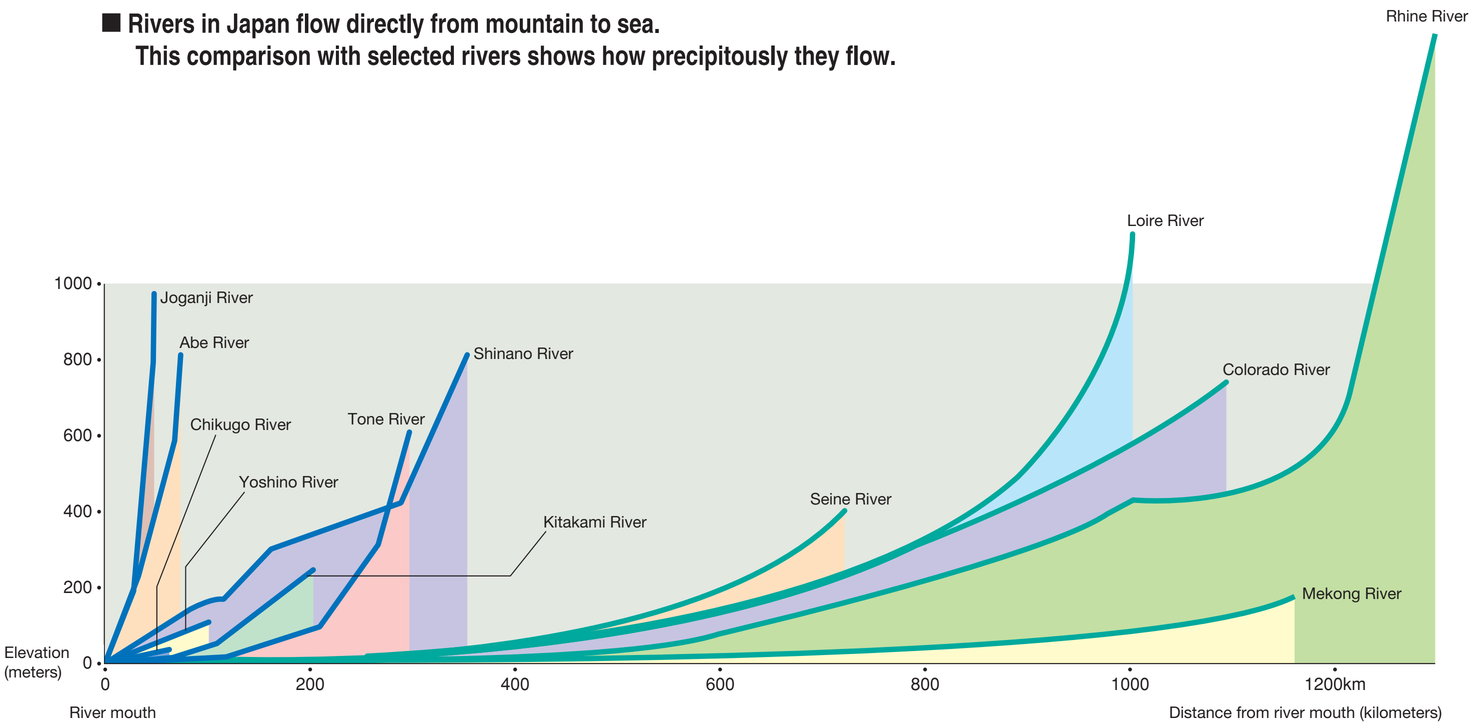
Maximum discharge is about one hundred times as much as minimum discharge, while 30 times in the Mekong, 4 times in the Donau and 3 times Mississippi. Floods suddenly occur and also recede soon in Japan.

■ Floods in Japan act like sprinters: short and quick.

Ratio of flood duration to flood discharge per unit area of catchment discharge. (m^3/sec/km^2)



■ Rivers in Japan flow directly from mountain to sea.
This comparison with selected rivers shows how precipitously they flow.

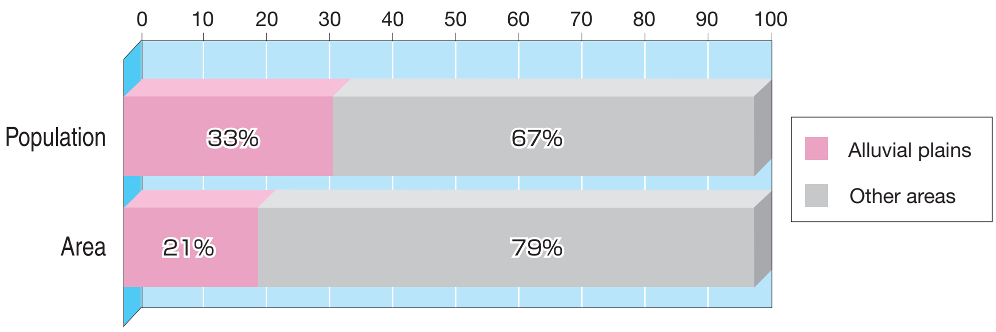


Flood and sediment disaster

Japanese cities are quite susceptible to floods. Most population and property, and therefore most flood damage, concentrate on alluvial plains.

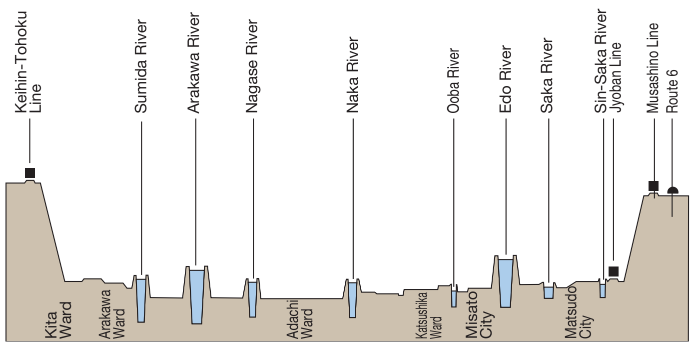
About 33% of the population of mountainous Japan is concentrated on alluvial plains (areas below flood level), which account for only 21% of the total land area. Consequently, flood damage can be serious.

■ **Concentration of population on alluvial plains**

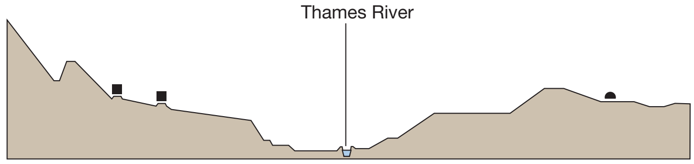


Most of Japanese cities are susceptible to floods because they lie in lowlands which are below flood water level of rivers. Rivers in Tokyo run though the upper level of city, while the Thames flows through the lowest level of London.

■ **Tokyo**



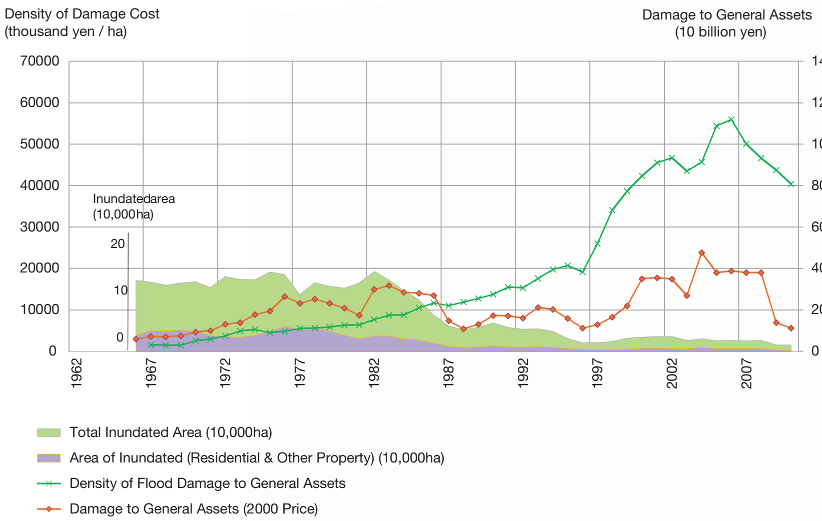
■ **London**



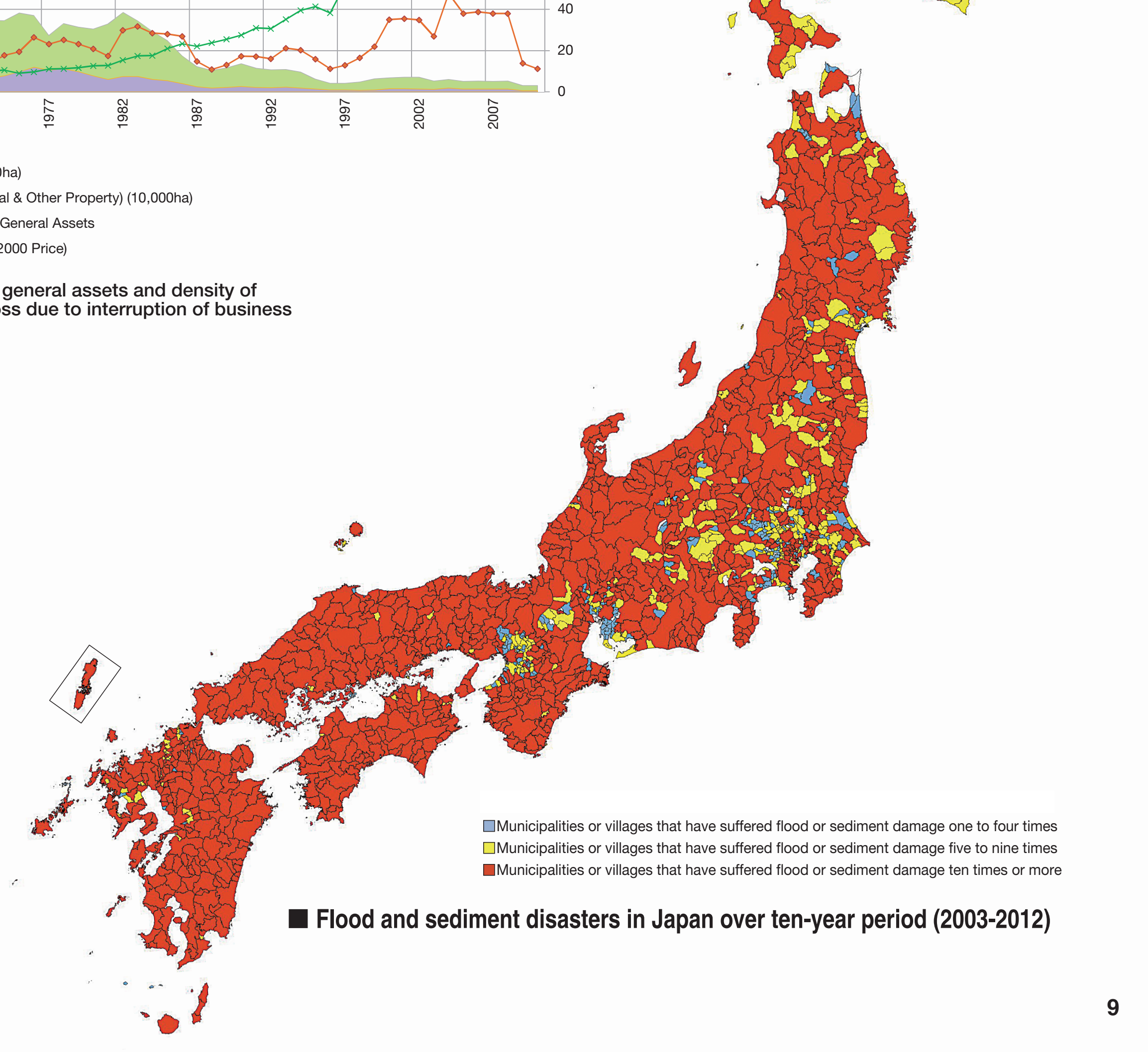
Total inundated areas has been reduced; but property continued to concentrate in flood plains. The net result is that flood damage is as high as ever.

Many years of flood control efforts have reduced total inundated area, but the flood damage has hardly decreased. The reason is that populations and properties continued to be located in flood hazard areas.

■ History of extent of flood damage and density of flood damage to general assets Flood damage density



Note 1: Extent of damage to general assets and density of damage, including loss due to interruption of business
Source: MLIT



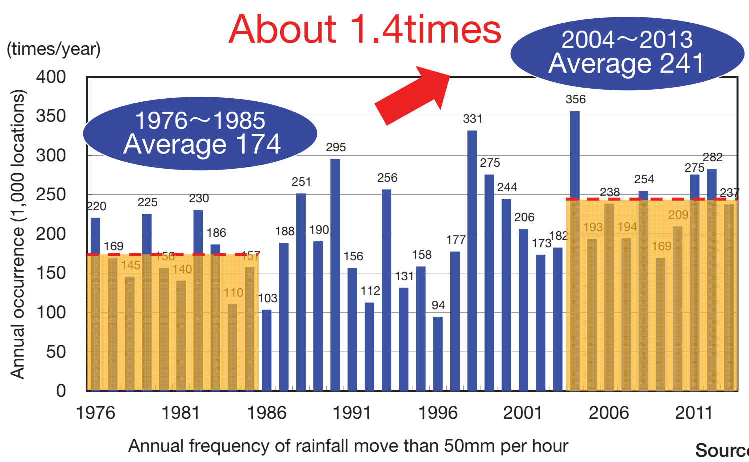
■ Flood and sediment disasters in Japan over ten-year period (2003-2012)

Flood and sediment disaster

Frequent local torrential rain

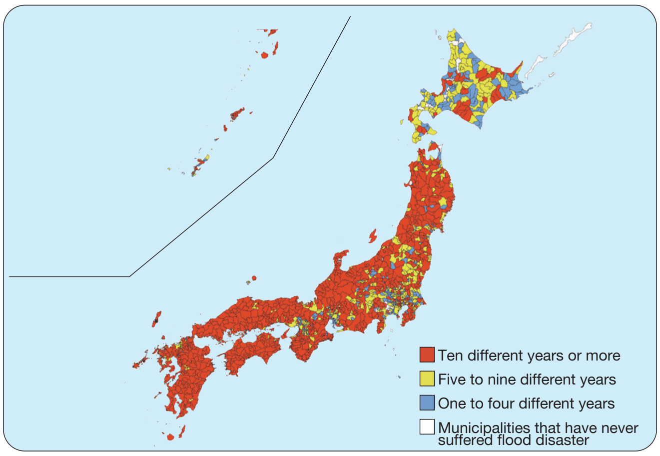
In recent years, Japan has experienced frequent local torrential rain bringing amounts of rainfall, tide levels, and wave heights that have exceeded record levels observed in various parts of the country. As a result, small catchment areas along medium- and small-size rivers, which are susceptible to torrential rain, suffered flood and sediment disasters. In addition, once a dike is broken, floodwater exerts substantial energy, causing the water levels to rapidly rise. It is newly recognized that this results in great loss of life and property, imposing a substantial burden on victims and creating the need for post-disaster response activity.

■ **Annual occurrence of rainfall of more than 50mm per hour (per 1,000 locations)**



Source : Japan Meteorological Agency

■ **Municipalities (cities, towns, and villages) suffering flood disasters (2003 - 2012)**



Source: MLIT

■ **Flood disaster in Fukuoka City, 2004**

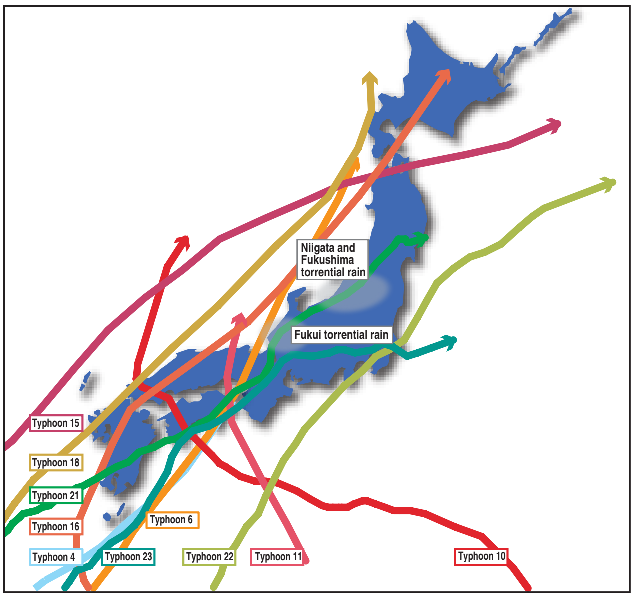
Upsurge in number of disasters in 2004

In 2004, Japan was hit by ten typhoons in the period up to October, a number that is nearly four times the annual average, and a past record. Flood and sediment disasters as well as storm surges causing substantial damage occurred in large numbers nationwide because of torrential rain and storms.

Typhoon No.23 generated near Guam on October 13 was particularly gigantic. Growing in strength, it hit Shikoku on October 20 and passed through the Kinki, Chubu, and Kanto Districts, causing heavy rain, storm surges, and sediment disasters in various parts of Japan that resulted in 27 fatalities (as of October 26). In addition, the Maruyama River in Hyogo Prefecture, a Class A river (under direct control of the government), suffered a dike break at two points, resulting in kflooding of nearly 10,000 homes (as of October 25).

Moreover, torrential rain occurred frequently in various parts of Japan under influence of the Bai-u fronts (rain fronts), inflicting flood and sediment disasters. Specifically, the observatory in Tochio in Niigata Prefecture recorded, during torrential rain that hit the Niigata and Fukushima areas in the middle of July, daily amounts of rainfall of 421 mm, the largest in its history. Niigata suffered a catastrophic disaster, with dikes on six rivers breaking at 11 points, resulting in 15 fatalities and one serious injury. As many as 14,000 homes were flooded.

■ Map of courses of typhoons hitting Japan in 2004



■ Fukui torrential rain

The town was inundated by muddy water due to the dike break on the left bank of Asuwa River (Kasuga 1-chome, Fukui City)

Muddy water flowing into Miyama Town (west side of Miyama Junior High School)

■ Niigata and Fukushima torrential rain

Series of areas of Nakanoshima Town were inundated by overflow of Kariyata River

Series of areas of Nakanoshima Town were inundated by overflow of Kariyata River

Flood and sediment disaster

About 70 % of Japan is mountains, many of which are volcanoes. The country is also rainy and seismically active. These conditions predispose the land to sediment disasters.

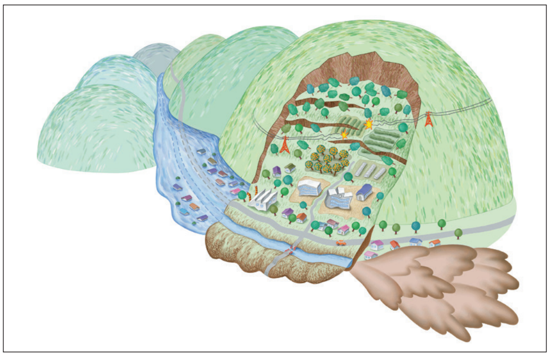
Mountains cover about 70% of the land area of Japan. The Japanese archipelago is also one of the world's very seismically active regions. Topographical and geological factors, such as steep mountains, fast-flowing rivers, and unstable and soft ground, combine with the rainy climate and frequent earthquakes to make Japan very disaster-prone.

Consequently, sediment disasters of one kind or another, such as debris flows, landslides, and slope failures, occur throughout the country every year.

■ Debris flows

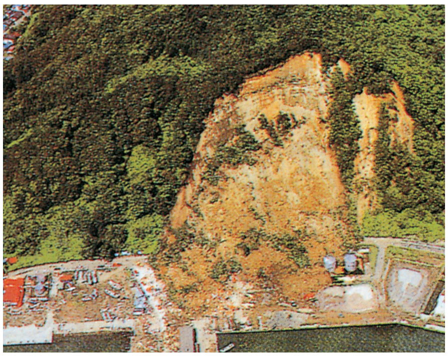
A debris flow is a washout of stones and sand that had been deposited on hillsides or in river beds due to long or heavy rain. Debris flows can instantly bury houses and farmlands.

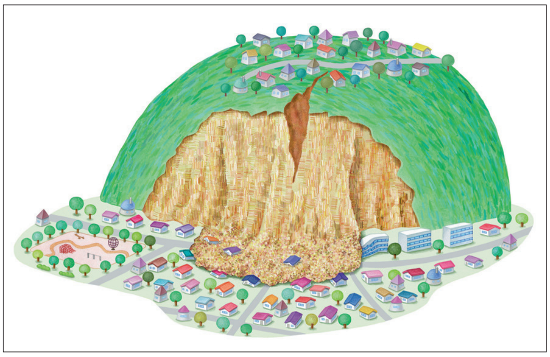
■ Landslides



A landslide is a downslope movement of a block of earth, loosened by, for example, rain. Damage caused by a landslide can be extensive.

■ Slope failures

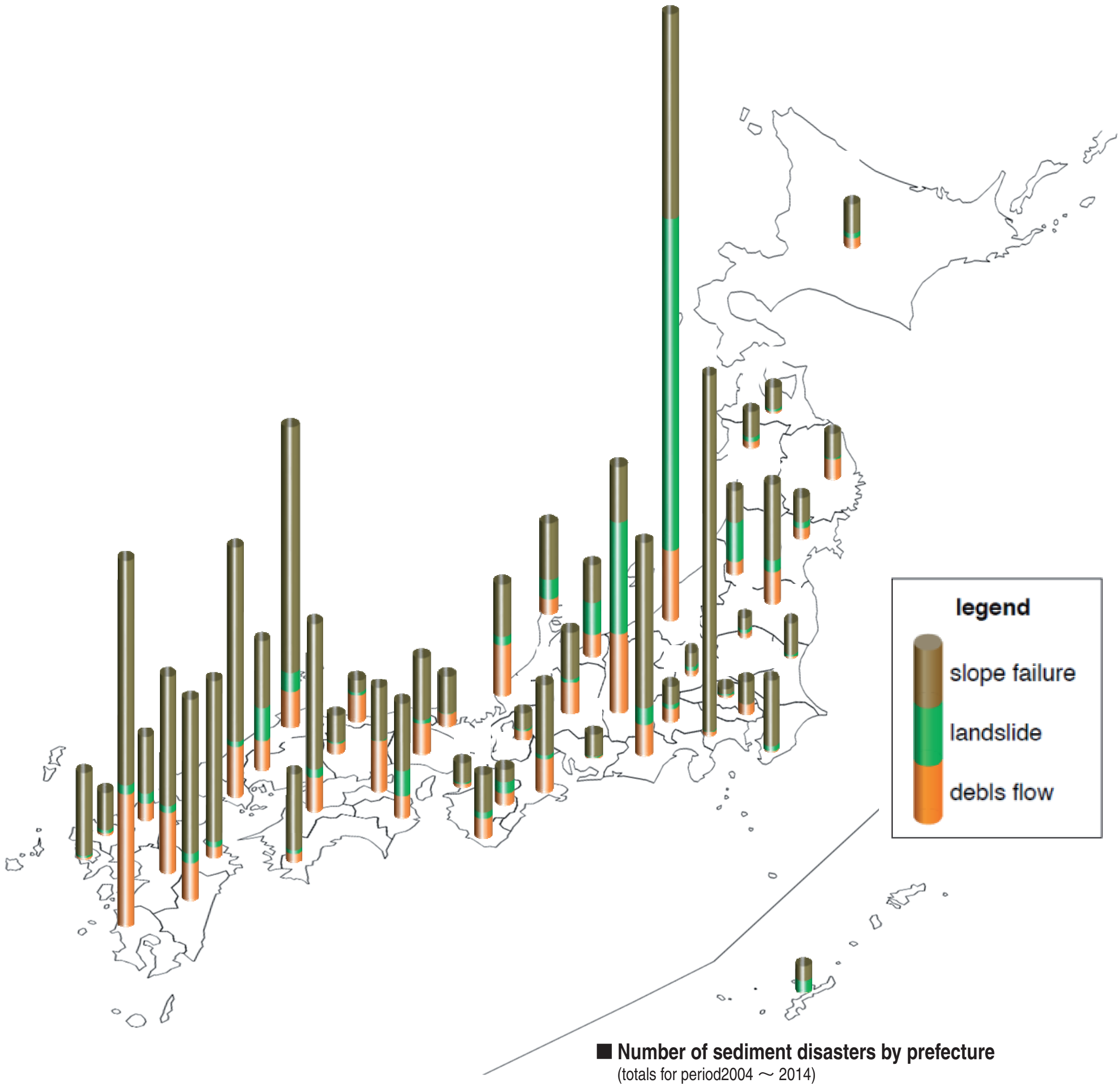




A slope failure is a downslope movement of wet, loose rock or soil that is triggered by rain or an earthquake. Because of the rapid movement, slope failures often cause many casualties.

