Rivers in Japan

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C O N T E N T S

I

Geographical Characteristics

Japan, though blessed with abundant natural beauty, is plagued by frequent natural perils including floods, landslides, earthquakes, tidal waves, and volcanic eruptions. With the enactment of The River Law in 1896, a regular flood control plan was established. In recent years, however, with urbanization resulting in greater damage from natural disasters, river maintenance projects have become even more essential.

Water management

Various types of projects contribute to conservation of land and preservation of scenic landscapes.

Natural disasters are common in Japan. Urbanization has created new types of disasters (disruption of inner water, the triggering of landslides, etc.) and increased water demand. Calamities and sudden water shortages can paralyze cities and impact heavily on everyday and economic activities. We implement various projects to protect the land and people and to create safe and comfortable living environments within the active society.

- **Small dams for water supply**
Water shortage has been a problem in mountainous regions where there are no major rivers to supply water. Building small dams to supply water has improved the living conditions in such places.

- **Hometown Rivers and Hometown Erosion Control Projects**
As part of localized community development, particularization of stream improvement projects helps to preserve regional environmental characteristics.

- **Avalanche control measures**
In addition to the installation of fences and the like to prevent avalanches, establishment of warning and evacuation systems alleviates destruction caused by avalanches.

- **Water quality improvement**
Improving water quality of rivers, lakes, and reservoirs protects water resources and waterside environments.

- **Slope failure prevention**
Slope failure prevention measures protect area residents.

- **Maintenance of coastal environments**
Creating promenades and planting trees on coastlines enhances parks; and coastal development provides space for marine sports.

- **Improvement of dam environs**
Improving dam environs preserves lush natural settings and develops space for recreational use, contributing to revitalization of the community.

- **Dams**
Dams store stormwater temporarily to regulate streamflow and prevent flooding. Dams also ensure a reliable water supply.

- **Detention basins**
Detention basins regulate or moderate sudden changes in river flow.

- **Coastal protection**
Coastal protection measures prevent destruction by storm surges, tsunamis, and erosion by strong waves.

- **Ecological river development**
Utilizing features of natural rivers such as shoals and pools and creating ecology-friendly revetments yields nature-rich scenic river environments.

- **Underground floodways**
Underground water channels divert flood flow to protect urban areas from floods.

- **High-standard levees ("super levees")**
High-standard levees ("super levees"), which are much wider than conventional embankments, strongly resist extreme flooding and earthquakes. (about 100 - 300 m) The wide tops of the embankments provide a space that helps to integrate a community with its river.

- **Landslide control measures**
Preventive measures, such as surface and underground dewatering and setting deep pilings, prevent highly destructive, large-scale landslides that can be caused by groundwater or other geological influences.

- **Creating rivers that enable fish to migrate upstream**
Various fishways enable anadromous fish to navigate weirs and dams.

- **Rainwater percolation intakes**
Filtering rainwater into the ground prevents overloading of urban rivers and sewer systems.

- **Check dams**
Regulating sediment runoff prevents sediment disasters.

- **Shortcutting**
Straightening out winding river channels helps prevent flooding by channeling high waters more directly down to the sea.

- **Control of volcanic flow**
Implementing both structural and nonstructural measures helps to minimize damage caused by flow of mud, debris, and lava.

- **Dredging**
Removing bottom sediment increases the cross-sectional area of the river to prevent flooding.

- **River marinas**
Construction of mooring facilities for small boats encourages use of rivers.

- **Pump stations**
In areas where flood water rises higher than ground level, stormwater is pumped into the river.

- **Improvement of river environment**
High water channels, promenades, and overflow fields provide attractive riverside areas that encourage use of the river.

- **Detention basins**
Detention basins regulate the amount of water flowing into the river and prevent flooding.

- **Conveyance channels**
Channels that transfer water from river to river secure a source of water for everyday use.

- **Floodways**
Cutting artificial channels in the middle or lower reaches to divert water from the main channel protects riverside communities.
Detention basins regulate the amount of water flowing into the river and prevent flooding.

- **Levees**
Levees prevent rivers from flooding. River banks are raised or set back to widen the river channel, thereby increasing the river's discharge capacity.

The Land and it's River

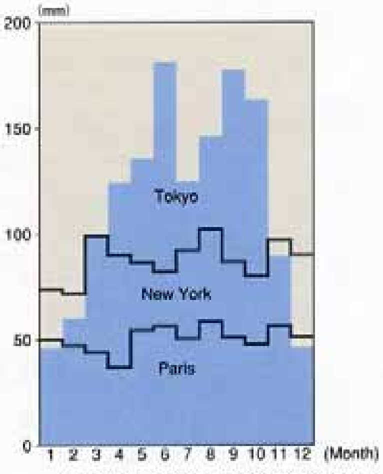
Rivers in Japan are short and steep and flow rapidly and violently. Moreover, the ratio between the normal volume of flow and that during a storm is extremely great.

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.

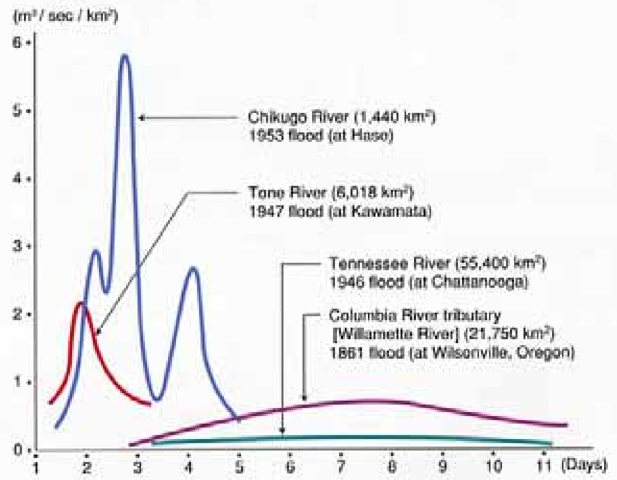
■ Japanese cities have more precipitation than large cities in other countries.



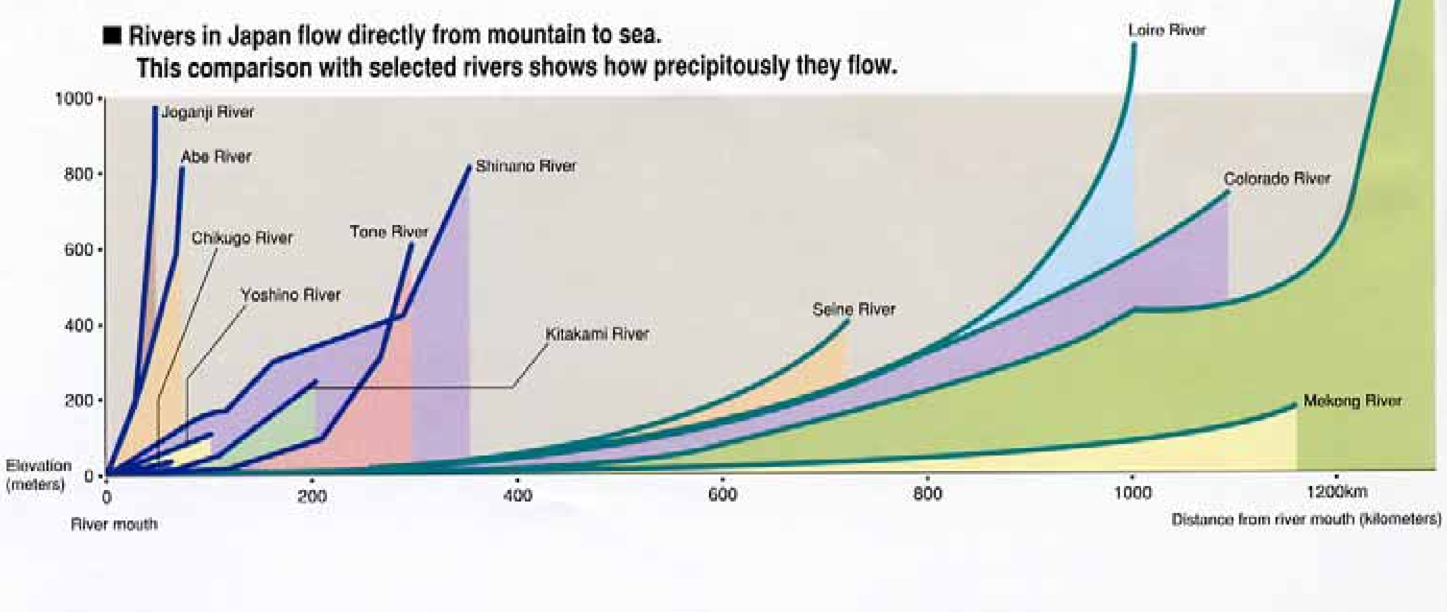
Source: Chronological Scientific Tables 1993.

■ 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.