■ Major sediment disasters and damage they caused

Date	Prefecture	Hard-hit area	Cause of disaster	Damage	
				Dead or missing	House damage
Aug. 2009	Hyogo/Okayama, etc	Hyogo Prefecture	Typhoon No.9	1 person	58 houses
Jun. to Jul. 2010	Gifu/Hiroshima/Saga, etc	Nagano/Gifu/Hiroshima Prefectures	Rainy season front	10 persons	204 houses
Sep. 2010	Shizuoka/Yamanashi	Oyama-chou	Typhoon No.9	-	20 houses
Oct. 2010	Kagoshima	Amami city/Setouchi-chou/ Yamato village/Tatsugo-chou	Severe rain	1 person	88 houses
Mar. 2011	Aomori/Iwate/Miyagi/ Fukushima/Ibaraki/Tochigi/ Chiba/Niigata/Nagano	Aomori/Iwate/Miyagi/Fukushima/Ibaraki/Tochigi/ Chiba/Niigata/Nagano Prefectures	Great East Japan Earthquake	19 persons	77 houses
Jul. 2011	Mie/Wakayama/Kouchi	Odai-chou/Shinguu city/Shirahama-chou/Aki city/ Mihara village/Kitagawa village/Yusuhara-chou	Typhoon No.6	-	6 houses
Jul. 2011	Niigata/Fukushima	Niigata/Fukushima Prefectures	Niigata and Fukushima torrential rain	-	78 houses
Aug. 2011	Mie/Nara/Wakayama, etc	Nara/Wakayama Prefectures	Typhoon No.12	62 persons	190 houses
Jul. 2012	Fukuoka/Kumamoto/Oita, etc	Fukuoka/Kumamoto/Oita Prefectures	Rainy season front/Typhoon No.4	23 persons	262 houses
Oct. 2013	Tokyo	Izu-oshima	Typhoon No.26	39 persons	203 houses
Aug. 2014	Hiroshima	Hiroshima city	Severe rain	73 persons	355 houses



■ **Number of sediment disasters by prefecture**
(totals for period2004 ～ 2014)

III

Flood Management, and Sediment and Erosion Control

Flood damage prevention

What is being done, and what can be done.

Various facilities and systems have been established to provide protection from flood damage.

River information systems ensure successful river management.

Radar raingauges and telemeter systems are used to measure water level, rainfall, etc. Information thus obtained is processed and provided to concerned governmental agencies and local residents so that timely and appropriate river management and flood defense measures can be taken.

● **Widening of channels and embankments**

Rise in water level is reduced by increasing the width. Levees are also used to prevent overtopping.

● **Detention basins**

Water is diverted from a swollen river, and the water is returned to the river after the threat of flooding has disappeared.

● **Floodways**

Canals are used to divert water from the middle or lower reaches of the river and directly channel the water to other rivers or the sea. This technique helps to reduce river flow.

● **Dam**

Dams store water in the event of flooding caused by heavy rain and control river flows downstream to alleviate flood damage. Dams function both as a means to ensure stable water supply to downstream residents and as a means to generate power.

Japan lags behind other countries in river improvement.

Flood control plans for major rivers are usually based on the greatest amount of rainfall that might be expected to occur, once in about 100 to 200 years. Since, however, the task of attaining this goal takes a very long time, current practice is to set a less ambitious goal for a shorter period and upgrade the degree of flood safety in stages. Japan is still far behind European countries and the United States in the field of channel improvement.

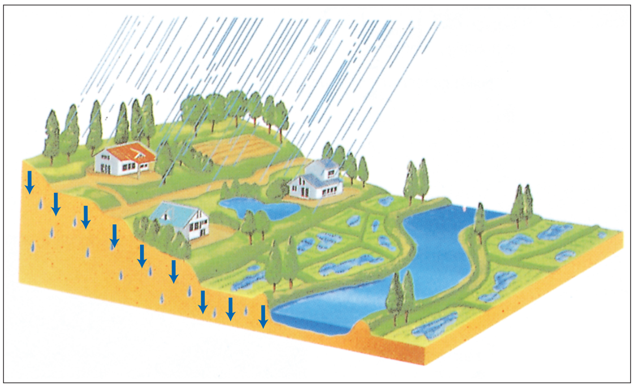
Urbanization and flood damage

Rapid urbanization and suburbanization is impairing the retention and detention capabilities of nature. Consequently, floods concentrate in a shorter time and in a greater quantity.

Rapid urbanization has been in progress in many parts of the country, particularly in the Tokyo metropolitan area. In Kanagawa prefecture, for example, rural land including forest and farmlands accounted for 90% of the land in the Tsurumi River basin in 1958. By 1997, however, rural land had decreased to about 15%.

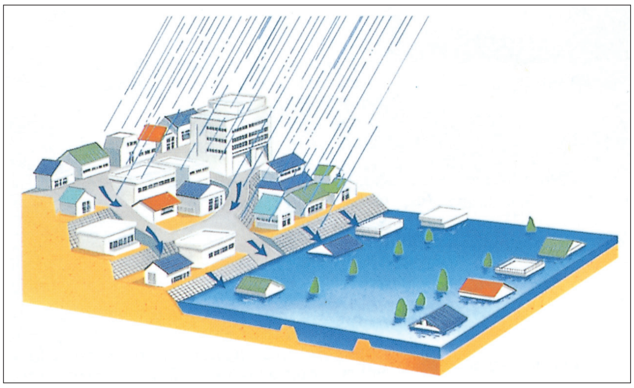
Asphalt and concrete prevent natural permeation of stormwater into the ground. As a result, stormwater fills rivers and depressions more quickly in urban areas than in rural ones, increasing the risk of urban flood damage.

■ Aggravation of flood damage by urbanization



● **Before development**

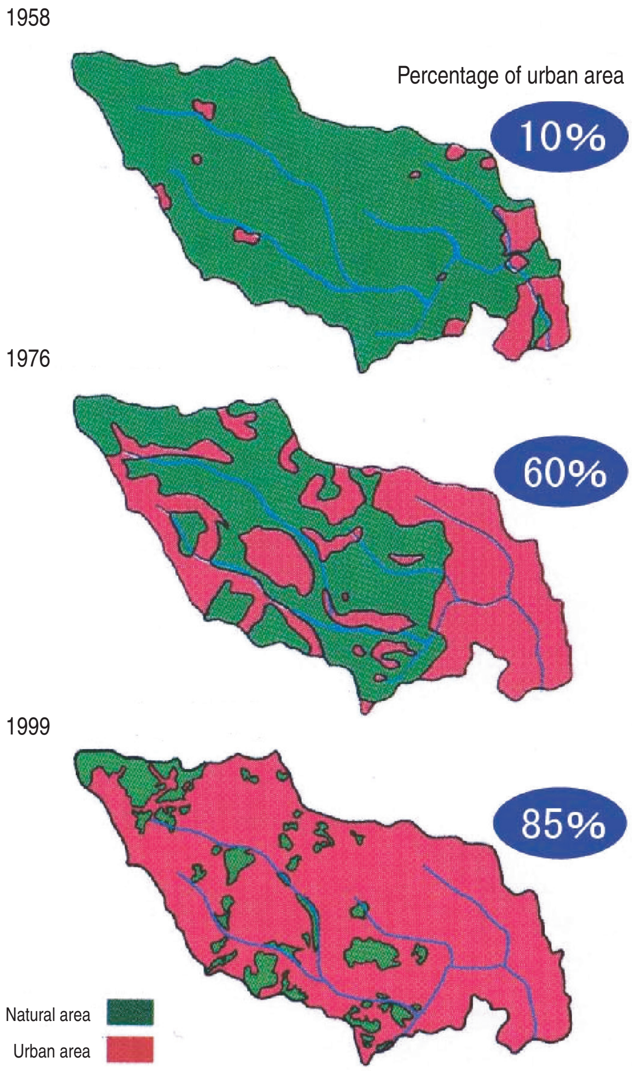
Most of the stormwater infiltrates into the ground or is retained on the ground surface. As a result, runoff downstream is reduced.



● **After development**

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

■ Urbanization in the catchment of the Tsurumi River



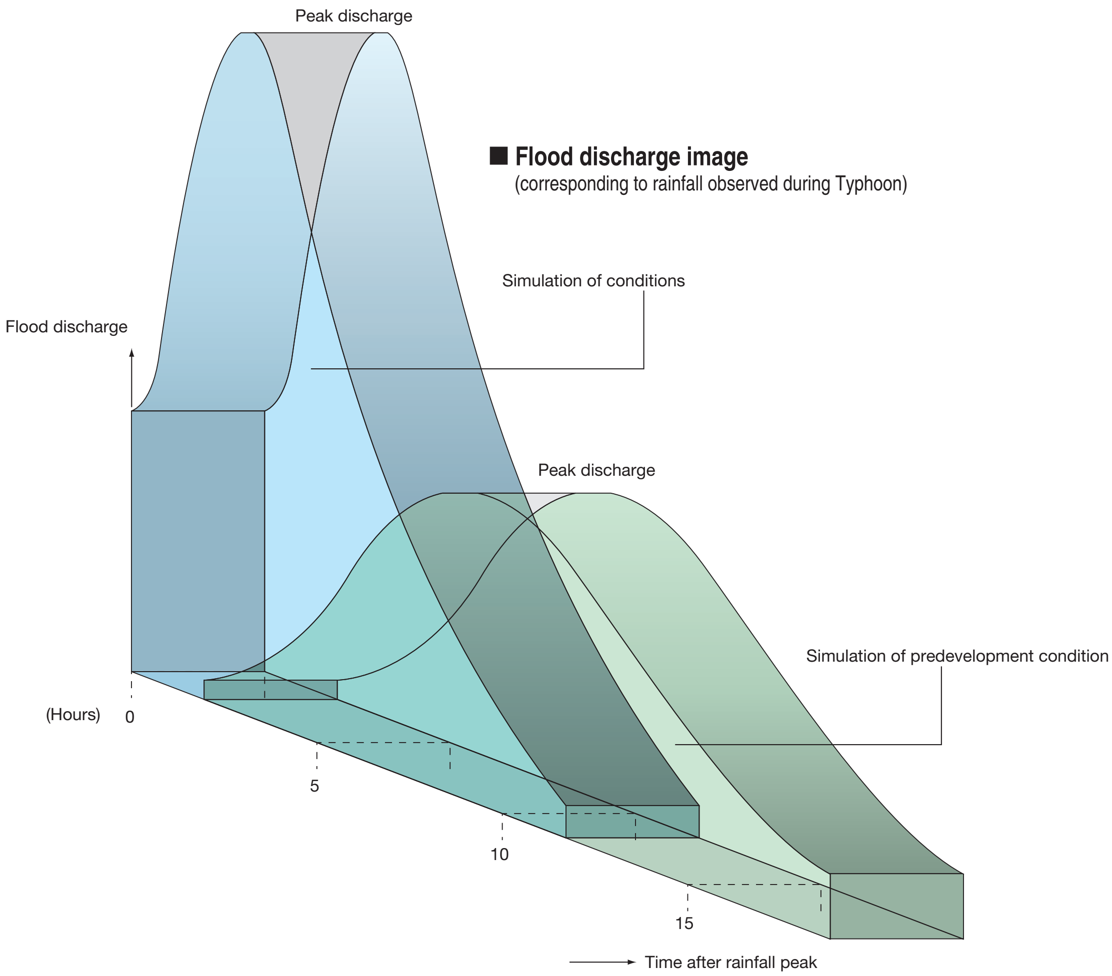
Occurrence of urban-type floods

Normally, the flow rate of rivers in urban areas is extremely low, but urban-type floods frequently occur when typhoons hit because the rainwater falling in the catchment concentrates and outflows within a short period, paralyzing urban functions and flooding underground shopping malls.

Kanda River, Tokyo (in normal state)

Flood condition during Typhoon No.11, 1993

■ **Flood discharge image**
(corresponding to rainfall observed during Typhoon)



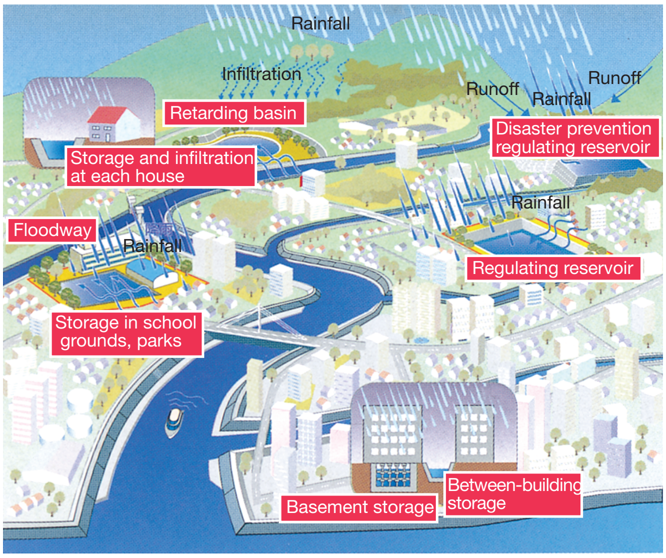
Comprehensive flood control measures

Japan is in need of comprehensive flood control measures to cope with rapid urbanization.

One consequence of rapid urbanization is the growing concentration of population and property in low-lying lands which have historically been subject to flooding. This trend is aggravating flood damage.

Conventional river improvement that relies on levees and retarding basins is not enough. There is an urgent need for a comprehensive approach that combines (1) river basin measures, such as the construction of facilities designed to preserve and enhance the retention and detention capabilities of river basins and the development of land uses and buildings that are highly resistant to floods, and (2) damage mitigation measures, such as the establishment of warning and evacuation systems.

■ Conceptual view of comprehensive flood control measures



■ Comprehensive flood management measures

- Comprehensive Flood Management Measures
  - River improvement
    - ●Channel improvement (e.g. embankment, dredging)
    - ●Construction of retarding basins, floodways
  - Runoff control
    - Retention areas
      - ●Maintenance of controlled urbanization districts
      - ●Conservation of nature
      - ●Construction of reservoirs and regulating basins
      - ●Installation of permeable pavements and seepage sumps
    - Detention areas
      - ●Preservation of urbanization control zones
      - ●Control of landfill
      - ●Promotion of conditions favorable to agricultural activities
    - Low-lying areas
      - ●Development of interior drainage facilities
      - ●Construction of storage facilities
      - ●Encouragement of use of floodproof buildings
  - Damage mitigation measures
    - ●Establishment of warning and evacuation system
    - ●Augmentation of flood-fighting management system
    - ●Publication of the maps of historical inundation areas and flood-prone areas
    - ●Encouragement of use flood-proof buildings
    - ●Dissemination of information among local residents

Typical examples of comprehensive flood control (Countermeasures on watershed, multipurpose retarding basin)

■ Countermeasures on watershed

Kirigaike regulating reservoir, Kanagawa Prefecture
This is normally used as a tennis court.

Reservoir filled with water in June 1985

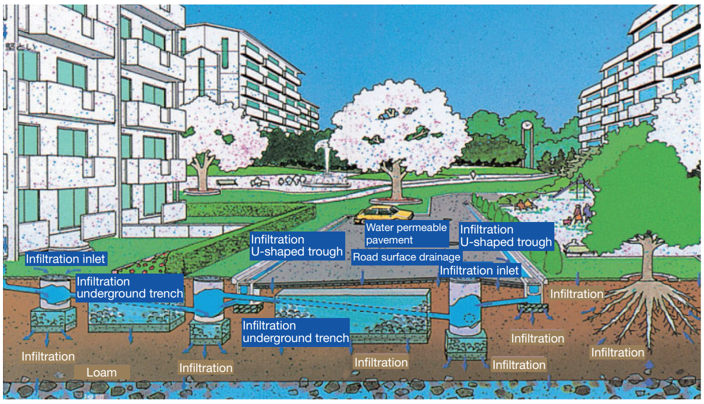


Image of development of storage and infiltration facilities

■ Multipurpose retarding basin

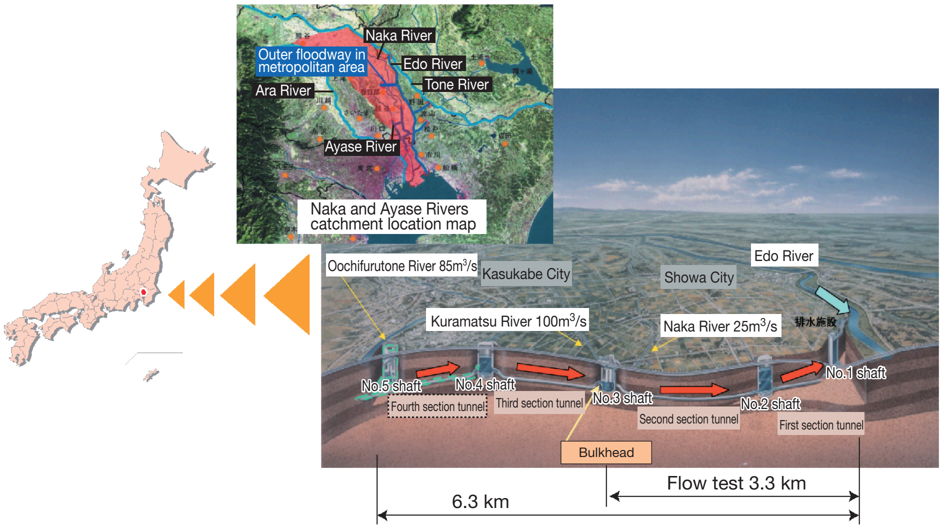
Multipurpose retarding basin of Tsurumi River,
Yokohama City, Kanagawa Prefecture

During No.6 Typhoon in 2002

Development of underground floodways and underground regulating reservoirs

■ Effects of outer floodway in metropolitan area

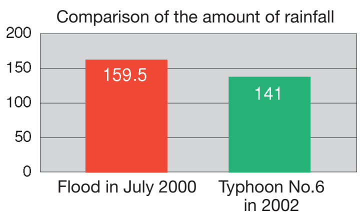
The outer floodway of the metropolitan area is the 6.3 km underground river (Kasukabe City to Showamachi, Saitama Prefecture) running through a tunnel 10 meters in diameter under Route 16, which drains the water of Naka River from its midstream section to Edo River. This is intended to alleviate flood damage substantially; a flow test was conducted for the 3.3 km section in June 8, 2002.

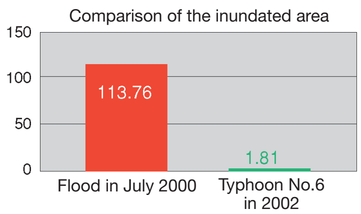


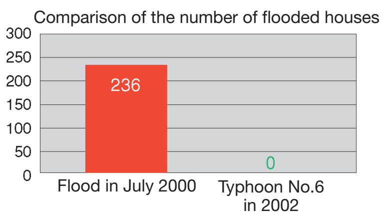
Headrace tunnel

Outline of outer floodway facilities of metropolitan area

During Typhoon No. 6 in 2002, the amount of recorded rainfall was 141 mm, which was similar in the magnitude to that of July 2000. Different from the case of 2000, test operation of the outer floodway succeeded in eliminating flooding of homes in the surrounding area.







* The amount of rainfall is the average amount of the catchment (for 48 hours).

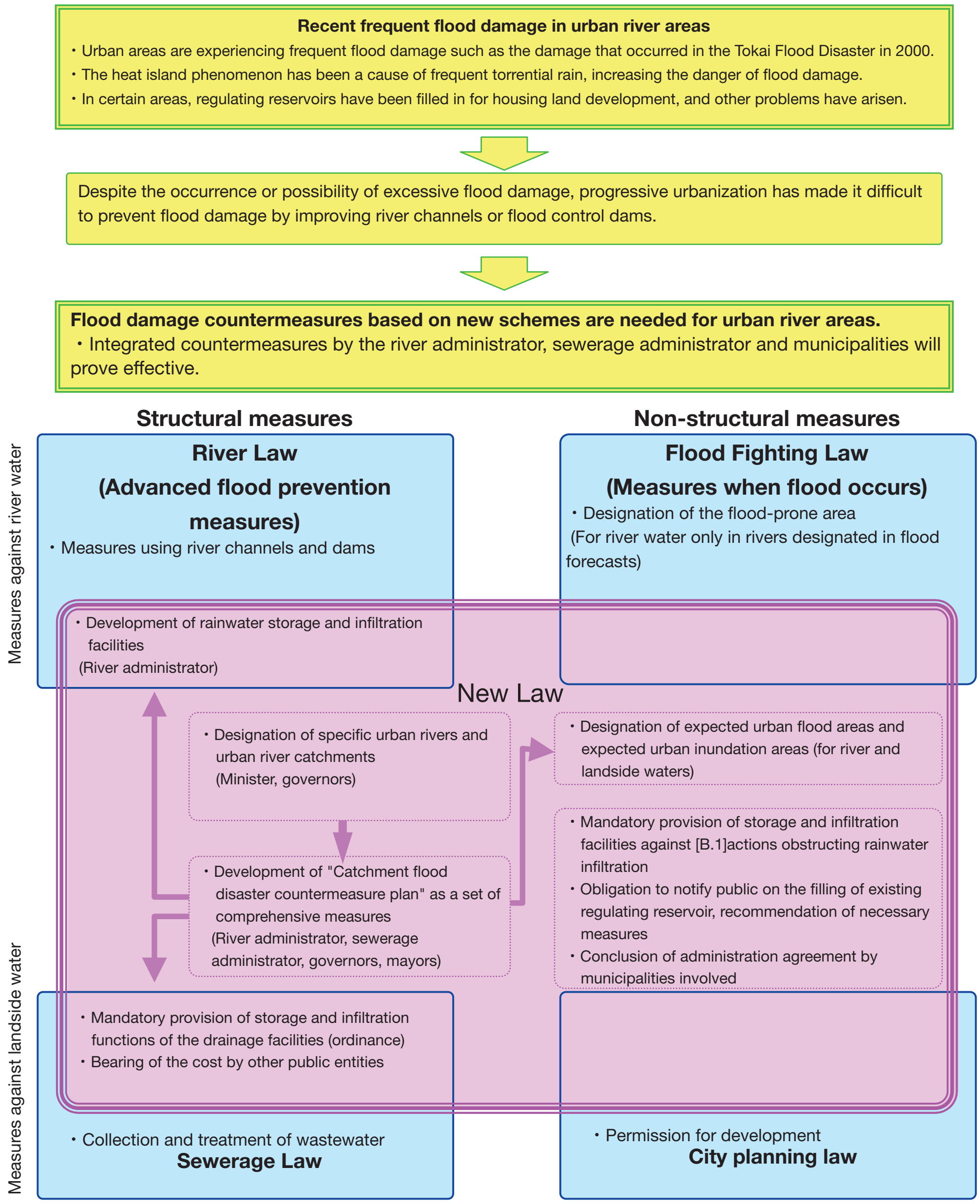
Floods in July 2000 (area around Midoridai 2-chome, Satte City)

Typhoon No.6 in 2002 (area around Midoridai 2-chome, Satte City)

Implementation of the comprehensive measures against urban flood

Measures to prevent flood disasters in specific urban catchments will be enhanced by specifying the urban rivers and catchments where flood disasters have occurred or may occur, where prevention of flood disasters by improving the river channel is difficult because of progressive urbanization and where developing catchment flood disaster countermeasures, developing rainwater storage and infiltration facilities by the river administrator and other measures will prove effective as part of comprehensive flood disaster countermeasures.

■ Specific Urban Rivers Flood Disasters Countermeasures Law (Law No.77 in 2003)



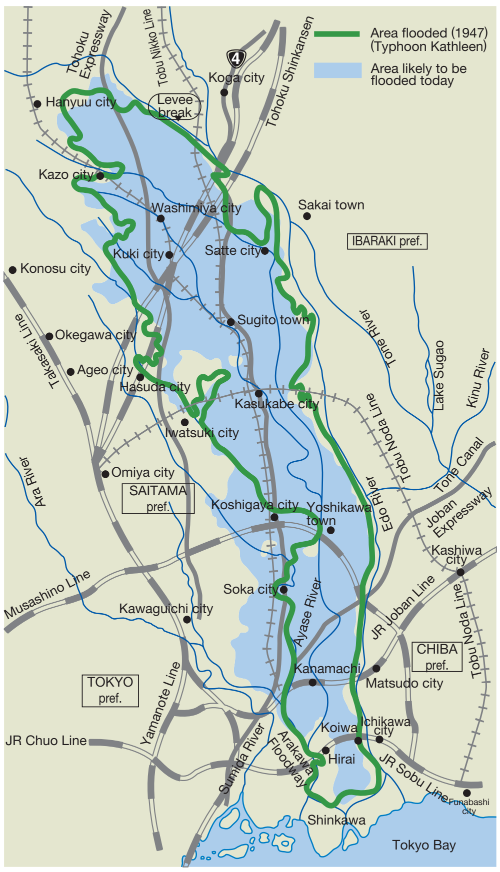
Super levees for flood preparedness and community development

If another Typhoon Kathleen hits Japan today, direct damage alone would amount to 15 trillion, about 150 times as much as the damage caused by the 1947 typhoon.

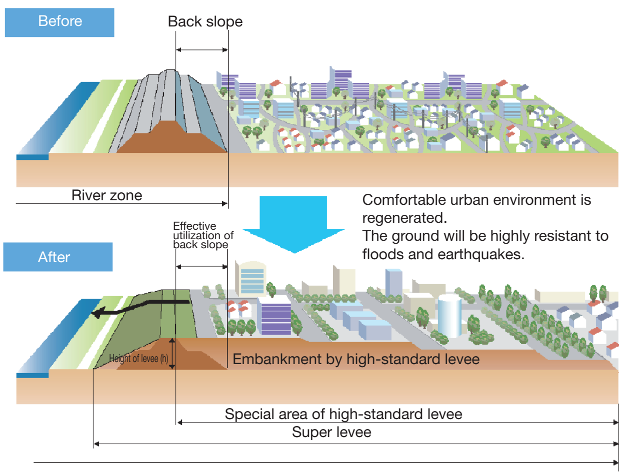
The function of a dam is to regulate the downstream flood discharge by storing storm flood only when flood discharge is high. Thus, dams reduce the peak discharge downstream and prevent a sharp increase in streamflow.

	Area flooded (1947) (Typhoon Kathleen)	Area likely to be flooded today	Remarks
Flooding area	estimated 440 km^2	estimated 555 km^2	Aggravation due to subsidence
Economic loss	estimated ¥100 billion	estimated ¥15 trillion	(at 1992 prices)
Number of affected persons	estimated 600,000 (1947)	estimated 210,000 (1992)	
Number of houses damaged	estimated 150,000	estimated 660,000	

■ Map showing projected flooded areas in event of dike break at Higashimura on Tone River



■ Concept of "Super levee"



■ High-Standard Levee (Super Levee) development project

Wide levees will be constructed along rivers flowing through urban areas with high density of population and property. Also integration with non-point developments, such as urbanization development, in the hinterland should be attempted. These types of levees, which will prove superior in coping with unexpected overtopping, are being constructed for river sections where unexpected effects would be considerable, such as the Tone, Edo, Ara, Tama, Yodo, and Yamato Rivers.

"Super levees" (High-standard levees) are the ultimate defense against a usual flood in alluvial lowlands. Super levees also provide space for a scenic and comfortable living environment.

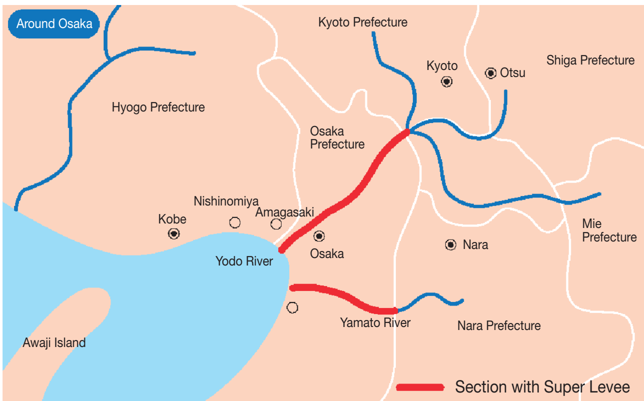
Even in the event of an extreme flood, damage can be minimized if levees do not break. Levee failure due to overtopping can be prevented by increasing levee width. Super levees are by far wider than conventional levees. A gently sloped super levees helps to connect the community to the river smoothly. The community side of super levees can also be used effectively, for example as residential land and parks. Thus, super levees can make it possible to build a safe and scenic community integrated with the river.

■ Komatsugawa area: development of high-standard levee along Ara River in Tokyo

Before development: 1980

After development: 2000

■ Rivers where Super Levees will be constructed

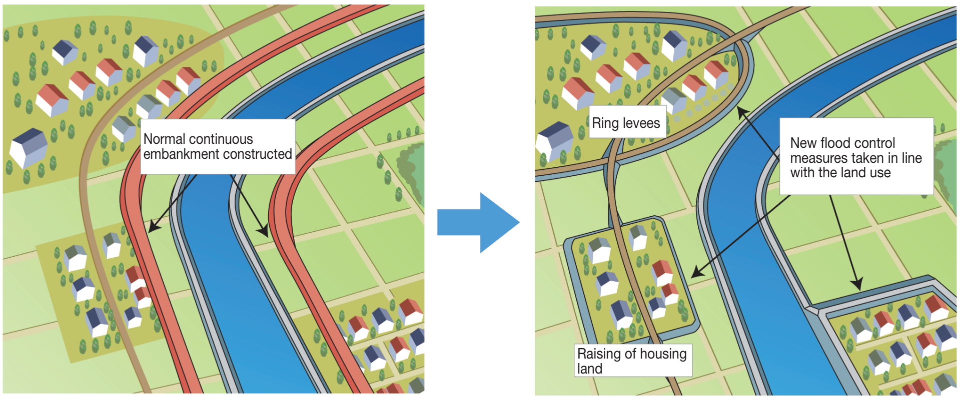


Measures for flood-prone areas

Flood control project considering land use

To protect homes and projected residential areas where long-term river improvement is difficult to implement because of difficulty in balancing needs of upstream and downstream areas, residential land will be raised or embankments (ring levees, etc.) will be built to prevent inundation economically and within a short time.

■ **Image of flood disaster prevention projects for specific rivers**



Mass migration in a special urgent project to avoid severe natural disaster

■ **Special urgent project to prevent severe natural disaster in the Kokai River area (Hakojima retarding basin)**

The Kokai River area suffered major inundation damage due to a typhoon in 1986.

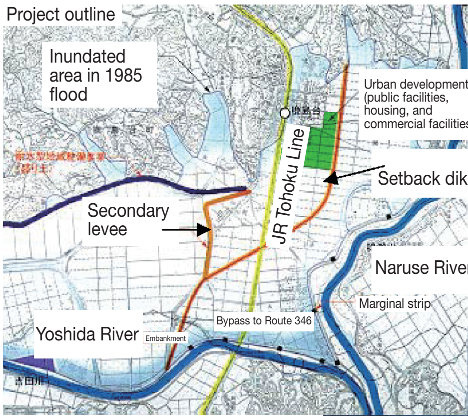
This experience led to a plan to develop a retarding basin in the Hakojima area that is located at the confluence of the Kokai River and its tributary, the Ooya River. Since villages existed inside the planned site for the retarding basin, land development was carried out by raising land inside the area to which residents migrated en masse.

Flood disaster situation

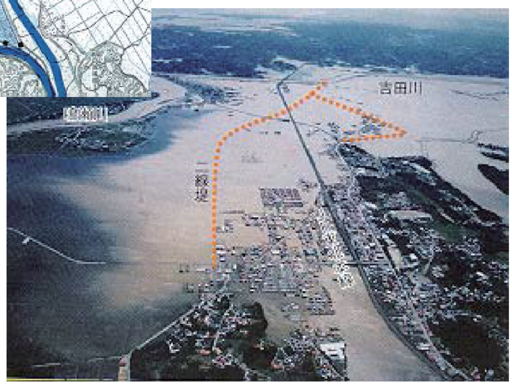
Mass migration

City planning to avoid and prevent flood damage

The recent experience of frequent torrential rain and consequent large floods because of abnormal weather forced the government to adopt new measures. To protect the life and property of the people in damage-prone areas, taking measures inside catchments has become essential. This is in addition to sewerage development and normal river improvement work such as widening of river channels. These new activities must be undertaken on the basis of consideration of the land use condition of surrounding areas. Certain flood damage indicates that comprehensive measures, including those in catchment are indispensable. Intensified implementation of suppression of runoff and measures in flood-prone areas are needed more than ever where such measures as preventive measures in line with the land use in catchments should prove to be effective.



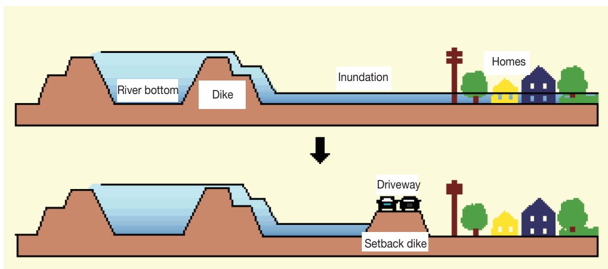
Naruse and Yoshida Rivers and planned setback dike



Inundation damage in 1986 and location of planned setback dike

Aerial photo of the project area

■ Setback dike preventing spread of inundation

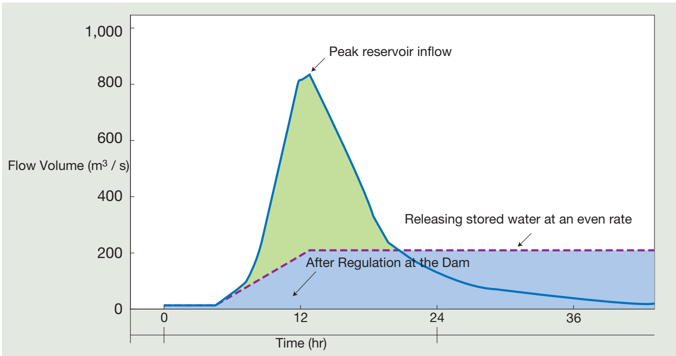


The use of dams for flood control

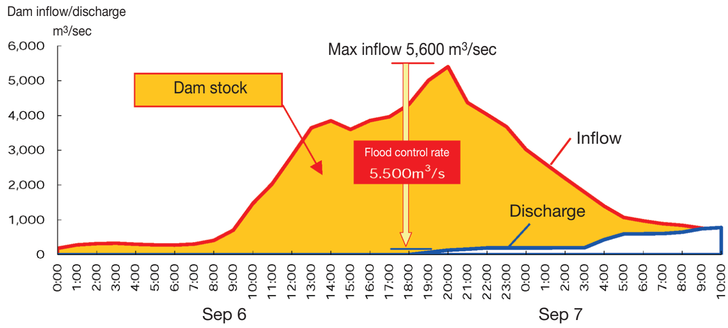
Flood control by dams

In 2005, with precipitation in Japan relatively low compared to the annual average, many authorities decided to reduce water intakes from June. Water intake restriction began on June 15 for canals in Tokushima and Kagawa. In the latter half of August, the percentage of storage of Sameura Dam dropped to 0%. Due to flooding caused by Typhoon No. 14 on September 6, Sameura Dam experienced a maximum inflow that was the second largest inflow ever after commencement of its operation. Due to the flood, the dam stored about 248 million m3 or 94% of the capacity of water use and flood control to mitigate damages in the downstream areas. The percentage of storage of the empty dam therefore recovered to 100% due to the flood.

■ Example a dam can regulate Flood discharge



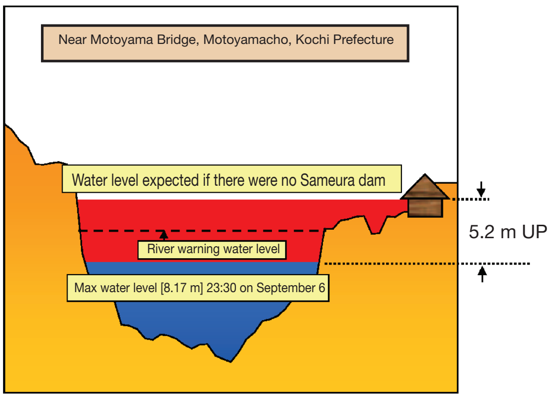
■ Flood control of Sameura dam



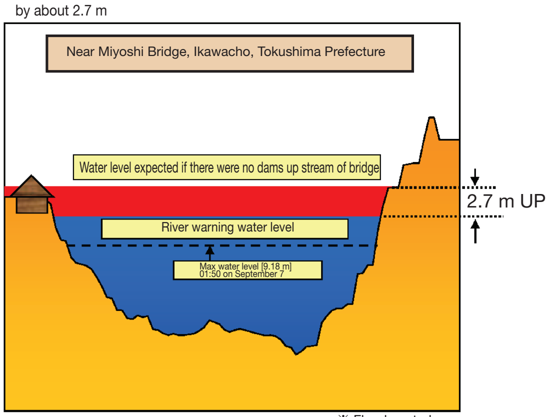
Sameura dam reservoir before flood

Sameura dam reservoir after flood

Motoyama Bridge point (near Motoyama Bridge, Motoyamacho, Kochi Prefecture)
* For the river with the width of about 150 m, the water level lowered by about 5.2 m.



Miyoshi Bridge point (near Miyoshi Bridge Ikawacho, Tokushima Prefecture ;downstream of Motoyama Bridge)
* For the river with the width of about 200 m, the water level lowered by about 2.7 m



※ Flood control map

Functional improvement and linked activities of existing dams

■ Effective utilization of facilities

Various measures are adopted to enhance effects of existing facilities by making better use of them.

○ **Integrated management**

When multiple dams are operated within the same catchment, the storage water in those dams is comprehensively managed to achieve the most effective service water supply.

○ **Redevelopment of dam**

Flood control and water utilization functions of dams are enhanced by increasing the reservoir capacity by raising the dam or removing sediment or by changing the dam operation by installing new intake and discharge facilities.

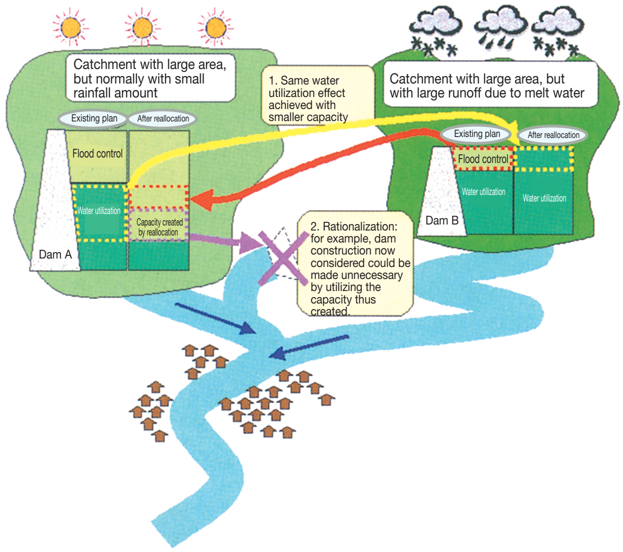
○ **Projects linking dams with channels**

Water stored in existing dams is effectively used by linking multiple dams via channels to allow storage of water amount that will otherwise be discharged and wasted.

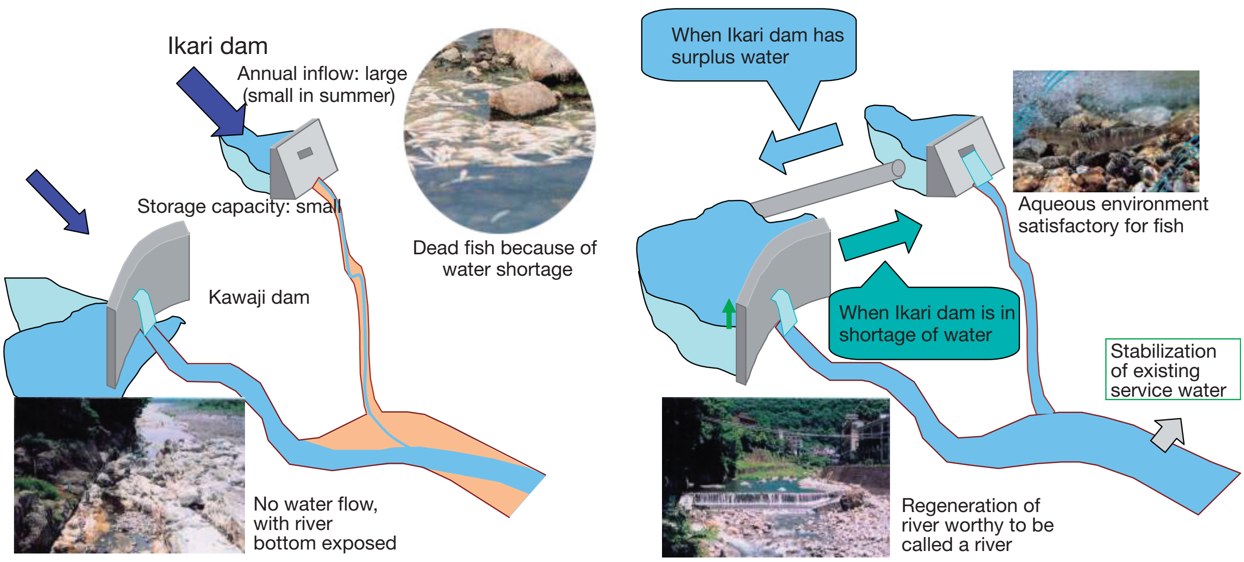
○ **Reorganization of dam groups**

Effectiveness of flood control and river environment improvement will be achieved by reallocating the reservoir capacity efficiently between dams with high flood control functions and those with high water utilization functions.

■ Image of dam linkage



■ Outline of the Kinu River upstream dam group linkage project



Preventing sediment disasters

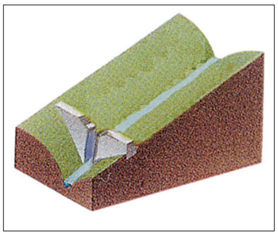
Sabo works ensures safety from sediment-related disasters occurring in various forms in various places.

Sediment-related disasters occur in very extensive areas from a headwater area to downstream cities and in a variety of forms. In order to protect people and properties from sediment-related disasters, two types of preventive measures are taken: structural measures for disaster prevention by building facilities and structures; and non-structural measures by way of establishing a system for warning and evacuation, and restricting and controlling new residential land development in areas vulnerable to a sediment-related disaster. Prevention of sediment disasters requires a comprehensive approach encompassing both structctural and non-structural measures.

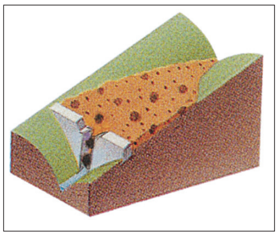
Structural measures

■ Sabo dam as preventive measures against debris flows

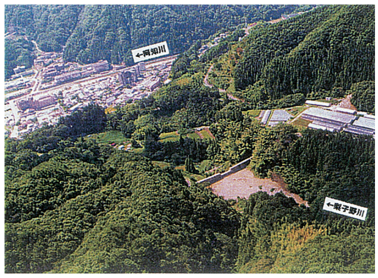
Sabo dams built in the upstream areas of mountain streams accumulate sediment and suppress production and flow of sediment. Those built at the exits of valleys work as a direct barrier to a debris flow which has occurred. A sabo dam with slits is particularly effective in capturing a debris flow because it has a larger capacity of sand pool under normal conditions. In case that there is a fear of flow-down of driftwood, a slit sabo dam is built as a preventive measure.



The dam allows sediment to flow downstream under normal conditions.



When a large scale debris flow occurs, sediment is captured and temporarily held here to prevent disasters in downstream areas.



A debris flow was caused along the Nashikono river in Nagano Prefecture in September 2000. The existing sabo dam captured debris flows.

In structural measures, various sabo facilities are installed to minimize damages by volcanic mudflow, pyroclastic flow and lave flow as well as sediment-related disasters caused by rainfall.

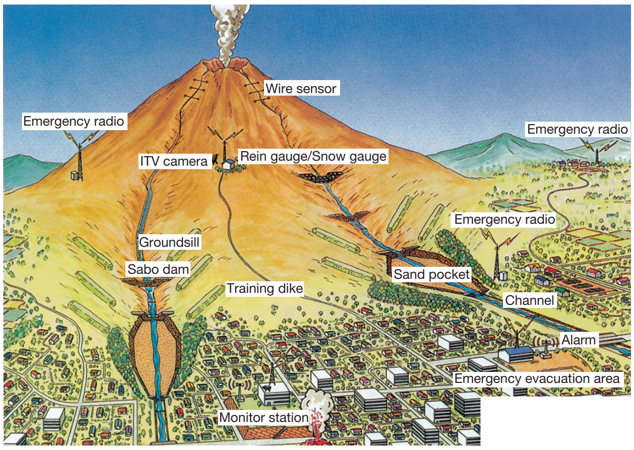
Major volcanic disaster prevention facilities include "energy dissipater" for checking the flow of volcanic products, "training dike works" for guiding mud flow and lava flow to safe zones and "permeable-type sabo dam" for preventing large rocks from rolling down and "sand pocket works" for allowing mudflow to accumulate.

Immediately after a volcanic disaster (Shimabara City, Nagasaki Prefecture)

Training dikes and sand pockets

■ Sabo works as comprehensive measures against volcanic eruptions

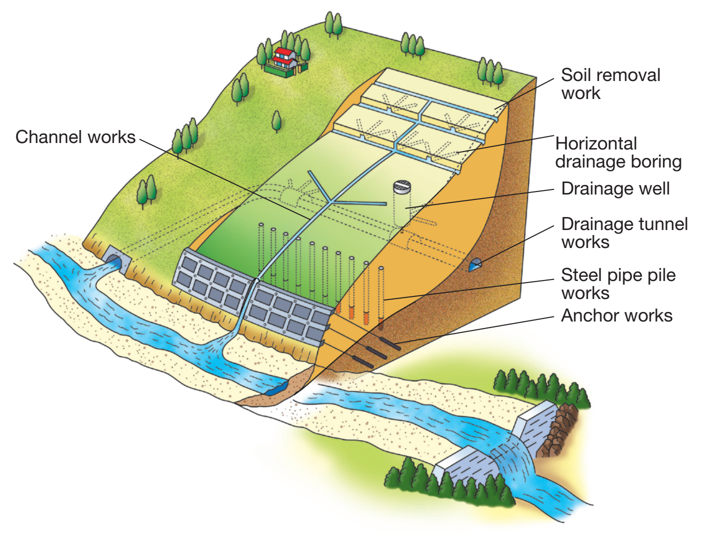
A volcanic disaster extends over a wide range of areas involving a loss of lives and properties. As a preventive measures, it is necessary to take comprehensive volcanic disaster prevention measures including non-structural preventive measures like establishment of a warning and evacuation system as well as structural preventive measures like the construction of sabo dams and other facilities.