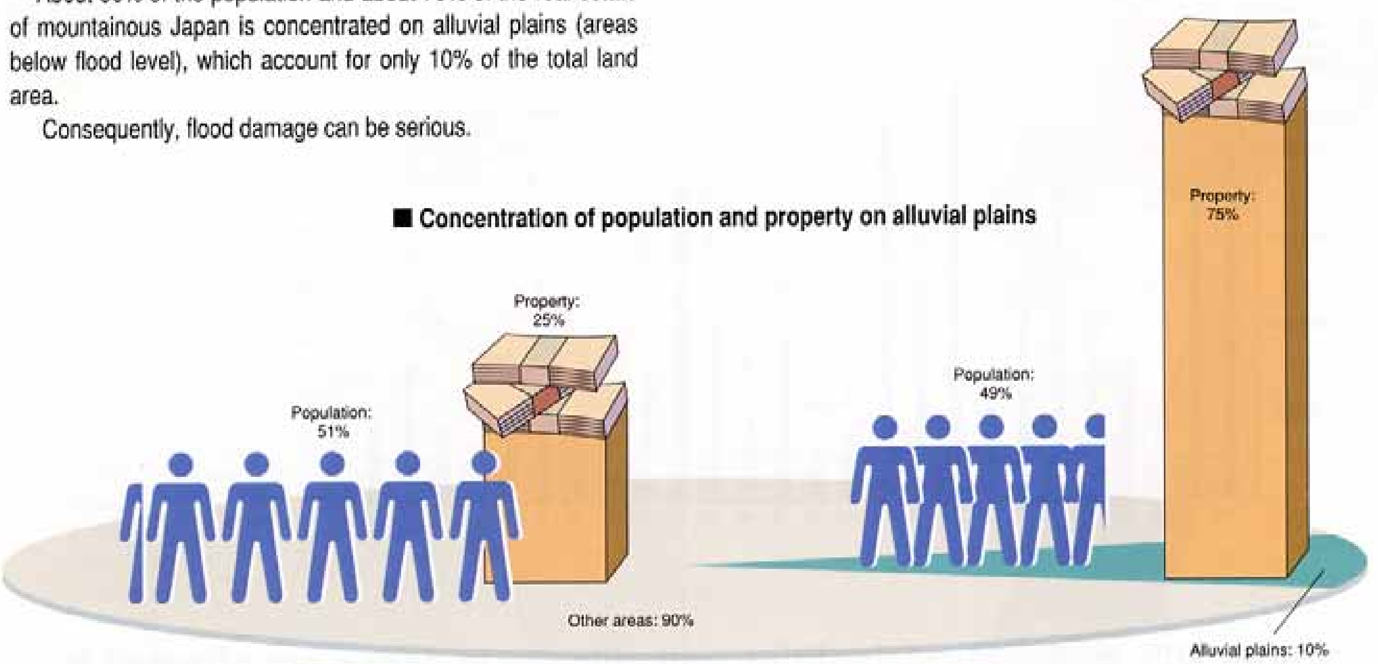


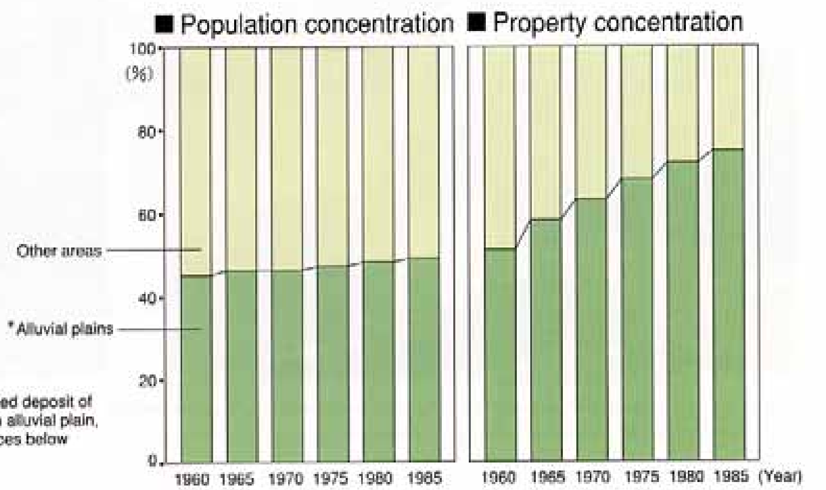
Japanese cities are quite susceptible to floods. Most population and property, and therefore most flood damage, concentrate on alluvial plains.

About 50% of the population and about 75% of the real estate of mountainous Japan is concentrated on alluvial plains (areas below flood level), which account for only 10% of the total land area.

Consequently, flood damage can be serious.

■ Concentration of population and property on alluvial plains



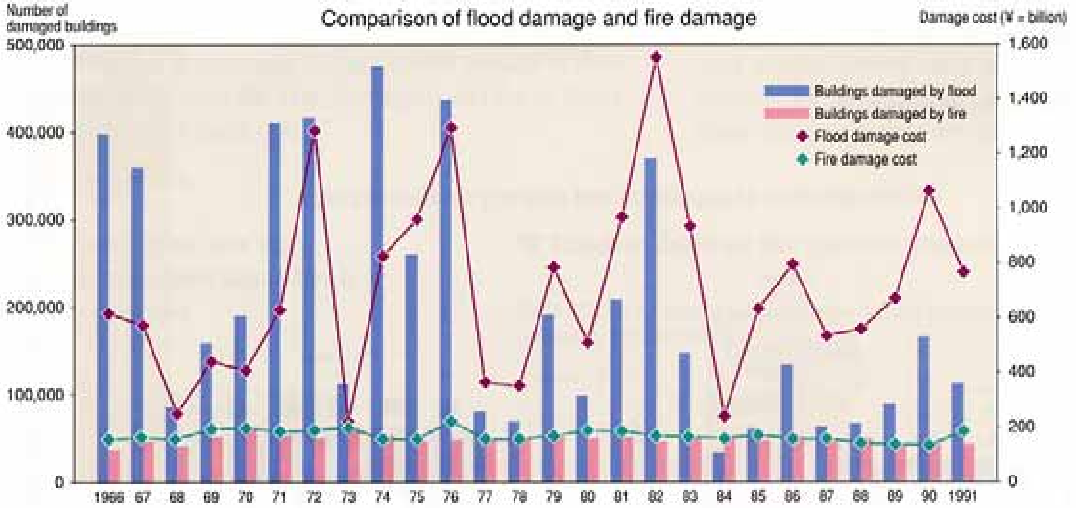


* Alluvial plain.
A plain formed by repeated deposit of river-borne sediment. An alluvial plain, therefore, is in many places below flood level.

Flood and sediment disaster

Damage due to flooding is about 4.5 times that due to fire.

Every year severe local rains cause flood damage in early summer and during the rainy season and typhoon season. Total flood damage (direct damage alone) in 1991 was about 4.5 times as much as fire damage.



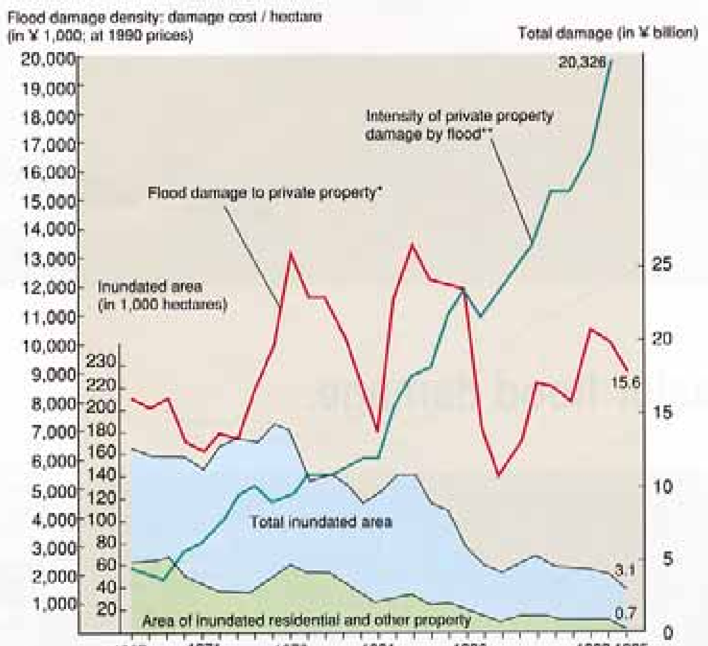
About 80% of the municipalities and villages in Japan are affected by disaster.

In the past 10 years, about 80% of the municipalities and villages in Japan have suffered some flood or sediment damage. The danger of flood and sediment disasters is ever-present.