■ Landslide prevention works

A landslide is caused by a combination of various factors (topography, geology, geological structure, ground water, etc.). Accordingly, measures to be taken for landslide prevention come in a variety of types. Broadly the landslide preventive measures are classified into two types of works: control works and restraint works. The control works are intended to remove or mitigate factors which may lead to the occurrence of a landslide. On the other hand, the restraint works aim at stabilizing a slope by the construction of structures. Landslide-prone slope is effectively stabilized by the combination of both types of works.

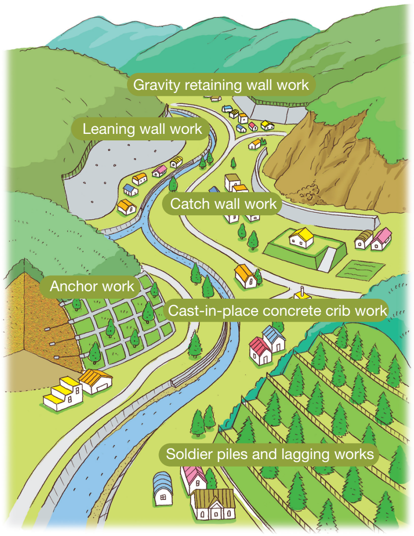
■ Schematic view of control works and restraint works



Large-scale landslide on Mt. Jizuki (Nagano City, July 1985)

Landslide prevention works have made this area safe. (Photo taken in June 1990)

Preventing sediment disasters



■ Slope failure prevention works

A slope failure is a phenomenon that a slope collapses abruptly due to weakened self-retainability of the earth under the influence of a rainfall or an earthquake. There are countermeasures to the slope failures. such as wall works which check sediment from upper slope in front of the resident area, crib works which is constructed by concrete crib and cover the inside with vegetation, and soldier piles and lagging works which set up sheet piles between stakes

Immediately after the completion of the works

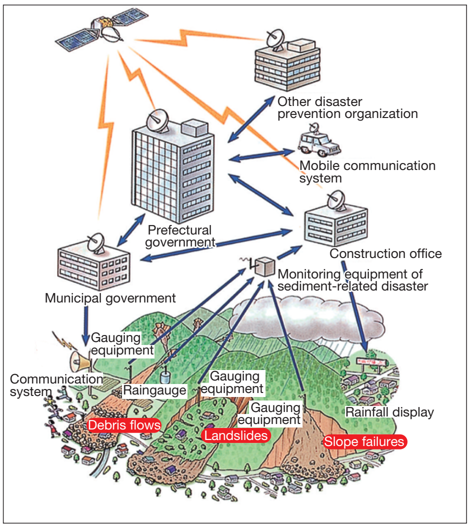
Immediately after a slope failure disaster (Kagoshima City, Kagoshima Prefecture, July 1986)

Several years after the completion of the works

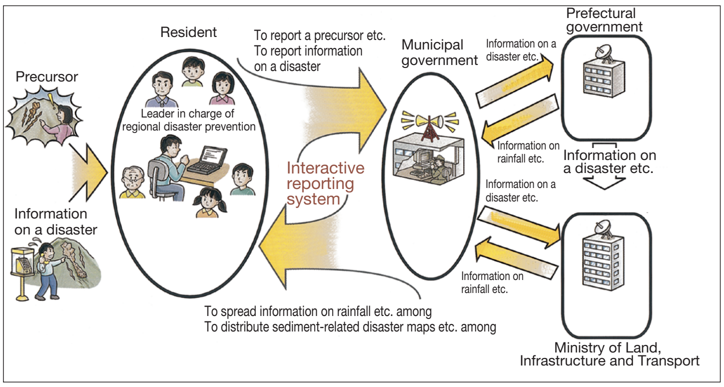
Non-structural measures

■ Disaster monitoring system including installation of equipment for collecting and processing information on rainfall

Safety measures are taken for areas which are vulnerable to sediment-related disaster damages. These measures include: installation of equipment for collecting and processing information on rainfall, etc.; use of an advanced disaster monitoring system intended to support warning and evacuation activities in a sediment-related disaster.



■ Promotion of establishment of interactive systems for reporting information on sediment-related disasters.



In order to protect invaluable lives from sediment-related disasters, we have set up a system that allows mutual communication on sediment-related disasters between local residents and administrative organizations both under normal condition and in an emergency.

Contents

■ Outline of the Sediment-related Disaster Prevention Law

The "Sediment-related Disaster Prevention Law" was established with the intention of instituting comprehensive non-structural measures to protect people from sediment-related disasters. These non-structural measures include public of risk information of areas prone to sediment-related disaster, development of warning and evacuation system, restriction on new land development for housing and other specific purposes, and promotion of relocation of existing houses.

Targeted Sediment-related Disasters :
Debris flow, Landslide, Slope Failure

Preparation for Guidelines on Sediment-related Disaster Prevention Measures

↓

Basic Survey

↓

■ Designation of Hazard Area

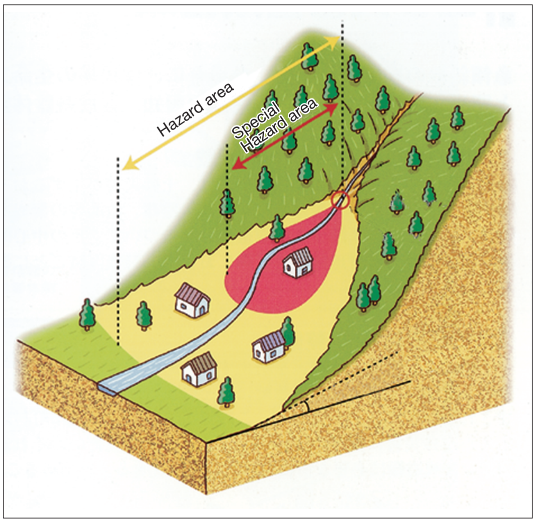
Area vulnerable to sediment-related disasters

・Preparing for the early warning and evacuation system

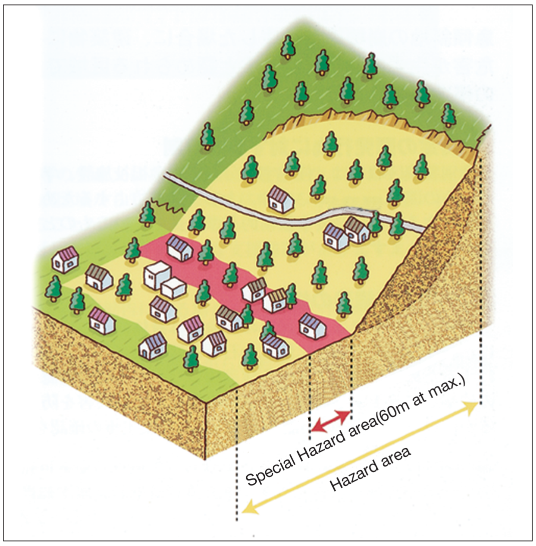
■ Designation of Special Hazard Area

Among hazard areas, special hazard areas are designated where there is a fear of damages to buildings and serious human injuries.

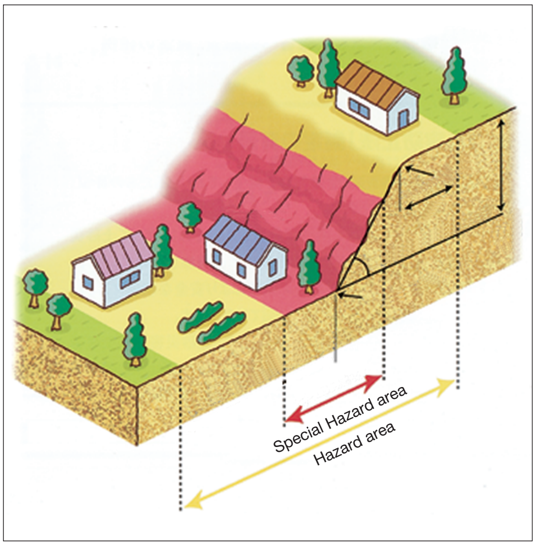
・Restriction of the building in the area
・Establishment of building regulations for the safety
・Advice of moving the building from the area
・Financial support for the people who move from the area



Debris flow



Landslide

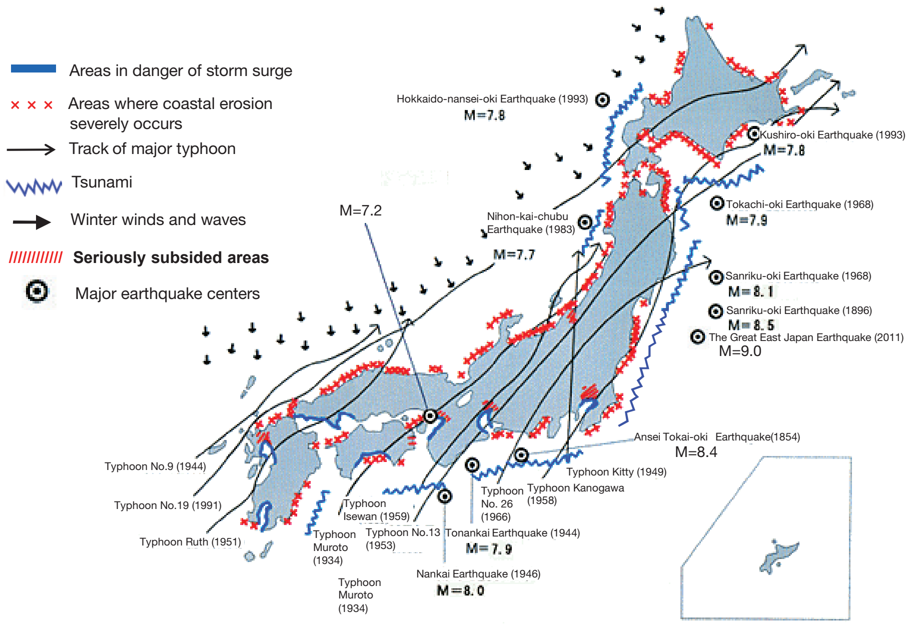


Steep slope failures

Coastal disasters in Japan

The coastline of Japan is highly complex and long of its land. Severe natural conditions, such as earthquakes, typhoons, and heavy winter waves, make the Japanese coastline all the more vulnerable to natural disasters.

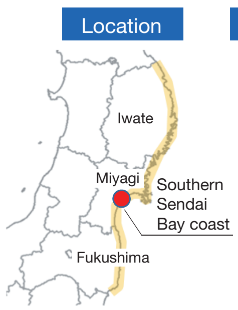
The total length of the Japanese coastline is about 35,000km. This is approximately equal to the circumference of the earth. Under severe natural conditions including earthquakes, typhoons, and heavy winter waves, the Japanese coastline is very vulnerable to natural disasters, such as tsunami, storm surge, high waves, erosion, and subsidence. Coastal erosion is particular serious throughout the country.

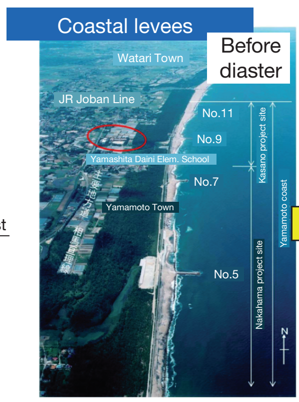


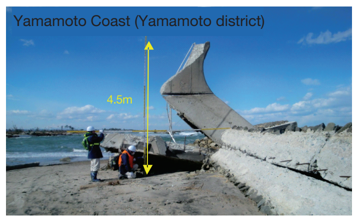
Damage caused by the Great East Japan Earthquake and Tsunami

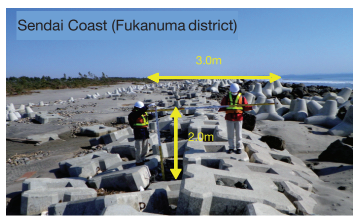
Along the 1,700km coast of Iwate, Miyagi & Fukushima prefectures, there were 300km of coastal levees. 190km of the levees were fully or partially destroyed.

■ In Southern Sendai Bay coast









Tsunami mitigation measures

Basic concepts for tsunami mitigation measures based on the lessons from the Great East Japan Earthquake

The Great East Japan Earthquake was far beyond prediction and the resulting damage was extensive. A new attitude towards disaster mitigation and damage minimization is demonstrated by the implementation of multiple combinations of hardware building and software measures against tsunamis of maximum class (L2).

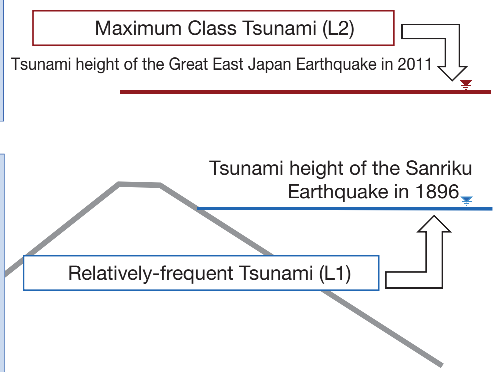
Promotion of the development of coastal embankments is to preserve national land and protect human life and assets against relatively-frequent tsunamis (L1).

Maximum Class Tsunami (L2)

Against maximum class tsunamis, the aim is to minimizefatalities by a combination of structural measures, urban developments and establishment of warning and evacuation systems.

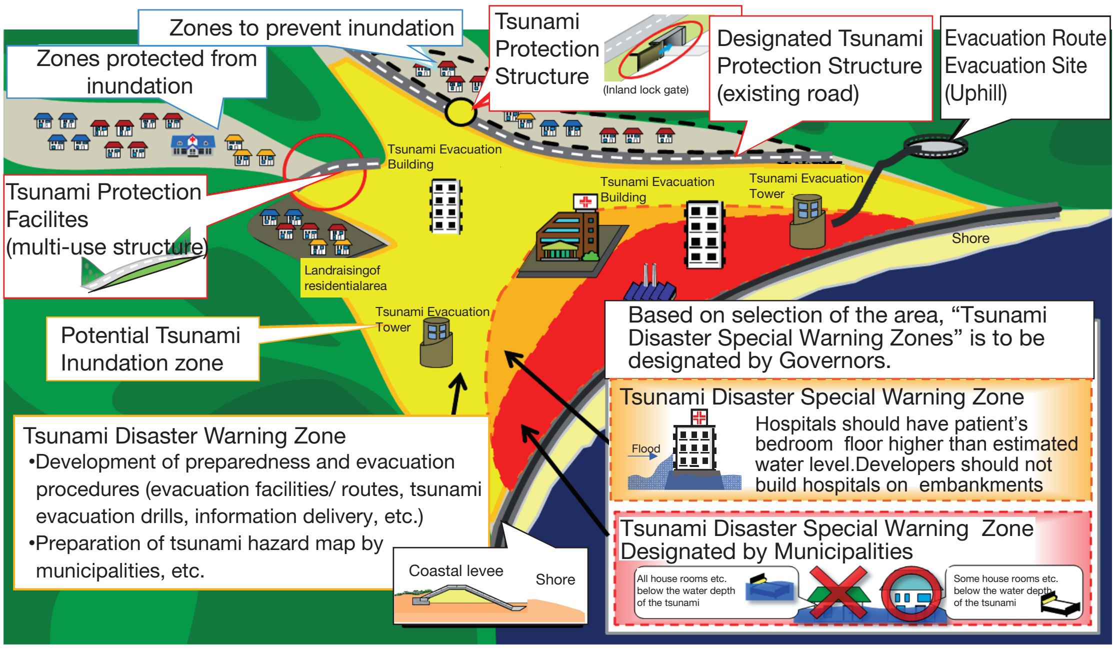
Relatively-frequent Tsunami (L1)

Against relatively-frequent tsunamis (about once every several decades to a hundred years), the aim is to protect human life, assets, and national land (coastline) as a basic adaptation by developing shore protection facilities. In addition, technical development and construction is installed so that facilities can withstand the impact even if the tsunami exceeds the height of the designed object.



Development of Tsunami-resilient communities

To minimize damage and loss by appropriately integrating structural and non-structural measures, based on a concept that human lives must be protected even in the event of the similar magnitude of tsunami to the Great East Japan Earthquake.

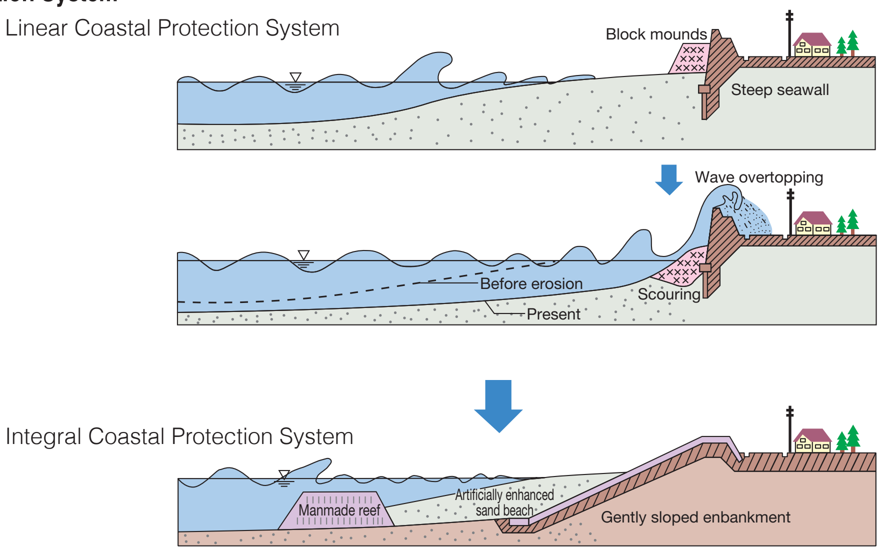


Coastline protection

Promote Integrated Coastal Protection System to prevent disasters considering recreational use and environment.

In various parts of Japan, coastal areas had been protected mainly by steep seawalls and block mounds. However, continuous coastal erosion has resulted in severe damage to these facilities through scouring and wave overtopping. This is why the Integrated Coastal Protection System has been developed. This system is a combination of several measures, such as gently sloped embankments, artificially enhanced sand beaches, and artificial reefs. This not only improves durability against high waves and erosion, but also enhances scenic, and recreational aspects.

■ From Linear Coastal Protection System to Integrated Coastal Protection System



Ishikawa Coast in Ishikawa prefecture

Kaike Coast in Tottori prefecture

Disaster recovery

Emergency response is an important component of flood control measures

Recovery is as important as prevention of disasters in Japan, a disaster-prone country.

In the event of a disaster, emergency measures are taken to minimize damage and the damaged facilities are restored.

Along with the recovery of public civil engineering structures controlled by the national government, the government generally bears most of the cost of the facilities managed by local authorities.

Disaster recovery projects can broadly be classified into two groups:

Disaster recovery projects and augmented recovery projects. In disaster recovery projects, the predisaster condition is restored. In augmented recovery projects, which are undertaken when simple restoration is not enough because a similar heavy rainfall event is expected to cause recurrence of a disaster, restoration work out includes unaffected areas, in accordance with permanent measures based on a set plan. Also restoration is carried out taking account of cost performance, and the surrounding environment of the river systems in mind. Disaster recovery is as important as preventive measures.

Confluence of Yosasa and Kuro Rivers in the Naka River System in Tochigi Prefecture at time of disaster in August 1998

Five years after improvement

Confluence of Yosasa and Kuro Rivers in the Naka River System in Tochigi Prefecture just after improvement (May 2000)

IV

Flood Fighting

Outline of the Flood Fighting System

1. The Flood Fighting Act

Geologically and meteorologically, Japan is located in an environment prone to flood disasters. The country has a long history of dealing with floods. Flood-fighting activities by local autonomous organizations of villages have long been implemented for defense measures along with flood control works. Since the heavy disasters inflicted by Kathleen Typhoon, the importance of flood-fighting activities against flood disasters by large typhoons was recognized, which led to establishment of the Flood Fighting Act in 1949.

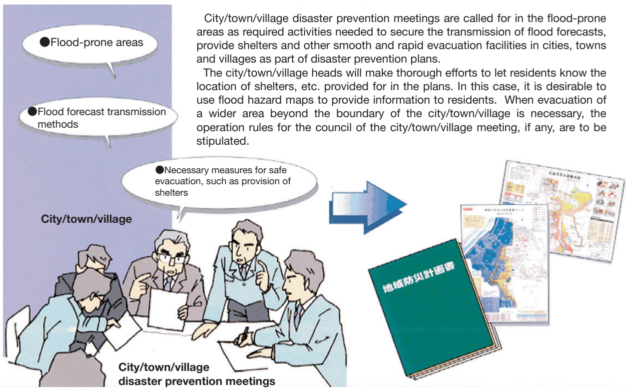
2. Revision of the Flood Fighting Act

The Flood Fighting Act revised in 2005 has additional provisions to enhance flood fighting strength including expansion of the scope of rivers designated as flood-prone areas, improvement of disseminating flood information for medium- and small-size rivers, foundation of flood-fighting cooperative organizations, and provision for payment of retirement benefits for members of part-time flood-fighting groups.

3. Flood-Fighting Organizations ... Flood-Fighting Management Entities

In view of the historical background in which flood-fighting was conducted and developed by traditional autonomous organizations, mainly at the village level, the flood-fighting management entities were basically city, town, and village authorities according to the Flood Fighting Act. Such entities can organize flood-fighting teams and can also help standing fire-fighting agencies take part in flood fighting under their control.

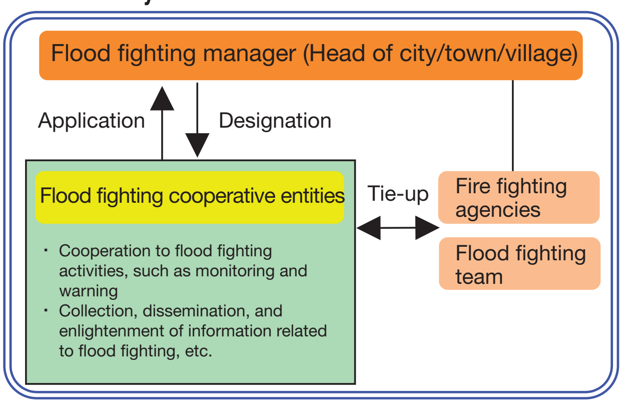
Leaders (managers) of flood-fighting management entities (city, town, and village chiefs) must establish flood-fighting plans incorporating monitoring, warning, communications, liaison, transport, operation of related facilities, and cooperation and aid among entities.



(Revised in 2005)

The revised law allows the flood fighting manager to designate public-interest corporations and incorporated nonprofit organizations as flood fighting cooperative entities according to application. It also establishes regulations on retirement benefits for part-time members of flood-fighting organizations.

■ **Conceptual view of the flood fighting cooperative entities system**

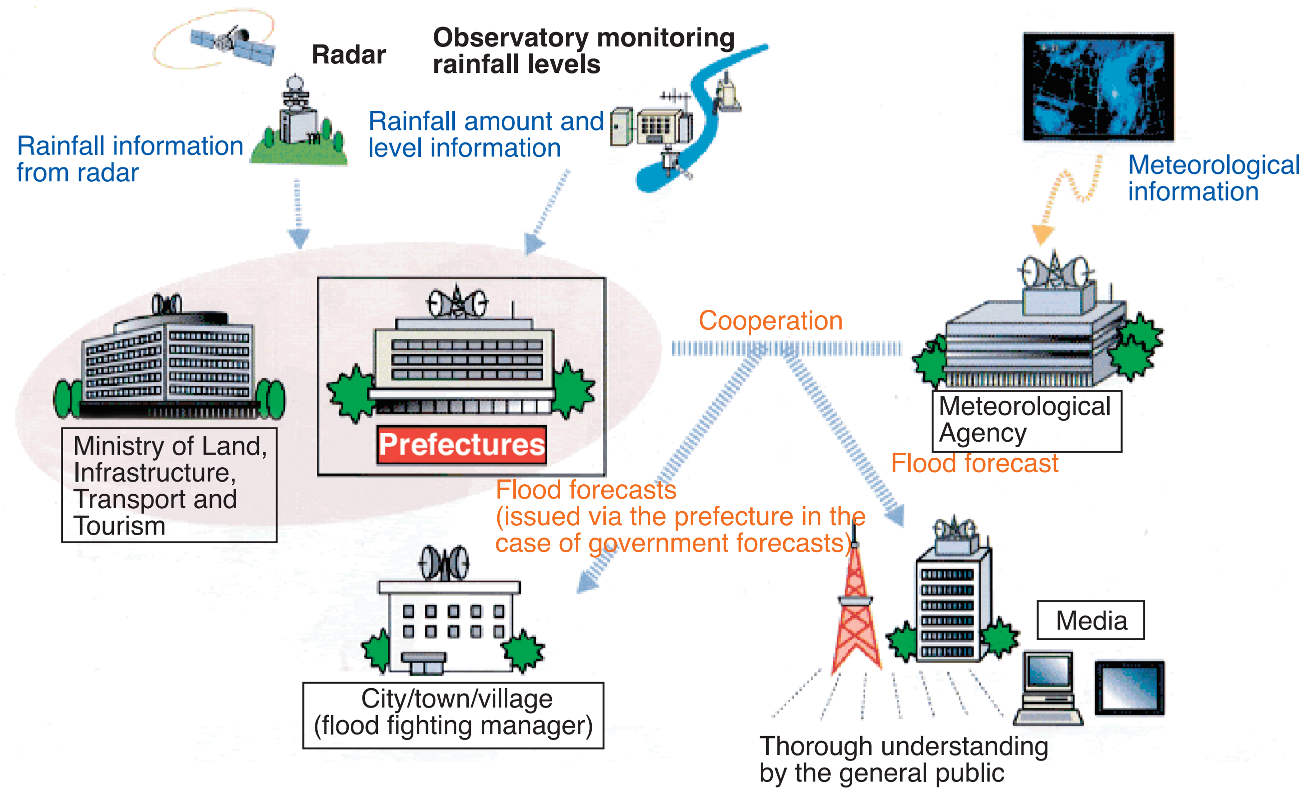


Outline of the Flood Fighting System

4. Flood-fighting warnings, flood forecasts

For rivers that may cause substantial damage to the national economy (109 Class A river systems and some of the Class B river systems nationwide), the Ministry of Land, Infrastructure, Transport and Tourism or the prefectures have to cooperate with the Meteorological Agency in providing flood or possible flood forecasts thoroughly to residents. The Ministry of Land, Infrastructure, Transport and Tourism or the prefectures also designate the rivers, lakes/marshes or the seacoasts to provide the flood-fighting warnings to guide flood-fighting activities of the flood-fighting management entities.

■ **Expansion of designated rivers for flood forecasting**



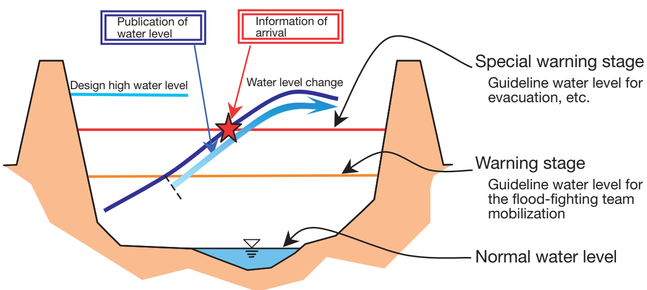
(Revision in 2005)

Improvement of flood information transmission for major medium- and small-size rivers

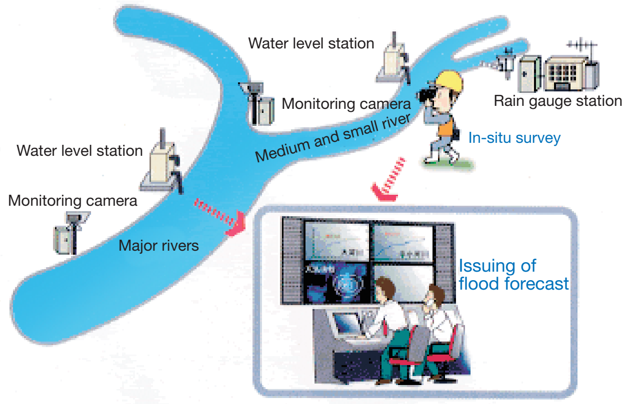
A special warning stage for major medium- and small-size rivers other than those designated for flood forecasts by the Ministry of Land, Infrastructure, Transport and Tourism or the governor (Fig. 5), is specified as one of guidelines for evacuation warnings as a substitute for the flood forecast. If the water level reaches this stage, this fact has to be notified to flood-fighting managers. Request for the cooperation of the media is to be issued as needed to inform the general public thoroughly. In Japan, the following water levels are set for each river for issuing of flood forecasts:

- Bank-full stage: Water level at which the flood may cause dike break or inundation damage. When there is any possibility that the water level may reach the bank-full stage, a flood warning is issued to regional residents in cooperation with the flood-fighting teams, administrative agencies, broadcasting stations and newspapers.
- Warning stage: Water level during flood, which is a guideline for flood-fighting activities. If the water level reaches the warning stage and may rise continuously, flood-fighting activities, such as patrolling by the flood-fighting team, etc. will be done.
- Designated water level: Water levels during flood, which serve as a guideline for preparation of the flood-fighting activities. At this level, members of the flood-fighting teams will be mobilized and equipment will be prepared.
- Supply of the information that the water level has reached the special warning stage in principal medium and small rivers

■ Image of setting the special warning stage



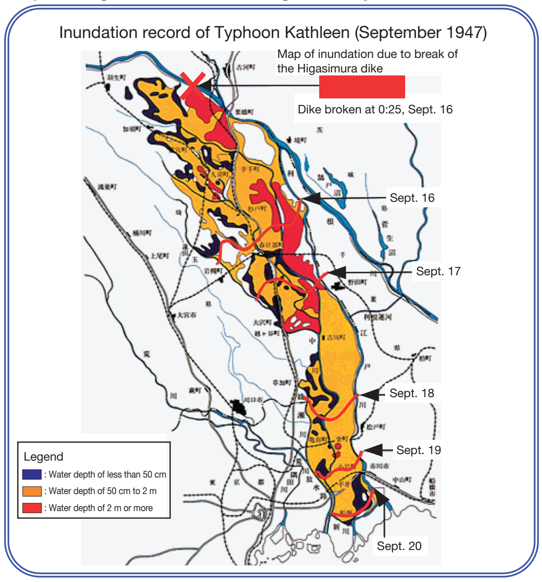
■ Image of flood forecasting for medium and small rivers



Improving flood forecasting for major rivers

For rivers designated by the Ministry of Land, Infrastructure, Transport and Tourism and whose flooding will cover a wide area, the flood inundation area and water depth can be forecast after flooding occurs, in addition to conventional forecasting of water levels and flows.

■ Improving flood forecasting for major rivers

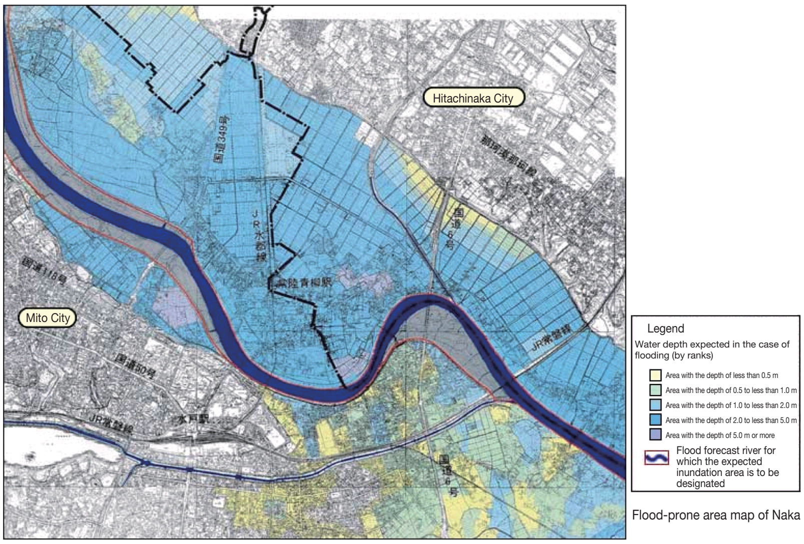


Outline of the Flood Fighting System

5. Publication of the flood-prone area maps (with reference to the revision in 2005)

■ Flood-open area map of Nata River

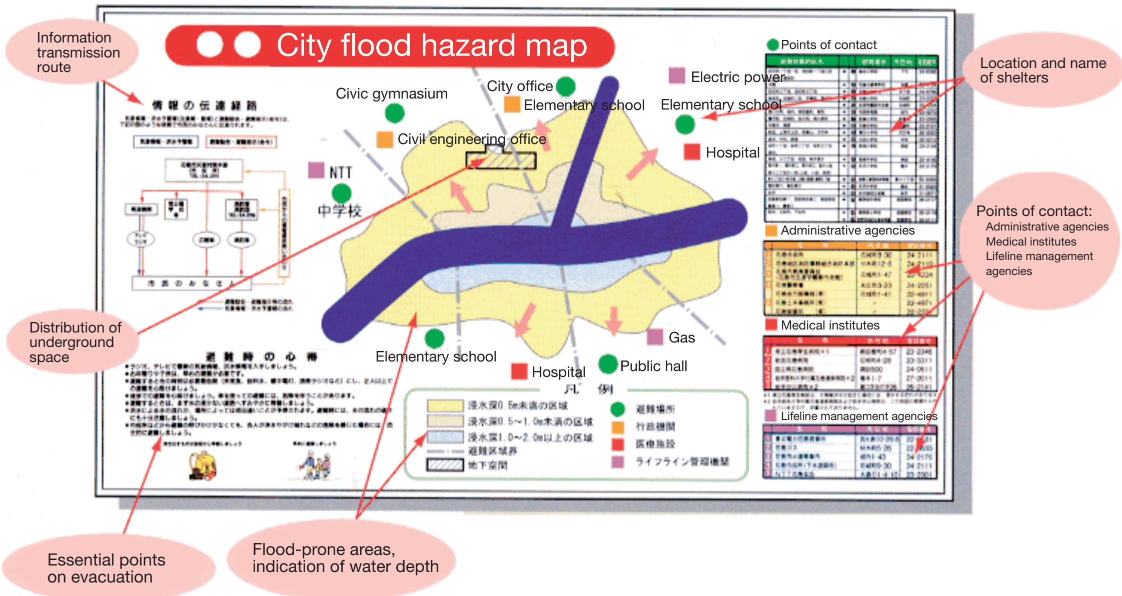
The Ministry of Land, Infrastructure, Transport and Tourism or the prefectural governor will designate, as flood-prone areas, those areas that may be inundated in the event of flooding. The Ministry of Land, Infrastructure, Transport and Tourism or the prefecture will announce publicly and notify the city/town/village concerned about the flood-prone area and the expected water depth in the event of inundation. On the basis of the flood-prone area map, the city/town/village will prepare and disseminate the flood hazard map (the map facilitating rapid and smooth evacuation of residents in case of disaster while enhancing their awareness) to residents.



Flood-prone area map of Naka River

(Revision of 2005)

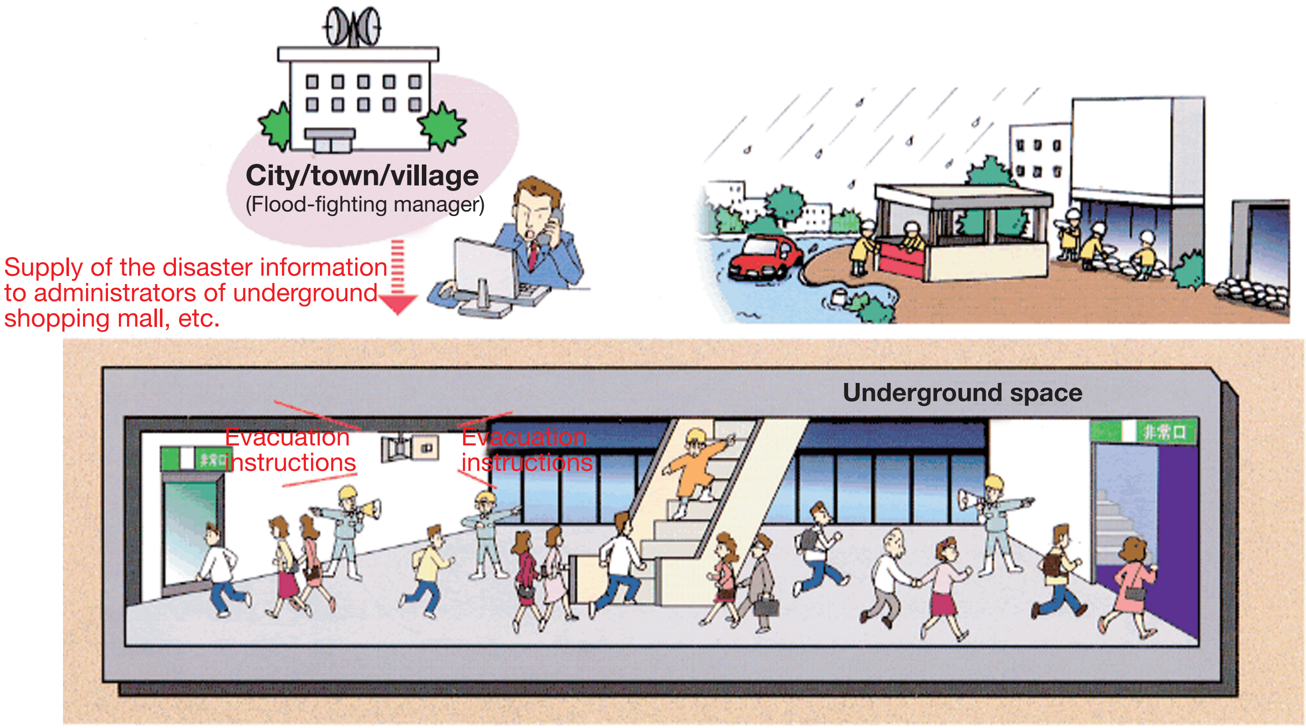
In addition to the rivers covered by flood forecasts, the flood-prone area is to be designated for major medium- and small-size rivers designated by the Ministry of Land, Infrastructure, Transport and Tourism or the prefectural governor. Concurrently, the city/town/village included in the flood-prone areas is to prepare flood hazard maps and distribute their content for thorough understanding of the general public in the form of printed materials.



6. Measures related to the underground spaces

In underground spaces, including underground shopping malls, subways, underground parking areas, etc., inundation depths increase dramatically faster than they do above ground. When there are underground facilities, such as underground shopping malls, in the flood-prone area, the flood forecast transmission method is set to ensure smooth and rapid evacuation of facilities in the event of flooding.

■ **Supply of desaster information to administrators of underground shopping malls, etc.**



(Revision of 2005)

Owners or administrators of the underground shopping mall, etc. inside the flood-prone area are to prepare evacuation assurance plans independently or collectively.

V

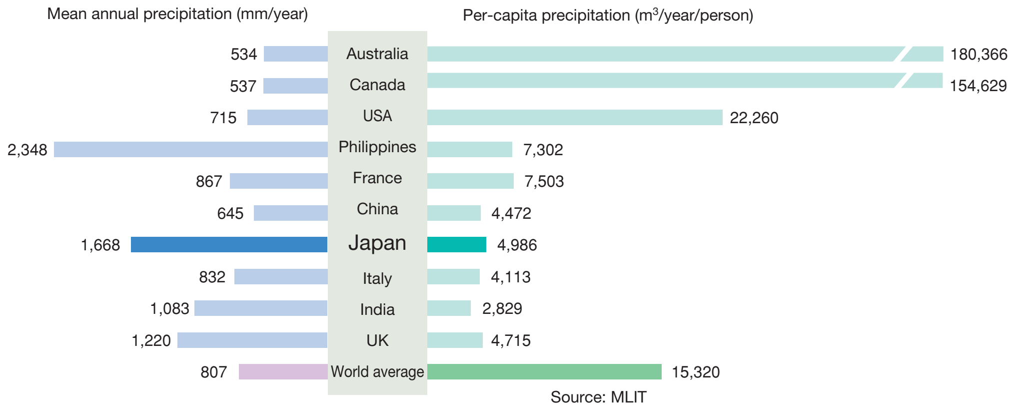
Water Resources

Characteristic water resources

Per capita precipitation in Japan is only one-fourth of the world average.

Precipitation in Japan is nearly two times the world average, but per capita precipitation is only one-fourth of the world average. From the viewpoint of available water resources, Japan cannot be considered a water-rich country.

■ Annual average amount of rainfall and annual average rainfall per capita

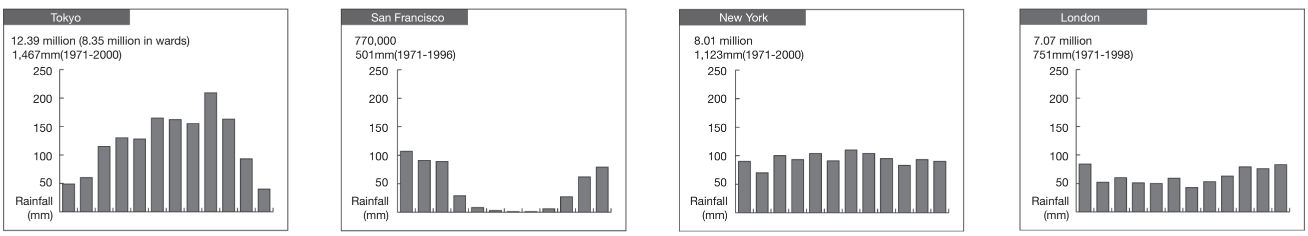


Source: MLIT

Since seasonal variations of precipitation are great, water availability is not reliable.

Tokyo, for instance, has considerable rainfall during the rainy season and the typhoon season but has little rainfall in winter. Consequently, even though annual precipitation is relatively high, seasonal variations mean that the amount of water available throughout the year is unreliable and unexpectedly small.

■ Population and annual amounts of rainfall in cities



* Source: "Japanese Statistics for 2004" and "World Statistics for 2004" edited by the Statistics Training Institute, Bureau of Statistics, Ministry of Internal Affairs and Communications
"2004 Chronological Scientific Tables" edited by National Astronomical Observatory of Japan, Maruzen (2004)
US Census Bureau and Tokyo Statistics Bureau

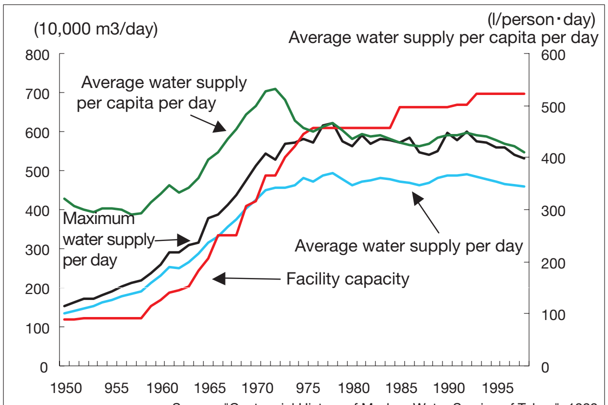
Characteristic Water resources

Growing water demand during period of high economic growth

The post-war Japanese economy before the Tokyo Olympics maintained a high growth rate on an average through waves of booms, in 1955-57, 1959-61 period, and 1963-64. Water demand grew rapidly during these periods due to population growth, industrial expansion, dissemination of washing machines, etc., and improvements in the quality of life where achieved due to improvement of the water supply and sewerage system, and large consumption of building cooling water.

In addition, the pumping of large amounts of groundwater to cope with rapidly increasing industrial water use led to ground subsidence at an annual rate of 10 cm or more. This in turn presented the problem of converting groundwater to surface water, which led partially to an increase in demand for surface water.

■ History of facility capacity and supplied water by the Office of Water Service of Tokyo



Source: "Centennial History of Modern Water Service of Tokyo"; 1999; Office of Water Service of Tokyo

■ Change in demand for water supply provided by the Office of Water Service of Tokyo

		1950	1965	1965／1950
Tokyo population		6,278	10,869	1.73
Office of Water Service of Tokyo	Population in water supply district (thousand persons)	5,631	8,877	1.58
	Population served by water supply as percent of total population (%)	74.4	90.2	1.21
	Average water supply per capita, per day	321	396	1.23
	Annual water supply (million m3)	491	1,156	2.35

Source: "Centennial History of Modern Water Service of Tokyo"; Reference and chronological table; 1999; Office of Water Service of Tokyo

■ Change in demand for industrial water (fresh water) in Tokyo

Unit: water amount in thousand m3/day, Sum: ￥100 million/year

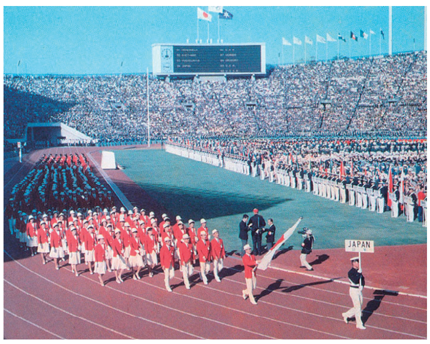
	Fresh water consumption				Product shipment sum	
	Total	Surface water	Ground-water	Recycling water	Total	Industries dependent on service water
1958	1,351	503	679	169	15,892	5,976
1965	2,774	924	1,491	359	41,581	12,759
1965／1958	2.05	1.84	2.20	2.12	2.62	2.14

Notes: Under fresh water consumption, the value for surface water is determined by deducting the recycling water and well water (groundwater) from the total of fresh water.
The value for service water dependent industries is the total of the medium classification of foods, textiles, paper pulp, chemistry, oil and coals, ceramic soil and stone, and iron and steel.
(Source: Land and Service Water section of Industrial Statistics compiled by the former Ministry of International Trade and Industries)

"Olympic" water shortage and emergency measures

Rapid growth of water demand forced the Office of Water Service of Tokyo to operate to supply water beyond its facility capacity. The service area of the reservoir system had to endure water supply restriction for as long as four years from October 1961 to March 1965.

The water supply restriction reached its peak in 1964, that is, immediately before opening of the Tokyo Olympic Games. The Office of Water Service of Tokyo had to implement the 50% water restriction in August, the same year.