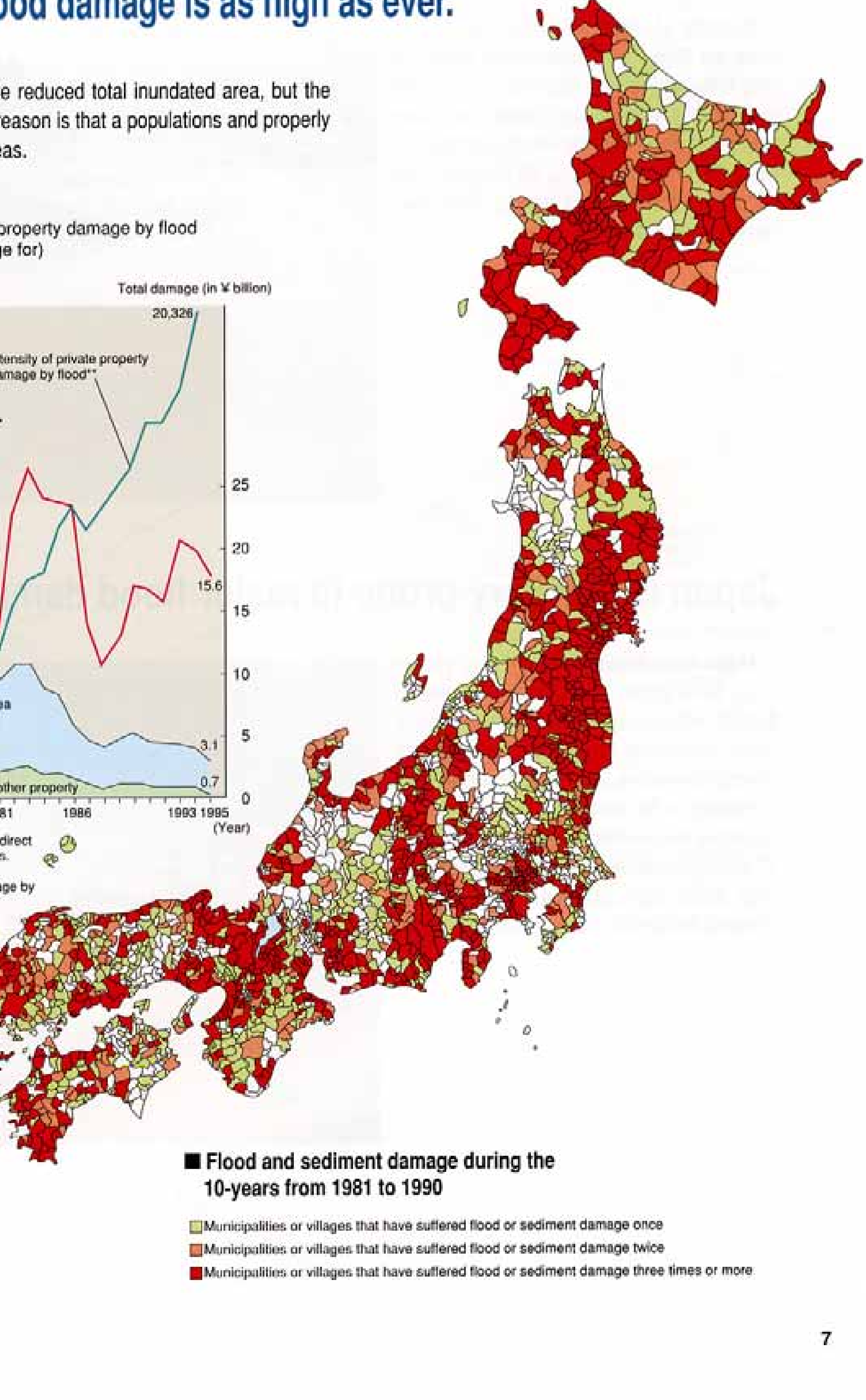
Total inundated areas has been reduced; but property continued to concentrate in flood plains. The net result is that flood damage is as high as ever.

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

Changes in intensity of private property damage by flood (the average for)



* Private property damage by flood is the sum of direct damage plus loss due to interruption of business.
** Density of private property damage by flood is calculated by dividing the private property damage by the area of inundated residential area.



■ **Flood and sediment damage during the 10-years from 1981 to 1990**

- Municipalities or villages that have suffered flood or sediment damage once
- Municipalities or villages that have suffered flood or sediment damage twice
- Municipalities or villages that have suffered flood or sediment damage three times or more

Flood and sediment disaster

Disasters occur during the rainy season and typhoon season almost every year.

Records of natural disasters during and since the Meiji Restoration (1868) show that long rains and severe local rains during the rainy season and typhoon season are major causes of flood and sediment damage. 30 typhoons, affect Japan and, on average, three typhoons hit the country directly each year, causing serious damage.

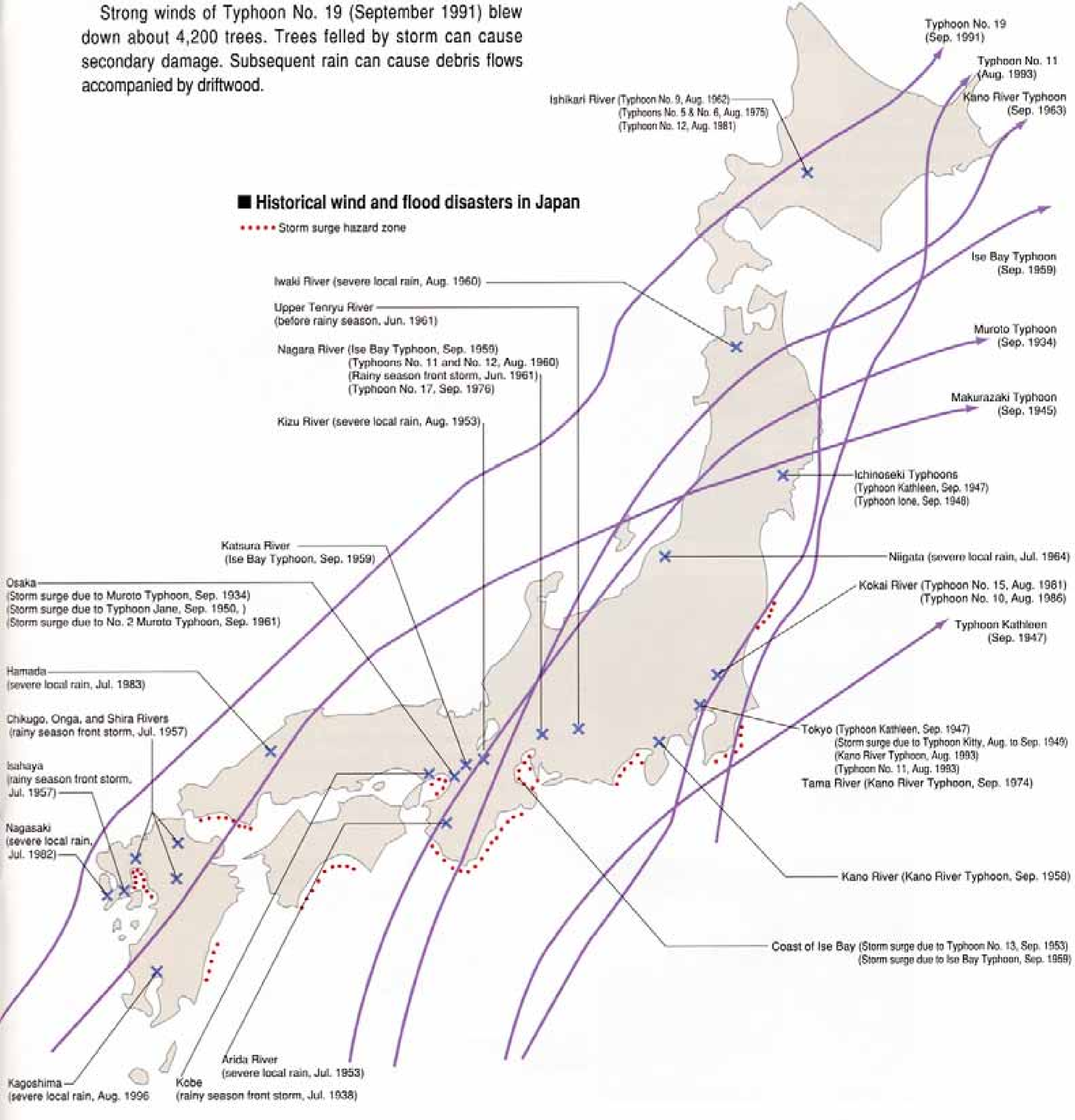
Japan is still very prone to major flood damage.

Major flood disasters occur every year in many parts of the country. For example, in August 1993, heavy rains that hit the Kyushu region, particularly Kagoshima prefecture and Miyazaki prefecture, left 79 people either dead or missing. In the same year, Typhoon No. 11 caused a major flood which affected about 27,000 houses in the Tokyo metropolitan area. This flood also severed transportation networks and greatly affected urban functions.

Great destructive power of trees felled by storms.

Strong winds of Typhoon No. 19 (September 1991) blew down about 4,200 trees. Trees felled by storm can cause secondary damage. Subsequent rain can cause debris flows accompanied by driftwood.

■ Historical wind and flood disasters in Japan



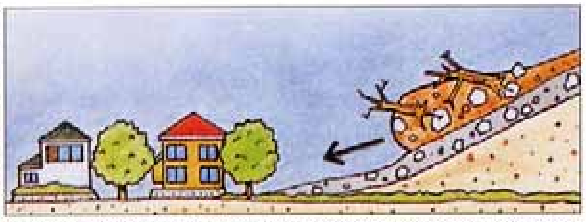
Flood and sediment disaster

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.

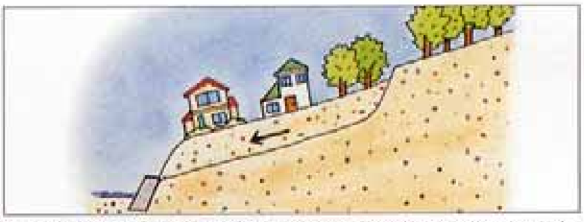
Consequently, sediment disasters of one kind or another, such as debris flows, landslides, and slope failures, occur throughout the country every year.

• Debris flows



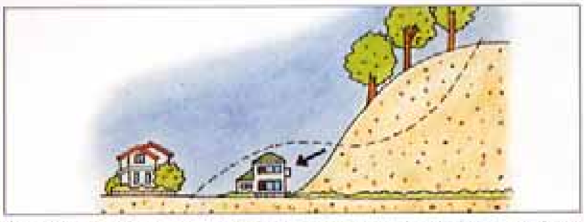
A debris flow is a washout of stones and sand that had been deposited on hillsides or in river beds due to long or heavy rain. Debris flows can instantly bury houses and farmlands.

• 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.

II

Flood and Erosion Control

Public demand is growing for systematic development of infrastructure. Measures to control floods, sediment disasters, volcanic eruptions, and coastal erosion are among the most important components of infrastructure because they provide a foundation on which to build safe and comfortable living environments.

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.

Japan lags behind other countries in river improvement.