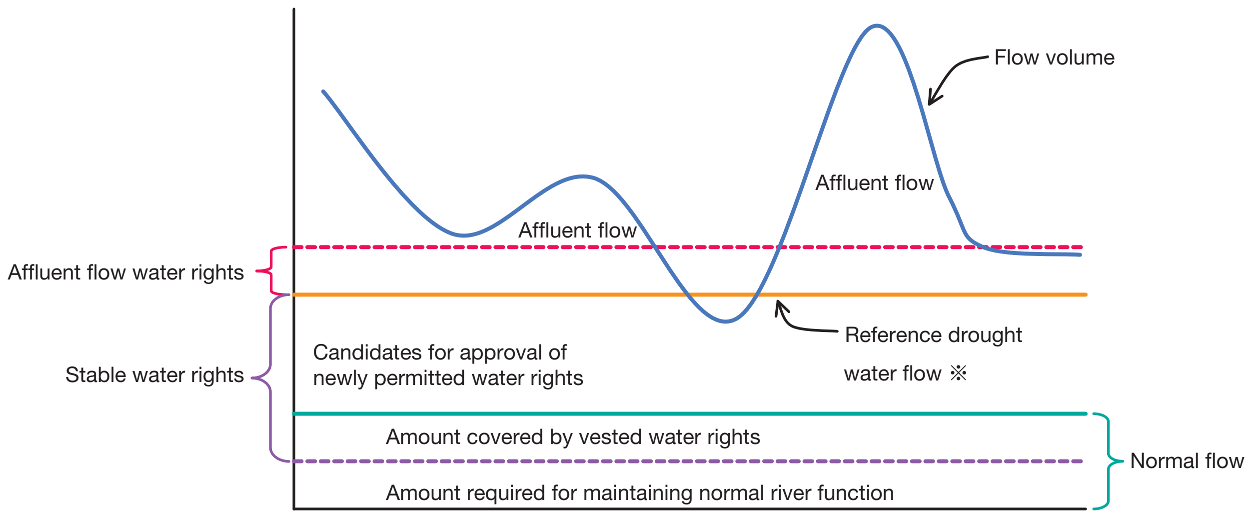
Opening ceremony of the Tokyo Olympic Games

Diverse approaches to water resources development

Water rights

In the 1960s, Japan reached its economic takeoff with a rapid pace. The serious problem was that an expansion in water demand could not be coped with. Since the demand for urban water, including drinking (household supply) water and industrial water rose on a dramatic scale, water was considered as an important resource. Based on this consideration, the River Law, which controlled the river administration in Japan, was revised in 1964, and all water rights became subject to a permit system. However, the customary rights of the past were subject to the permit system authorizing the use of water under the same conditions as before. In order to create new potentials for water use through the construction of water resource development facilities such as dams, it has therefore been necessary to seek conciliation with these vested interests and file applications for development projects as constituting a new water right. Based on the water rights, the river administrator has sought equitable, efficient and sustainable water use with respect to the historical background.

■ **Concept of Water Rights in Japan**



※ The smallest of the drought flows(river flows on 355 days or more in a year) in the past ten years

Diverse approaches to water resources development

Necessity of water resources development

When viewed from a global standard, Japan has a large amount of rainfall and is rich in water resources. However, river flows fluctuate substantially throughout the year according to season - with larges flows occurring during the snow melting season from April to May, the rainy season from June to July, and the typhoon season from September to October. In other seasons the flow is considerably less. Domestic use water and industrial water fluctuate in consumption depending on the season and the day of week, but not so much as the daily change of river flow. Accordingly, stable water utilization depends on enabling an intake of a constant amount of water from rivers throughout the year regardless of river flow fluctuation. Water resource development facilities such as dams and weirs have been constructed for this purpose.

Mechanism of water resources development

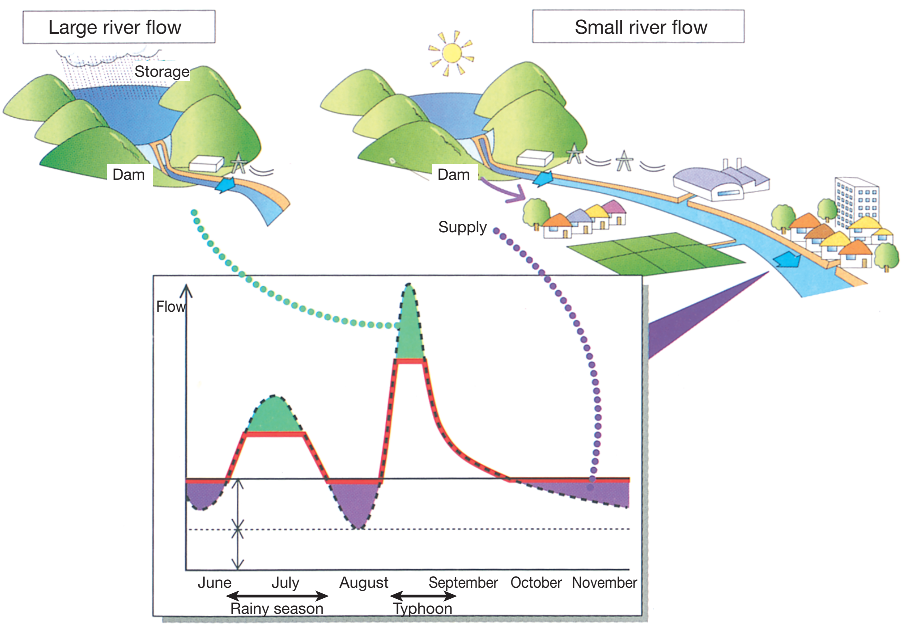
Let us assume the river flow at a point where the water intake is planned.

In a natural state without a dam, the river flow is large in rainy and typhoon seasons as shown with broken lines in the figure, but it decreases in other seasons. If intake of a constant amount of water is to be attempted throughout the year, only the water amount equivalent to A can be taken.

Accordingly, a dam is constructed to store water (the green portion in the figure) when the river flow is large during rainy and typhoon seasons and to discharge water to replenish river water when the river flow is small (the blue portion in the figure). The water flow fluctuates as indicated by the red line, enabling an intake up to A + B throughout the year.

The water volume indicated by B in the figure, which is the amount newly available, is sometimes called the "developed water amount" of the dam.

■ Image of water resources development



Water resources development facilities

The following facilities will be developed as water resources development facilities to enable utilization of the new water amount. Channels are also constructed to direct water from the river to points of water utilization, such as agricultural land and drinking water treatment plants.

Dams and weirs

There are two cases. One is to construct dedicated facilities to secure agricultural water, water for water supply, and industrial water. The other is to build multi-purpose facilities to control floods and to maintain normal functions of running water, and for use in the hydraulic power generation.

Chikugo River weir in Fukuoka Prefecture

Chikugo River weir in Fukuoka Prefecture

Lake and marsh development facilities

These facilities are intended to regulate water levels artificially to make new water available, as in the case of dams.

Facilities for lake Biwa

Channels for adjusting river flows

Multiple rivers differing in annual fluctuation of the flow are linked, so that the shortage of one river is supplied with water by redirecting water from another river, thereby making new amounts of water available.

Kasumigaura Water Introduction

Kasumigaura Water Introduction

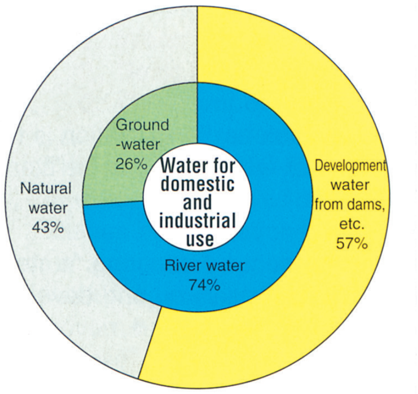
Diverse approaches to water resources development

Importance of water resources facilities

Up to the present, we have constructed about 860 multi-purpose dams and about 1,700 dedicated dams for agricultural water, water for water supply, and industrial water. Currently, as an annual amount, a stable intake of 16.7 billion m^3 of urban water (water for domestic and industrial use) is possible.

At present, Japan is consuming about 29.1 billion m^3 of urban water annually, of which about 74% is taken from the rivers. Development and construction of water resources development facilities has ensured a stable intake meeting the need for about 77% of the water taken from rivers and about 57% of total consumption.

In particular, for domestic water for the Kanto coastal area, where population and economic activities are concentrated, a stable water intake has been assured for about 90% of the water taken from rivers because of improvement of the water resources development facilities.



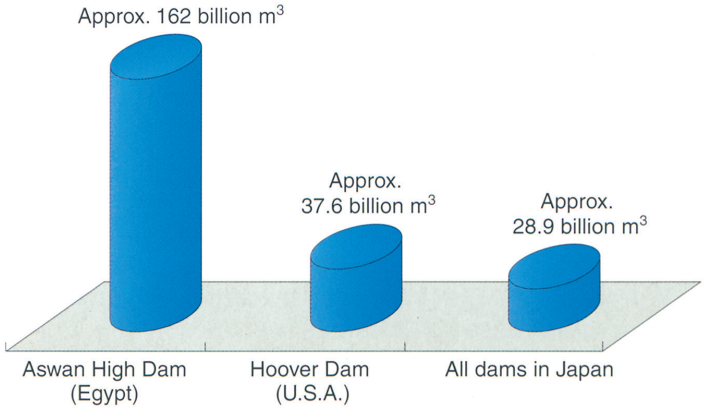
(Note) As surveyed by the Water Resources Department, MLIT
Urban water is the sum of water for domestic use and industrial use.
(Percentage of water for domestic use accounted for by developed water)

Scale of water resources development facilities in Japan

The total storage volume of dams built up to now in Japan is approximately 23.7 billion m^3 This includes all of the capacity for power generation and flood control.

In Japan, construction of gigantic reservoirs is difficult because of the small land area and short and steep rivers. Many dams have been constructed despite these conditions. Nevertheless, the total storage volume of all dams in Japan is smaller than the storage volume of one Hoover Dam, and less than 20% of that of the Aswan High Dam of Egypt.

■ **Total storage capacity**



(Note) Excerpts from the Japan Dam Association and the Hoover Dam home page

Yagisawa Dam (Tone River System)

Serious consequences of drought

Every year drought occurs in many parts of the country.

In the past 20 years, almost every prefecture has experienced water shortage. Some areas have experienced drought almost every year. Since water demand is increasing, at this rate there will come a time when water shortage occurs frequently throughout the country.

Lessons learned from the "Fukuoka drought".

The so-called "Fukuoka drought" which hit the city of Fukuoka in 1978 persisted for 287 days. This drought caused serious inconvenience to the people of Fukuoka in connection with such everyday needs as cooking, washing, bathing, and toilet flushing. The drought affected about 3,280,000 people and even forced some people to move out of town temporarily. The drought also had impact on medical services and caused reductions of factory operations and the closing of beauty parlors, barber shops, cleaners, and other businesses, and economic activities.

■ Major historical droughts

Year	Area	Water use restriction			Remarks
	City	Principal river	Period (mm/dd/yy)	No. of days	
1964	Tokyo	Tama River	7/10/64-10/1/64	84 days	"Tokyo Olympics Games drought"
1967	Kitakyushu-city	Onga River	6/19/67-10/26/67	130 days	
	Tsukushino-city	Chikugo River	9/5/67-9/26/67	22 days	
	Nagasaki-city		9/25/67-12/5/67	72 days	"Nagasaki drought"
1973	Matsue-city	Ibi River	6/20/73-11/1/73	135 days	
	Otake-city	Oze River	7/27/73-9/13/73	49 days	
	Takamatsu-city		7/13/73-9/8/73	58 days	"Takamatsu desert"
	Naha-city, etc.		11/21/73-9/24/74	239 days	
1977	Yodo River area	Yodo River	8/26/77-1/6/78	134 days	
	Naha-city, etc.		4/27/77-4/7/78	176 days	
1978	Yodo River area	Yodo River	9/1/78-2/8/79	161 days	
	Kitakyushu-city	Onga River	6/8/78-12/11/78	173 days	
	Fukuoka-city	Chikugo River	5/20/78-3/24/79	287 days	"Fukuoka drougt"
1981	Naha-city, etc.		7/10/81-6/6/82	326 days	
1984	Gamagouri-city, etc. (Toyogawa Canal area)	Toyo River	10/12/84-3/13/85	154 days	
	Tokai city, etc. (Aichi Canal area)	Kiso River	8/13/84-3/13/85	213 days	
	Yodo River area	Yodo River	10/8/84-3/12/85	156 days	
1986	Gamagouri-city, etc. (Toyogawa Canal area)	Toyo River	8/26/86-1/26/87	152 days	
	Tokai-city, etc. (Aichi Canal area)	Kiso River	9/3/86-1/26/87	146 days	
	Yodo River area	Yodo River	10/17/86-2/10/87	117 days	
1987	Tokyo, etc.	Tone & Ara Rivers	6/16/87-8/25/87	71 days	"Metropolitan area drought"
	Gamagouri-city, etc. (Toyogawa Canal area)	Toyo River	8/24/87-5/23/88	274 days	
	Tokai-city, etc. (Aichi Canal area)	Kiso River	9/12/87-3/17/88	188 days	
1989	Naha-city, etc.		2/27/89-4/26/89	59 days	
1990	Tokyo, etc.	Tone & Ara rivers	7/23/90-8/9/90	18 days	
	Nara-pref.	Kizu River	9/1/90-9/16/90	16 days	
	Takamatsu-city, etc.	Yoshino River	8/2/90-8/24/90	23 days	
1991	Naha-city, etc.		6/10/91-7/27/91, 9/6/91-9/24/91 (excl. 9/12, 9/17, 9/18)	64 days	
1993	Ishigaki Island		7/19/93-3/3/94	219 days	
1994	Takamatsu-city	Yoshino River	7/11/94-9/30/94	67 days	"Islands drought"
	Matsuyama-city	Shigenobu River	7/26/94-11/25/94	123 days	
	Fukuoka city	Chikugo River	8/4/94-5/31/95	295 days	
	Sasebo-city		8/1/94-3/5/95	213 days	
1995	Kouchi-city	Kagami River	12/13/95-3/18/96	97 days	
1996	Tokyo, etc.	Tone & Ara River	8/16/96-9/26-96	42 days	
	Kanagawa-pref	Sagami & Sakou River	2/26/96-4/24/96 7/5/96-7/22/96	77 days	
1997	Kouchi-city	Kagami River	1/20/97-3/17-97	57 days	
1998	Takamatsu-city, etc	Yoshino River	9/7/98-9/24/98	18 days	
	Kouchi-city	Kagami River	12/22/98-3/15/99	84 days	
2000	Himeji-city	Ichikawa River System	7/24/00-10/2/00	71 days	
	Imabari-city,etc	Soujya River	8/3/00-9/22/00	51 days	
2005	Toyohashi-city	Toyo River	6/15/05-8/25/05	72 days	
	Yamatokoriyama-city	Kino River	6/27/05-8/26/05	61 days	
	Takamatsu-city, etc	Yoshino River	6/22/05-9/7/05	78 days	
	Anan-city, etc	Naka River	4/26/05-7/12/05 8/3/05-9/4/05	77 days 33 days	
2007	Takamatsu-city, etc	Yoshino River	5/24/07-7/14/07	52 days	
	Sasebo-city, etc		11/23/07-4/30/08	159 days	
2008	Takamatsu-city, etc	Yoshino River	7/25/08-11/25/08	124 days	
	Matsuyama-city	Shigenobu River	8/4/08-10/6/08	64 days	
2009	Takamatsu-city, etc	Yoshino River	6/3/09-8/10/09 9/12/09-11/18/09	69 days 68 days	
	Matsuyama-city	Shigenobu River	5/22/09-7/2/09	42 days	
2013	Gamagouri-city, etc (Toyogawa Canal area)	Toyo River	8/20/13-9/18/13	30 days	
	Takamatsu-city, etc	Yoshino River	8/11/13-9/4/13	25 days	

Source: MLIT

■ Damage and losses caused by the Fukuoka drought (1978)

Phase of drought	■ Impact on local residents	■ Social impact
Water supply hours: 11 - 18 hours Water supply restriction: 12 - 21% Total period: 93 days	- Storage (purchase of plastic containers) - Water supply interruption at higher-elevations - Red water, turbidity, sedimentation	- Termination of pumping to elevated water tanks during interruption hours - Shorter opening hours of municipal swimming pool - Water-saving menus (public elementary/junior high schools)
Water supply hours: 7 - 10 hours Water supply restriction: 28 - 34% Total period: 123 days	- School children had to carry canteens and wet towels. - Eating out - Reduced frequency of bathing - Reuse of bath water, etc. - Car washing on dry riverbeds	- Influence on medical services (shorter hours for delivery/operation, etc.) - Closure of schools - Shorter operating hours of factories - Sales losses due to shorter business hours (beauty parlors, barbers, cleaners, etc.)
Water supply hours: 5 - 6 hours Water supply restriction: 37 - 47% Total period: 71 days	- Temporarily moving out of town - Drilling of wells (For nondrinking purposes)	- Air transportation of mineral water (Japanese Red Cross Society) - Bankruptcy - Temporary Closure of more universities - Switching of crops

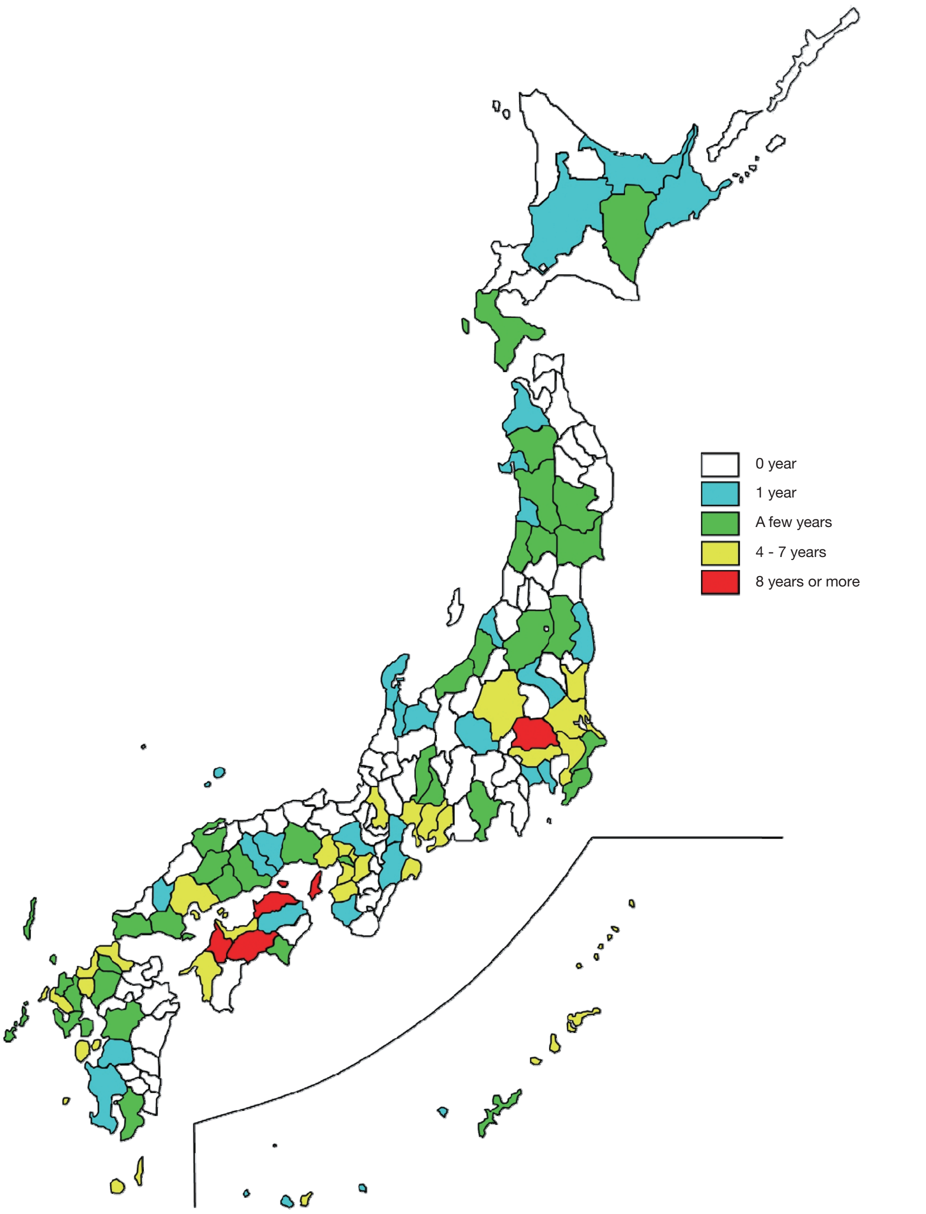
Serious consequences of drought

The information-oriented society is vulnerable to drought.

Large computers require strict control of ambient temperature and humidity and therefore need a large quantity of cooling water. A survey of major city banks showed that about 60 to 70% of water consumed in one day at a city bank is used for cooling.

Since cooling water is intensively recycled, further saving is difficult to accomplish; nor is it possible to store large quantities of water. In the event of a drought, shutting down the computers would be inevitable, even if the water supply for all other purposes such as toilet flushing and drinking were stopped, and such interruption would have a major negative impact on business.

■ **The Status of Drought Occurrence over These 30 Years**



Notes: 1. Investigated by the Water Resources Department of the Ministry of Land, Infrastructure, Transport and Tourism
2. The number of years when the decrease/stoppage of water occurs in the water supply system for 30 years from 1983 to 2012.

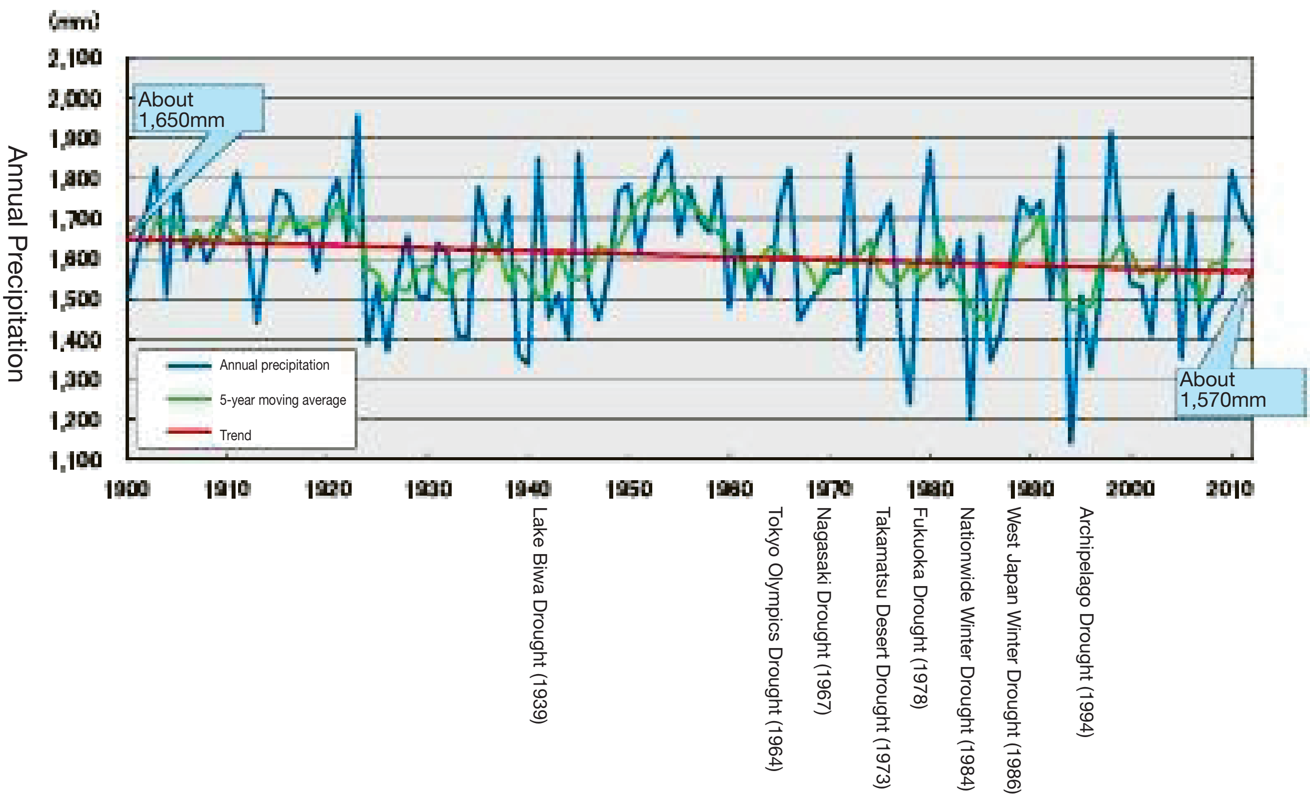
Changes in the amount of precipitation due to climate change

As a long-term trend, the annual average surface temperature has risen about 1 degree centigrade over the past 100 years, and about 3 degrees in large cities because of the effect of the heat island phenomenon. Certain reports say that the annual average temperature will rise by 1.4 to 5.8 degrees in the coming 100 years.

The average of amount of annual precipitation at 51 points nation-wide has tended to decrease as shown in the figure below. In addition, the number of years with relatively smaller amounts of precipitation has increased since 1970. Specifically, precipitation in 1973, 1978, 1984, 1994, and 1996 was far below the average, causing draught damage.

There is also a trend toward fluctuation between abnormally small and abnormally large amounts of rainfall.

■ **Year-to-Year Changes in Annual Precipitation in Japan (1900-2010)**



Serious consequences of drought

Drought conciliation

Speedier water-use conciliation during droughts, timely information and simpler procedures

The recent tendency toward less rainfall and the inadequacy of dams and other existing water resources development facilities have made communities throughout the country more prone to water shortage and have increased the frequency of drought. Fiscal year 1994, in particular, experienced extraordinary droughts in many parts of the country, making the demand for countermeasures all the more intense.

To cope with the situation, two reform measures have been implemented.

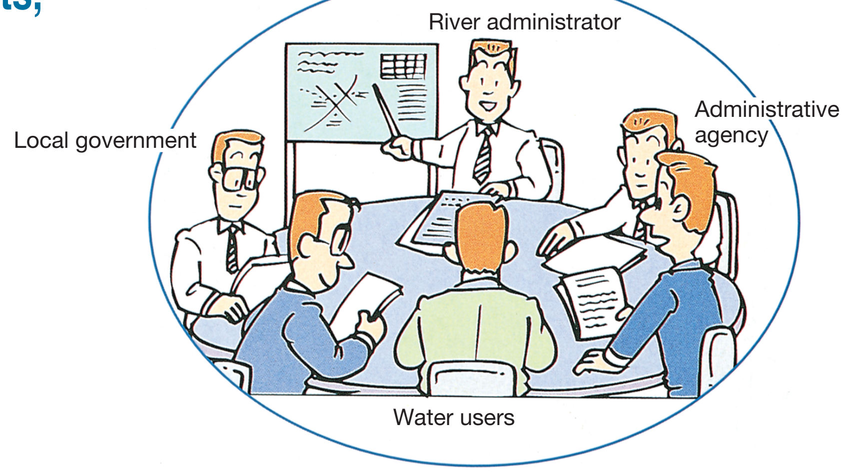
① Facilitating water-use conciliation during droughts

The River Law amendment of 1997 aims to ensure smooth water-use conciliation from the early stages of extraordinary drought. Under the amended law, in case of drought water users must make effort to coordinate their water uses not only in cases where one or more of the permitted water uses has become difficult but also in cases where such water uses are expected to become difficult.

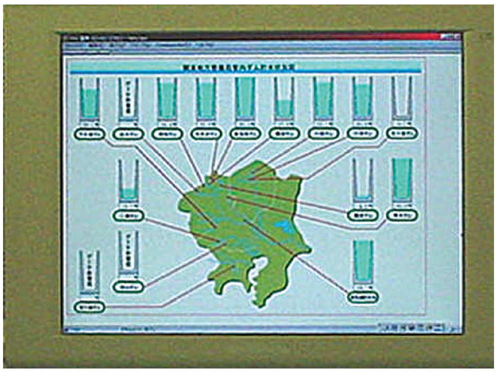
The amended River Law also requires that the river administrators make effort to provide information necessary for water-use conciliation.

② Facilitating water transfer between water users

The amended River Law has now created a new system under which water users may transfer all or part of water they have been permitted to use to other water users, subject to the approval of the river administrator.



Consultation for water-use conciliation during droughts


Provision of information by the Foundation of River and Basin Integrated Communications (FRICS)

Drought water-use conciliation councils established (as of March 31, 2002)		
Class A river systems	69 river systems	103 organizations
Class B river systems	25 river systems	25 organizations


A household storing up water during the 1994 drought (Yomiuri Shimbun, September 2, 1994)

VI

Water Environment

Creation of a "multi-nature" river environment

What do we mean by nature-oriented river works

Creation of multi-nature river environment means preserving or restoring a favorable river environment as well as avoiding or minimizing unavoidable alteration of habitats or growth environments favorable to natural life while securing a required level of safety and flood control.

Essential points in creating multi-nature river environments

(1) Preservation and restoration of diversified environment
Biodiversity must be attained by preserving and restoring diversified habitats and growth environments for natural life that originally existed in the river.
(2) Securing of a sustainable environment
For life to inhabit or grow in and around a river, the upstream-downstream as well as transverse continuity must be secured in line with networking with the surrounding area.
(3) Preservation and restoration of river habitats and growth environments
Preservation and restoration are attempted for habitats and growth environments unique to the river by focusing on the animals and plants representative of the river concerned as well as rare or endangered species.
(4) Securing of the water cycle
Efforts are made to ensure the hydrological cycle by securing the permeability of the waterfront so that the natural flow of groundwater or spring water is not hindered.
(5) Gaining the understanding and cooperation of citizens, persons with experience or academic background, and organizations concerned
In addition to providing information on rivers, an exchange of information and opinions is organized on a regular basis with the participation of citizens interested in rivers, persons with experience or academic background, and organizations concerned.

■ Habu River
Creation of natural waterfront environment using stones

(Above) One year and 10 months after work
Slender sweet-flag and pussy willow are growing on waterfront (April 1995)

■ Hikichi River
Recovery of waterfront nature together with a park

(Above) Two and a half years after work
The hometown river with abundant greenery along the waterfront has been recovered. (October 1995)

(Below) Before work
Shallow and flat flow.
Connected blocks exposed on the slope

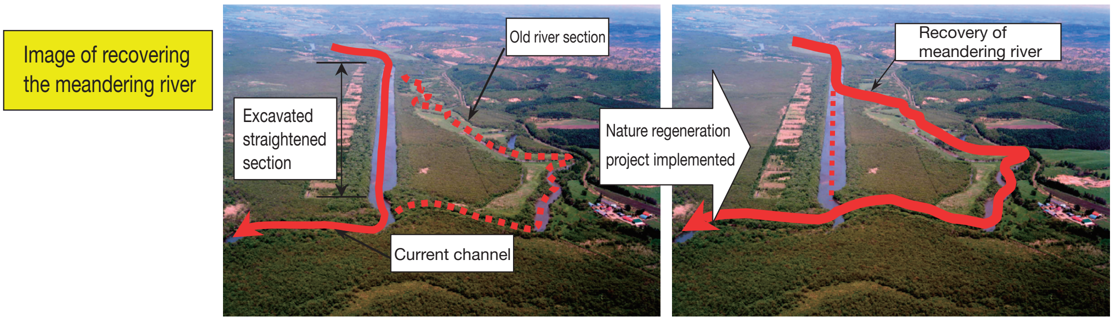
(Below)Before work
Straight river with less changes, which has a concrete revetment (December 1992)

Nature regeneration project

The object of the nature regeneration project is not to undertake preservation of the river environment as a part of mitigation included in flood control and water utilization project. This is the first river project to recover a natural river system from the viewpoint of the catchment for the purpose of preserving the river environment.

This project is designed to best exploit the natural resilience of the environment by minimizing the artificial work.

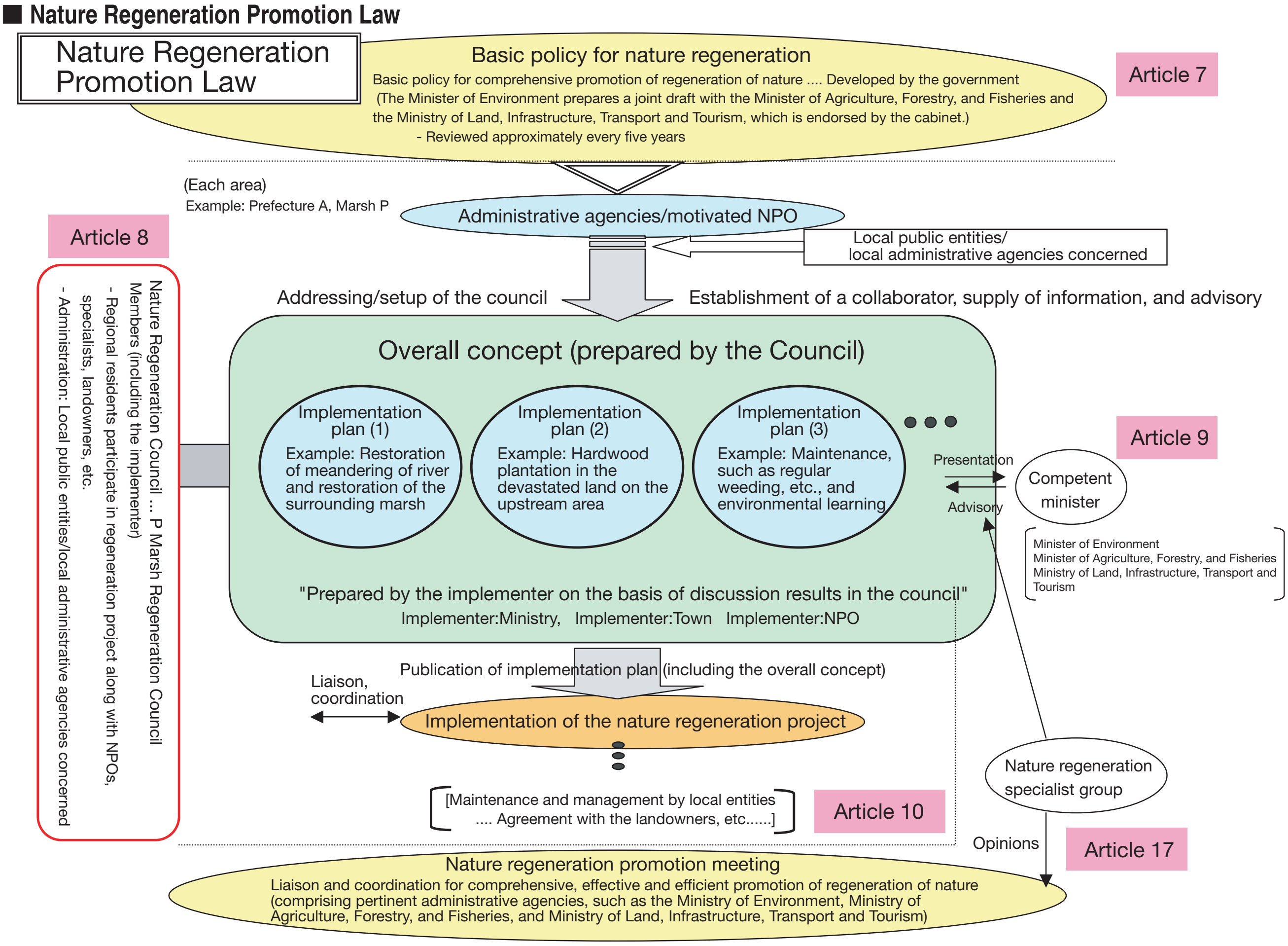
■ Regeneration of the Kushiro Marsh (Kushiro Marsh in Hokkaido)



[Straightened Kushiro River after river improvement (Hokkaido)]

[Recovered meandering river using the old river channel (image)]

■ Nature Regeneration Promotion Law



Activities for improvement of river environment

Improving the river environment through flexible dam management

A river environment in the true sense of the word is created through fluctuation of river flow volumes from low to high. In Japan, dams constructed for flood control, water resource development, and power generation have caused decreases in flow volumes and a flattening out of the flow fluctuation.

The effects are the loss of landscapes appropriate for rivers and damage to biodiversity. This has led to requests from growing numbers of residents along rivers for clear streams and bubbling brooks. What is now required is recovery of the fluctuation of river flows in order to restore the roles and functions that rivers originally had.

- What is the flexible dam management?

Flexible dam management means securing the capacity (utilization capacity) needed to preserve the river environment within the flood control capacity needed to ensure the effective dam operation.

- What is flush discharge?

Continuation of the flow with less change over a long period of time can cause stagnant water containing algae and contaminants adhering to the river bed, which exerts adverse effects on the environment and landscape. Regular discharge of water stored in the dam will eliminate stagnation and keep the water refreshed.

■ **Survey of flexible management of Sagae Dam (flush discharge)**

(1) Before flush discharge
Floating algae can be seen.

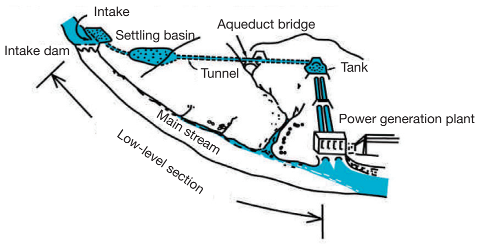
(2) After flush discharge
Floating algae is washed away.

Adjusting water utilization to improve river environment

Adjusting water utilization to improve river environmentThe original environment is recovered and maintained by discharge from the dam to maintain a flow, that is, a flow that would normally be observed if there were no dam.

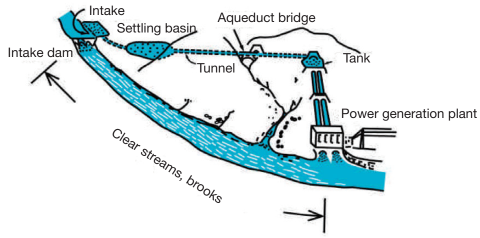
Conventional・・・・・・

Since a considerable amount of water is taken from the river to generate power, the low-water section exists between the intake dam and tail escape outlet.



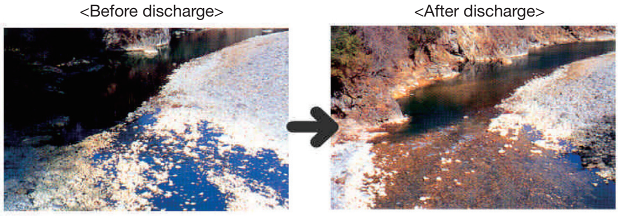
By discharging for flow maintenance・・・

Discharging a flow to maintain normal river water functions (flow maintenance) from the intake dam enables a return of a clear stream to the low-level section. However, the power generation decreases because the water amount taken into the plant decreases.

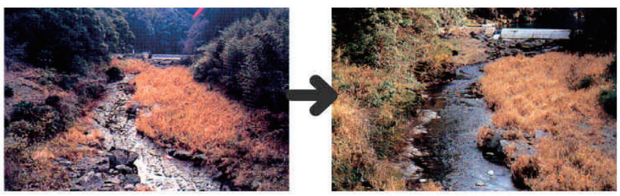


■ Improvement of coastal zones with due consideration for the environment

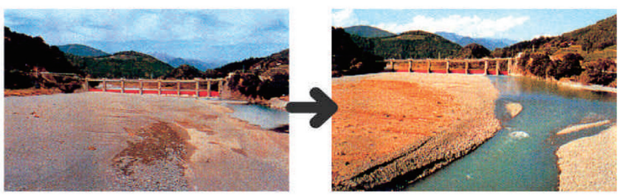
<Before discharge> <After discharge>



Class A river system Agatsuma River of Tone River system (Hakosima power plant, Gunma Prefecture) Since May 1994



Class A river system Ono River of Ono River system (Onogawa power plant, Oita Prefecture) Since November 1992



Class A river system Oi River system (Kawaguchi power plant, Shizuoka Prefecture) Since March 1989

Water purification measures

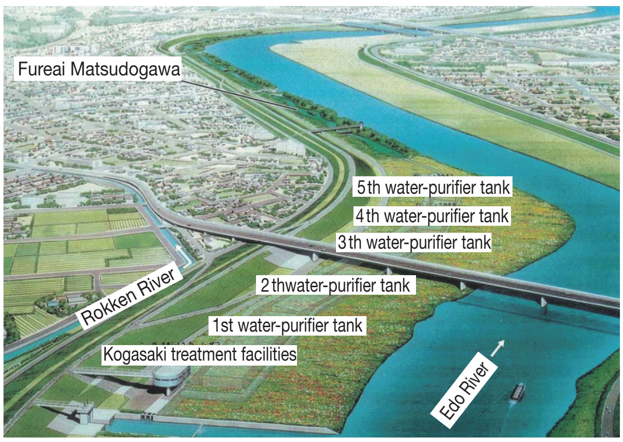
Water purification measures of rivers

Water quality purification is achieved by sludge dredging, development of treatment facilities, and introduction of purified water to improve the water environment.

High-tech dredger with high-performance pump (Kasumigaura, Ibaraki Prefecture)

Purification by vegetation using the artificial floating island (Kasumigaura, Ibaraki Prefecture)

Abashiri River, Hokkaido



Kogasaki Treatment Facilities

Water purification measures for dams

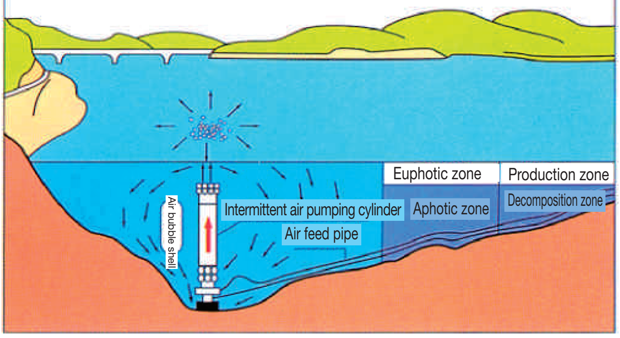
Some sections downstream of dams have no water or low water because of water intake for power generation. Downstream, water environments of rivers in cities are deteriorating due to progressive urbanization. In response to increasing interest in the development and preservation of river environments, efforts are underway to secure flow maintenance and introduce purified water into rivers for cities downstream. Against this background, recovery of clear streams is promoted by expanding the dam water river improvement projects to eliminate the no-water or low-water sections downstream and to improve the water for rivers in cities.

■ Water purification situation

Before

After

■ Aeration system

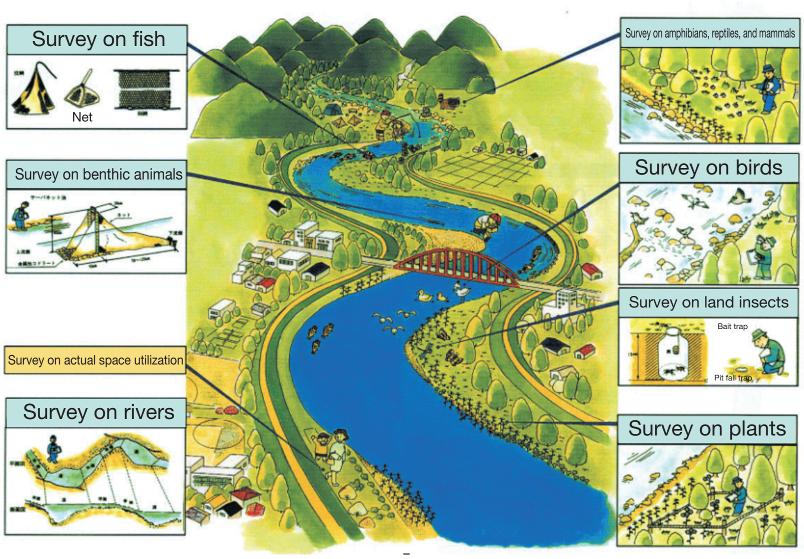


Survey and Study for Preservation of the River Environment

Census-taking of river waterfronts

To grasp the basic information on natural river environments, habitats and growth of natural life in rivers and dams are monitored regularly and continuously. This is being implemented for 109 Class A and 151 Class B river systems all over Japan.

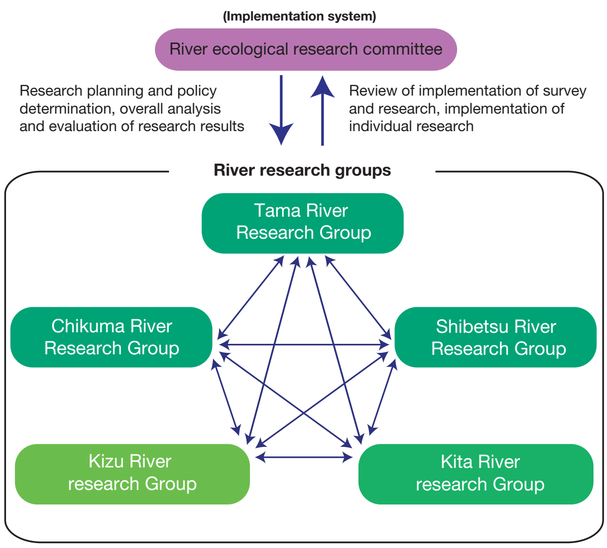
■ Image of National Censuses on River Environments



River Ecology Research Group of Japan

Researchers in biology and ecology as well as river engineering, at the National Institute for Land and Infrastructure Management, Public Works Research Institute are cooperating in researches in specific fields, studying the Tama River, Chikuma River, Kizu River, Kita River and Sibetu River for the purpose of understanding rivers from the ecological viewpoint and to find out how rivers can be improved.

Kizu River in Kyoto



Environmental education and experiencing the natural activity of rivers

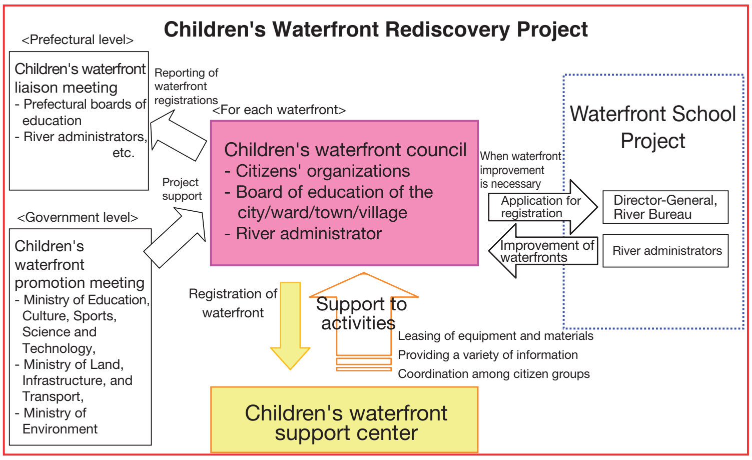
Environmental education in rivers

To motivate society to learn from rivers, we will promote the use of rivers as children's playgrounds or as fields to experience the activity of nature. For this purpose, the Ministry of Land, Infrastructure, Transport and Tourism, Ministry of Education, Culture, Sports, Science and Technology, and Ministry of Environment have coordinated efforts in a "Children's Waterfront Rediscovery Project." A "Waterfront School Project" is also being implemented to develop safe and enjoyable waterfronts.

In addition, tie-ups with citizen groups to foster the development of leaders on river issues, and activities in the field of rivers will be strengthened. Stress is also placed on utilizing rivers to create opportunities to experience nature activities and environmental education.

One-day educational lecture
(NPO Meeting to recover clear stream on Karabori River)

Leader training course
(Ecology research meeting in Hiroshima)



- Regional citizen groups, people in education, and river administrators have jointly established the Children's Waterfront Council.
- The "Children's Waterfront Support Center" supports the activities (by leasing equipment and materials).
- The "Waterfront School Project" develops and improves facilities as needed.

"Children's Waterfront" Activities (Kogi River in Osaka area)

Improvement harmonious with natural environment

Dams can perform the task of blending with the surrounding landscape.

Dams abound with the attractions found at features of resorts, such as abundant water, neatly constructed roads, and mountains covered with lush greenery. In order to enable people to enjoy the dams, more effort is under way to improve the environmental quality of dam areas.

(Okinawa pref.)