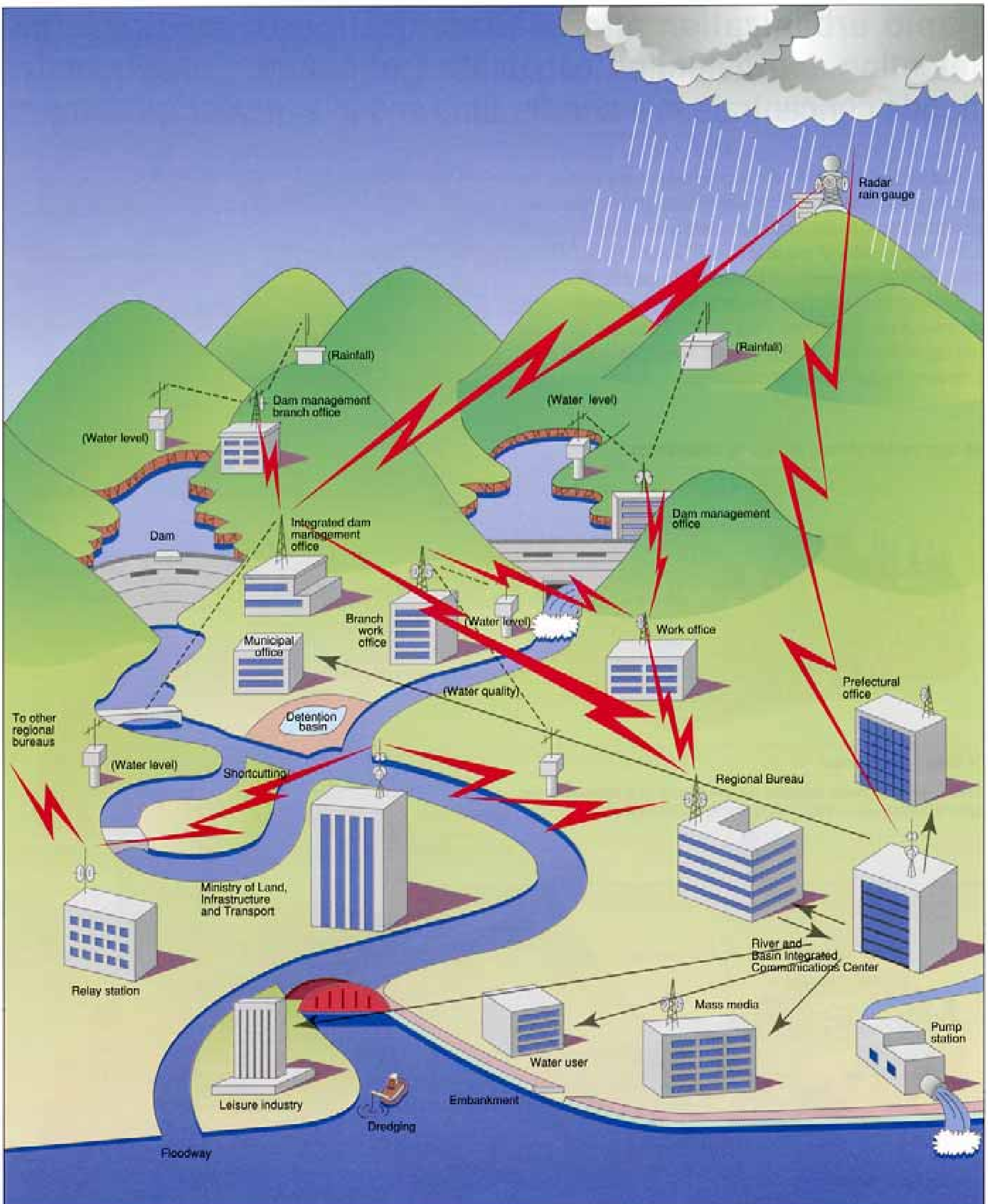
Flood control plans for major rivers are usually based on the greatest amount of rainfall that might be expected to occur, once in about 100 to 200 years. Since, however, the task of attaining this goal takes a very long time, current practice is to set a less ambitious goal for a shorter period and 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.

Channel improvement (Japan)

	Eighth Five-Year Flood Control Program	
	Goals (short term)	Expected improvement (end of 1991 to end of 1996)
Flood protection ratio in Uban area	To prevent flood damage resulting from heavy rains equivalent to 50 mm per hour	45%→53%
Major rivers	To prevent flood damage resulting from heavy rains occuring every 30-40 years	62%→69%
Smaller rivers	To prevent flood damage resulting from heavy rains occuring every 5-10 years	35%→43%
Sediment disaster prevention measures	To prevent sediment disaster resulting from heavy rains occuring every 5-10 years	20%→27%

Channel improvement conditions (Europe, US)

Country	Target flood probability	Degree of improvement of main channel embankment
US	Once in 500 years (Mississippi River)	70% (1979)
UK	Once in 1,000 years (Thames River)	Substantially completed (1983)
Netherlands	Once in 10,000 years (Storm surge plan)	Substantially completed (1985)
France	Once in 100 years (Seine River)	Substantially completed (1988)


Radar rain gauge
(Rainfall)
(Rainfall)
Dam management branch office
(Water level)
(Water level)
Dam
Integrated dam management office
Dam management office
Branch work office
(Water level)
Work office
Municipal office
(Water quality)
Prefectural office
To other regional bureaus
Detention basin
(Water level)
Shortcutting
Regional Bureau
Ministry of Land, Infrastructure and Transport
Relay station
River and Basin Integrated Communications Center
Mass media
Water user
Pump station
Leisure industry
Embankment
Dredging
Floodway

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 1990, however, rural land had decreased to 20%.

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

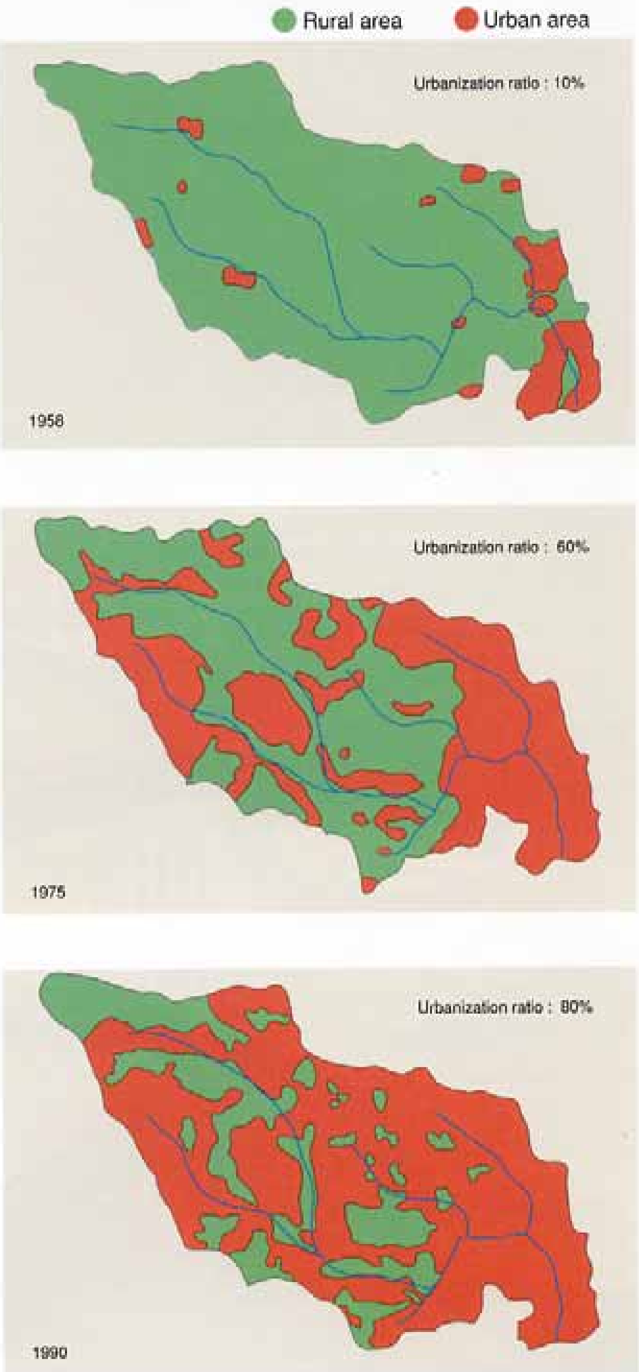
• Before development

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

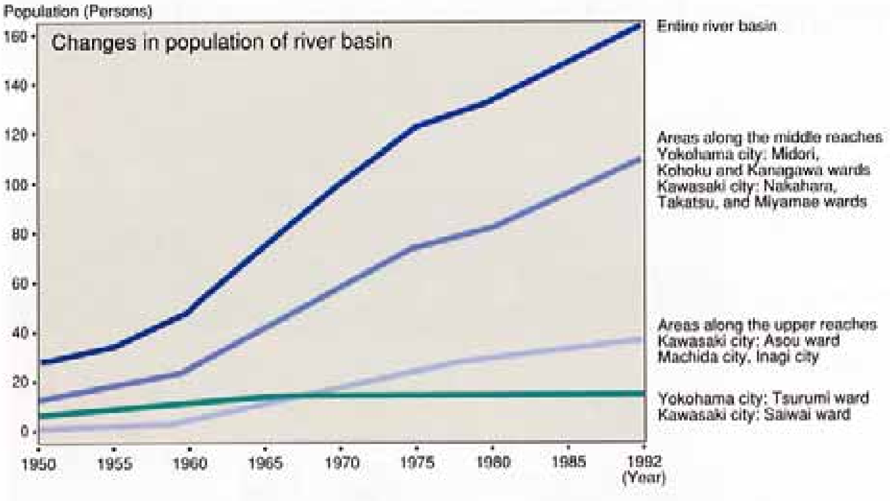
• After development

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

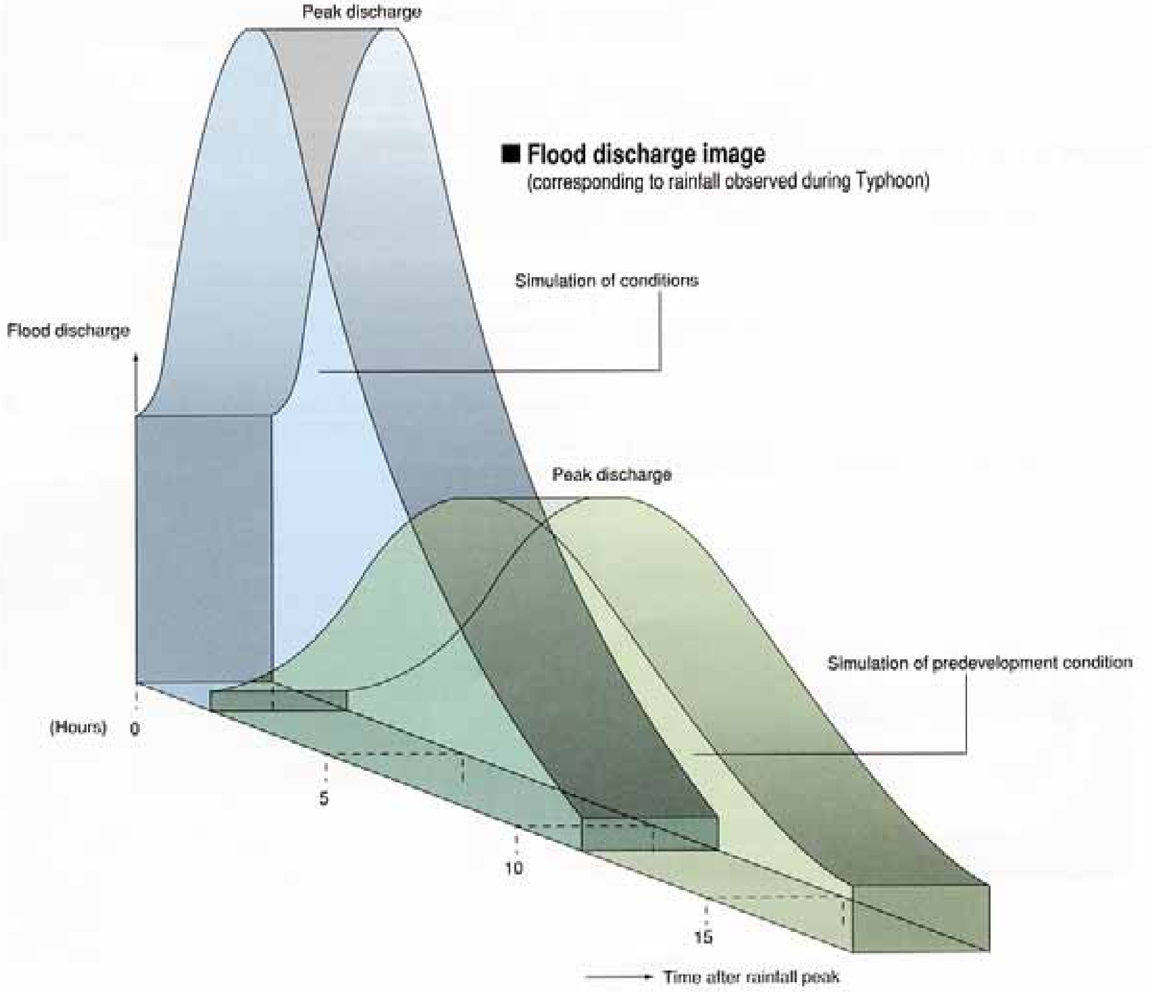
■ Urbanization in the Tsurumi River basin



In about 30 years, urbanization rose from 10% to 80%, leaving only 20% of rural land.