The Daiya river before sobo works (1947)

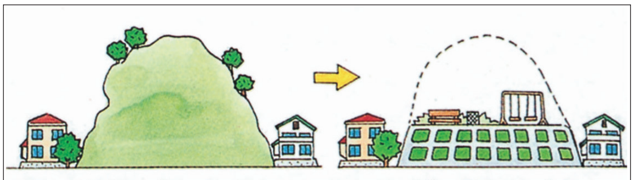
SABO works, prevent sediment disasters and support community development efforts.

Sabo works have made areas along Daiya River in Tochigi Prefecture safer than ever. As a result, the areas that used to be a flood plain have been developed into safe sites and effectively utilized for residential areas, athletic ground and parks, thus helping to revitalize local communities.

The Daiya river after channel works (Imaichi City, Tochigi Prefecture, 1995)

SABO Works prevent sediment disasters and make effective use of slopes as green parks or other purposes

The upper part of a hill prone to sediment disaster is removed. Then this stabilized area is used effectively as a park, for the purpose of regional revitalization.



Before the works After the works

About 120 houses were relieved from the danger of slope failures. A hospital, a health facility center for the aged and a community welfare center were newly built (Horikiri-yama, Onagawa-cho, Miyagi Prefecture).

Before the works

After the completion prevention works

Improvement harmonious with natural environment

We are working to make coastal zone more enjoyable and useful.

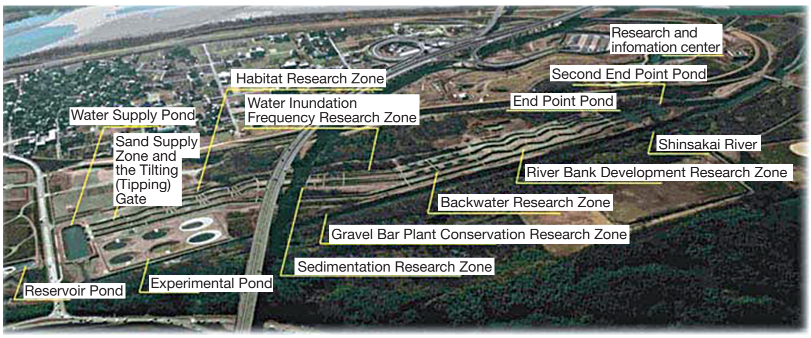
■ **Improvement of coastal zones with due consideration for the environment**

Conventional approaches to coastal development have focused heavily on disaster prevention. Future efforts, however, should encompass measures to not only prevent disasters but also develop coastal space into a medium through which to promote contact between human beings and the sea.

Kaike Coast in Tottori prefecture

Aqua Restoration Research Center

The Aqua Restoration Research Center was established to develop the technology which supports river improvement method harmonious with the natural environment in 1997. This facility is located in three divergent areas along Kiso river in Gifu Prefecture. Kiso river was chosen since it has a wide variety of habitats and its environmental condition is highly applicable to other rivers in Japan. This facility consists of three main facilities, the research center, three experimental rivers, and six ponds.



Town planning based on utilization of waterfronts integrated with the surrounding region

Rivers function as waterfronts affording people with pleasant experiences, providing enjoyable landscapes and disaster prevention functions as transport routes for possible evacuation and conveying critical supplies in the event of earthquake. The need is growing these days to utilize various functions of rivers in town planning, so that each region can best enjoy its own specific characteristics.

The Water and Disaster Management Bureau of Ministry of Land, Infrastructure, Transport and Tourism promotes project by registering and approving those intended for integrated structural and non-structural development in conjunction with the region, such as the Waterfront School Project and the Community River Improvement project for further development of flood control activities appropriate to regional characteristics and needs.

Such projects will also involve municipalities playing a substantial role in implementation.

Community River Improvement Project

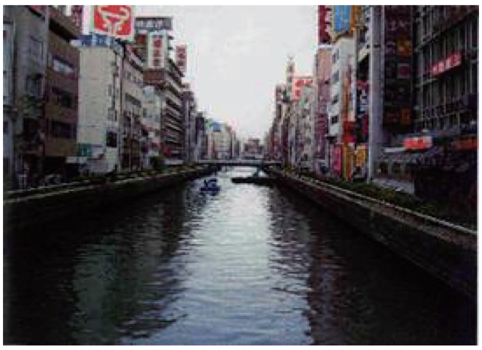
Established in 1987, this project was implemented while being integrated with town planning jointly by river administrators and municipalities.

Many rivers are now abundant in natural settings, with accessible spaces, and spaces to enjoy landscapes that are attractive to local residents.

Izumi River (Yokohama)

A Waterfront Plan project

The Dotonbori River is located in Osaka's well known shopping and entertainment area. Historically, Osaka has grown by linking its rivers with industries, people, and life. Osaka aims at restoration of "Water City, Osaka" in its regeneration activities. As a part of such activities, regulations on the river zone have been relaxed to allow utilization of this river. The river zone is a public space that cannot be occupied for purposes not accessible to all. In the Dotonbori River area, open cafes operated by private enterprises are permitted.



Bustling center around Dotonbori River

Opening of the river zone to private enterprises (image)

VII

River Informations

Objective of providing river information

Objective of providing river information

For municipal governments

Municipal governments need river information to engage in disaster-prevention activities.

1. Quick constituting of disaster prevention scheme
2. flood fighting activity
3. evacuation recommendation/instruction

For citizens

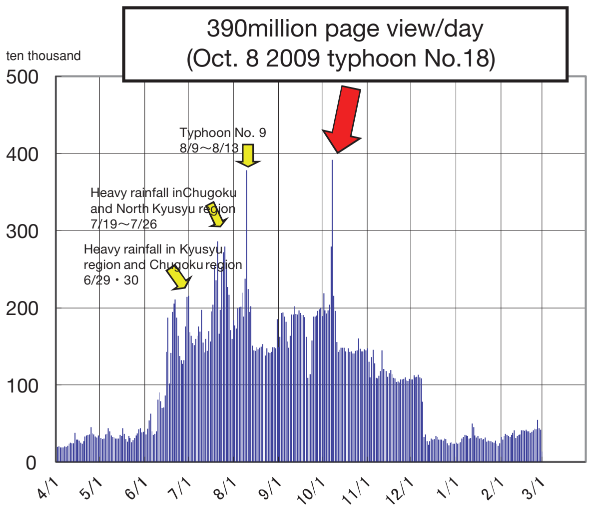
Citizens need river information to escape disaster or to avert water accidents.

Water accidents in Kobe city
(July, 2008 Toga riv.)

Flood in Kanazawa Ctiv
(July, 2008 Asano riv.)

Flood prevention activity

evacuation



Page view to Mlit (2009)

River Informations

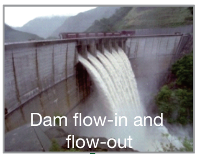
Outline

To protect citizens' lives and property from flood disasters and sediment disasters caused by deluge, a river information constantly observed is collected, worked out and edited in real time (24 hours for 365 days), and supplied to the river management, cities, towns and villages, and residents.

Rainfall monitored by radars and monitored on ground, river water levels and flow rates, and flow-in and flow-out volume of dams are observed and sent through telemeters.


Avalanche damage


Flooding


Dam flow-in and flow-out


River water level and flow rate


Rainfall monitoring on ground


Rainfall monitoring by radar

Rainfall monitoring on ground

To collect, observe, work out and edit in real time the monitored data, and to supply them in a easily-understandable form.

Collection
To collect and manage the monitored every data sent 10 minutes from all over 17,300 Japan (about monitoring stations)

Work-out and edit
To sum up the collected data and work out and edit them to show in the forms of tables, graphs, maps, drawings and so on for easy understanding.

Supply and store
To supply necessary information to each user in a understand-able way and to store the data.

Supervision and accuracy control
To supervise the supplying data and posting data on screens 24 hours for 365 days, to conduct cause investigation and take actions on any incidental abnormal matters if any.
(No. of incidents such as abnormal values in 2008: 29,650)

Being supplied to river man-agement, cities, towns and villages, and residents through website and cellar phones

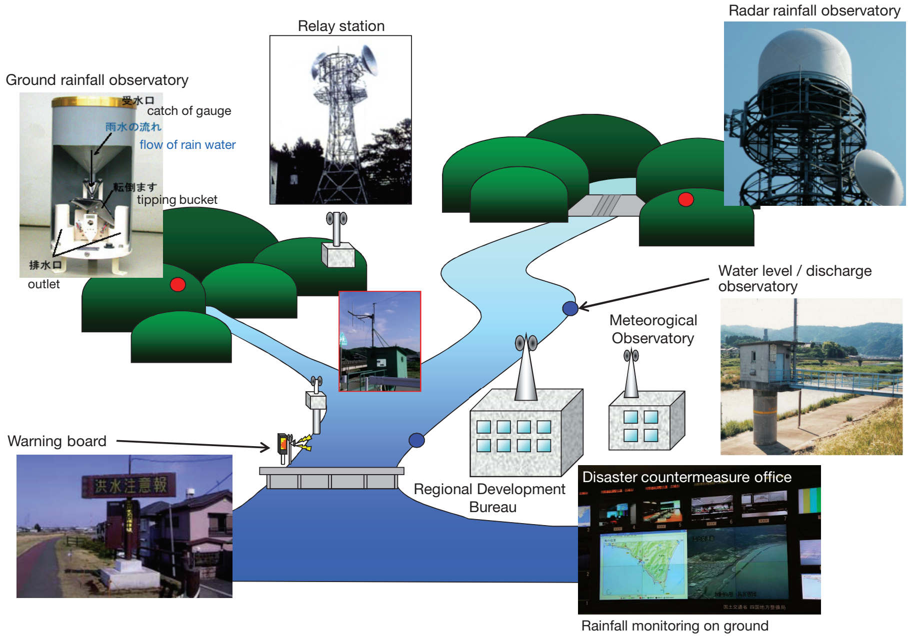

Residents


Cities, towns and villages


River management

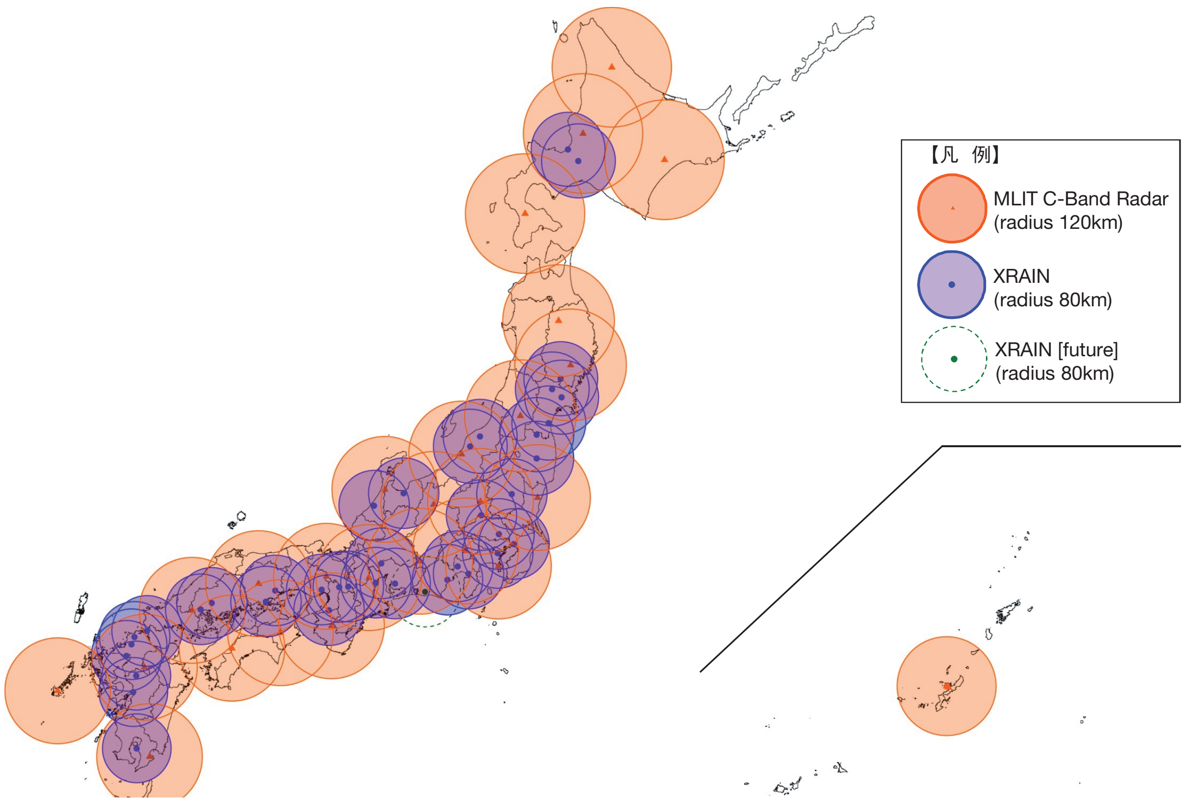
3.9 million view pages/ day (at the time of the typhoon on October 8, 2009)

Hydrological observation in rivers (image)



Radar Observation Network in Japan

(C-Band Radar/X-Band MP Radar Network=XRAIN)

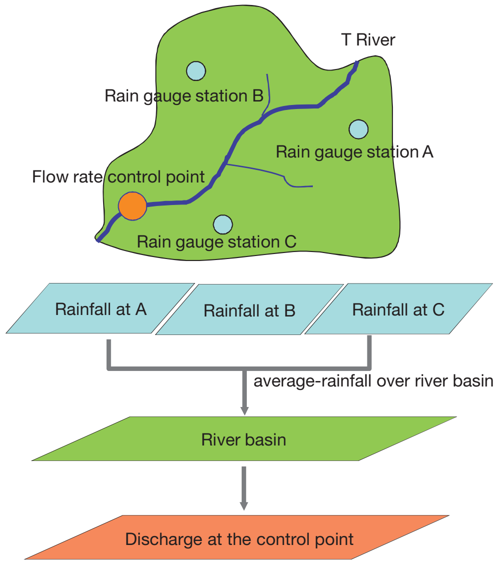


River Informations

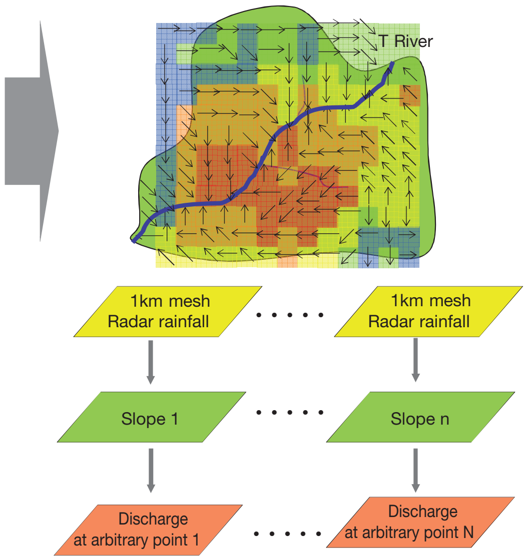
Precise discharge analysis via a distributed flood prediction model

By dividing a basin into fine mesh units and assigning rainfall distribution to each unit through a radar, it is possible to calculate precise amount of flow for any point in the basin.

■ **Existing model**



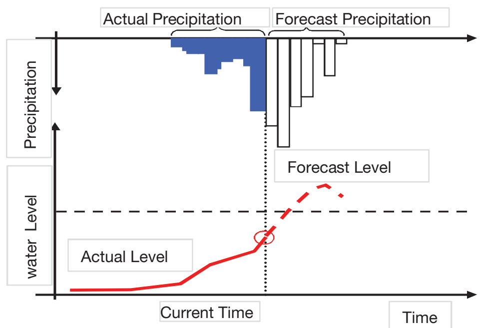
■ **Distribution type flood prediction model**



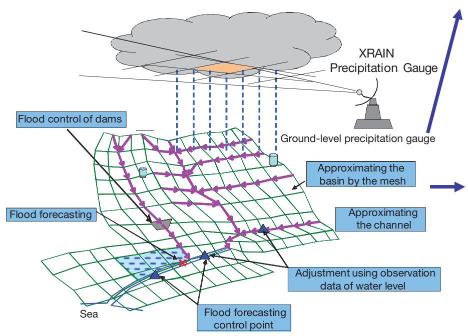
Improvement of Flood Forecasting accuracy Using XRAIN

MLIT inputs XRAIN data into flood forecasting systems for each river and uses it to improve the accuracy of flood forecasting.

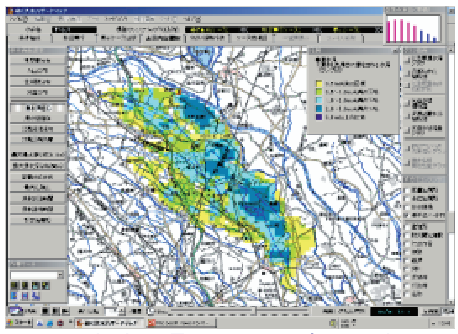
XRAIN



Water Level Forecast Information



Distributed Flood Forecast Model

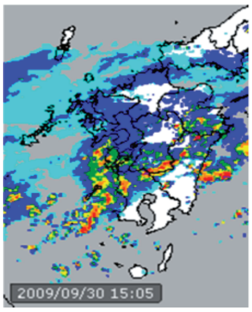


Inundation Forecast Information

Providing river information

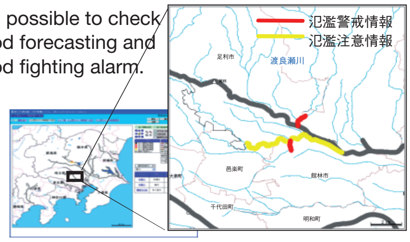
Radar rain gauge

It is possible to check distribution of rainfall and rainfall intensity, and drift of rain area.



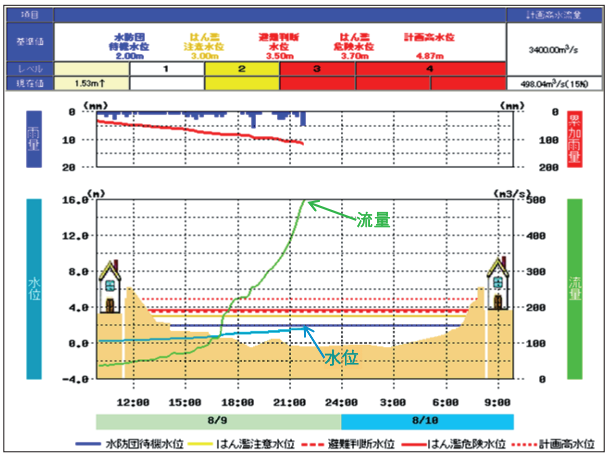
Forecast/alarm information

It is possible to check flood forecasting and flood fighting alarm.



Rain gauge・river level・river flow rate

It is possible to check relationship between river level and inhabitable area.



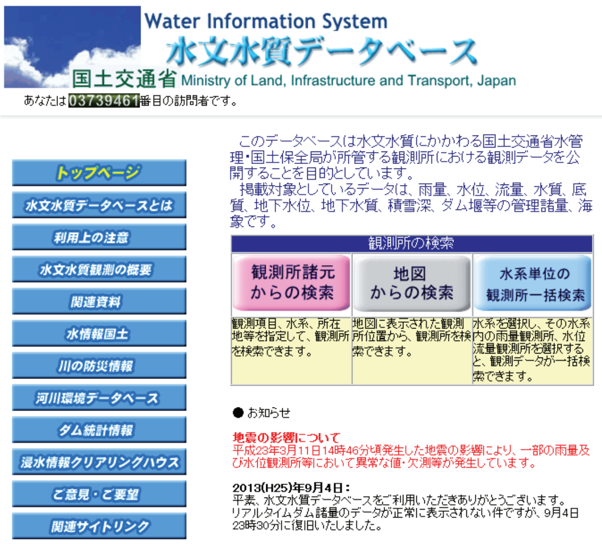
Benchmark river levels

It is possible to check benchmark river level.

観測所名	水系名	河川名	▼水位 (m)	観測時刻	基準水位(m)					位置	管理区分
					水防団待機	はん濫注意	避難判断	はん濫危険	計画高		
芦ノ湖	関東その他	芦ノ湖	2.47	13:40	2.35	2.50	2.60	—	—	—	自治体
槙尾山	淀川	宇治川	2.17→	13:50	2.00	3.00	3.50	3.60	—	左岸51.90k	国河川

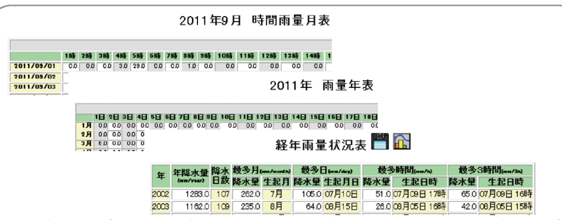
Publication of observational data

Saving and publishing observed results on precipitation, water levels, flow rate, etc., in the Hydrology and Water Quality Database.

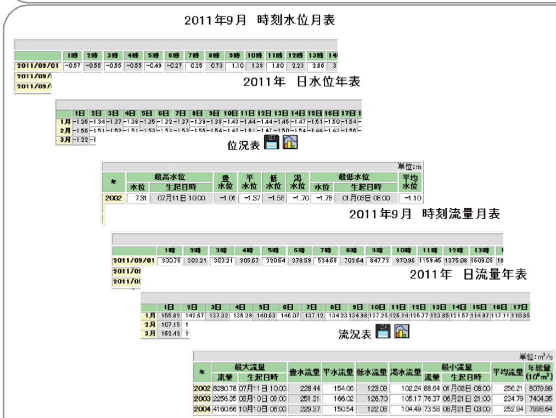


hydrological water quality database (http://www1.river.go.jp/)

Publication of observational data on precipitation, water levels, flow rate, water quality, etc., under MLIT Water and Disaster Management Bureau jurisdiction.
Number of observatories which publish data (as of Oct. 2013)
rainfall observatory : 2,682 water level/discharge observatory : 2,078



Rainfall data (hourly rainfall table, yearly rainfall table, over-year rainfall table)



Water level/flow data (hourly water level, daily water level, stage duration, hourly flow, daily flow, stream flow conditions, etc.)

River Informations

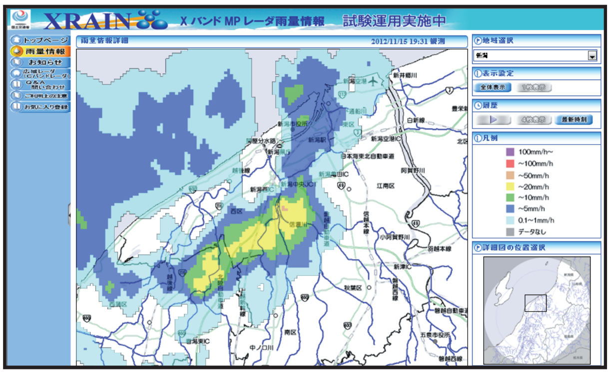
Delivery of Observed XRAIN Data to Citizens

XRAIN information is delivered to public in real time through the MLIT website.

Applications and contents for mobile devices are developed by the private sector and are widely used.

Delivery through MLIT Website

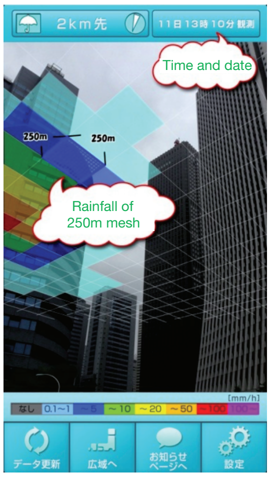
・XRAIN information is delivered in real time through the MLIT website.



http://www.river.go.jp/xbandradar/

Contents and applications for mobile phones developed by the private sector

・Applications for mobile phones and contents for forecasting information of rainfall are developed by the private sector.



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