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



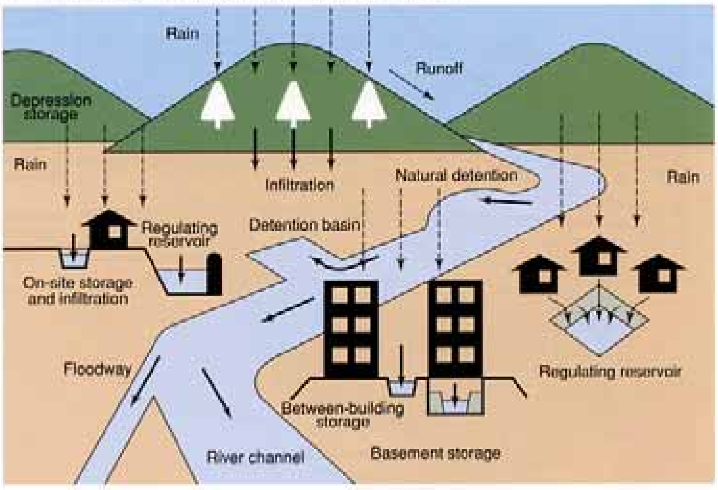
Integrated flood control measures

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

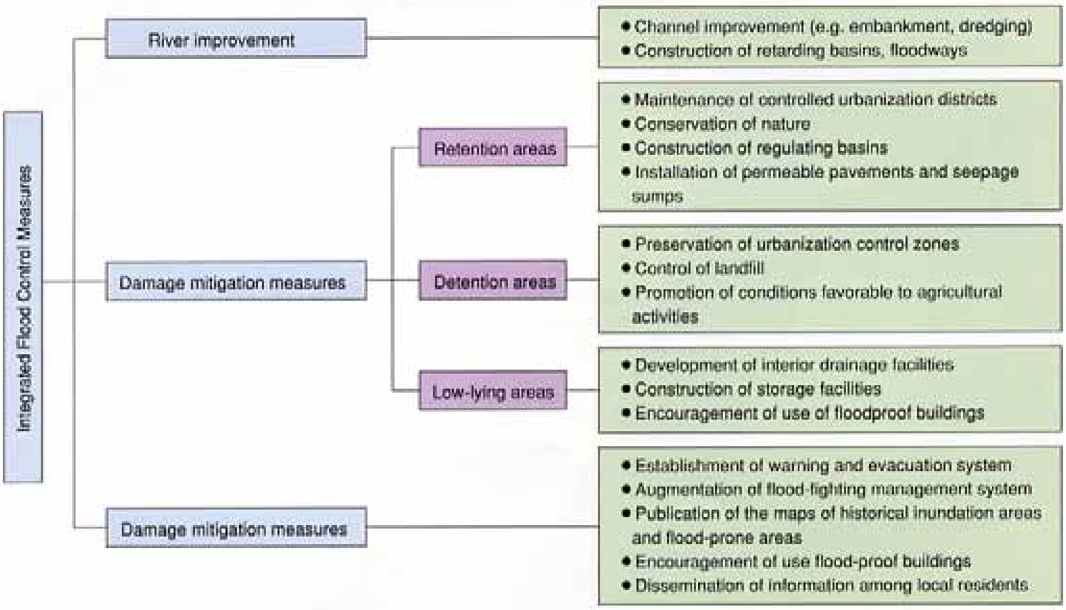
One consequence of rapid urbanization is the growing concentration of population and property in low-lying lands which have historically been subject to flooding. This trend is aggravating flood damage.

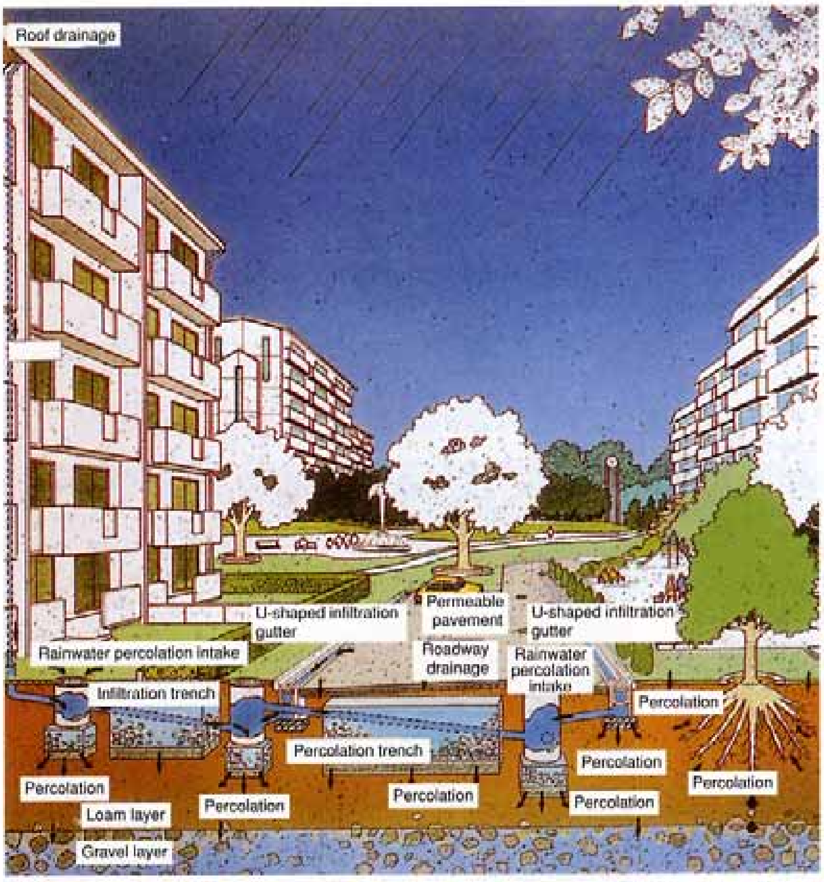
Conventional river improvement that relies on levees and detention basins is not enough. There is an urgent need for a comprehensive approach that combines (1) river basin measures, such as the construction of facilities designed to preserve and enhance the retention and detention capabilities of river 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.

■ Concept of comprehensive flood control



■ Integrated of flood control measures

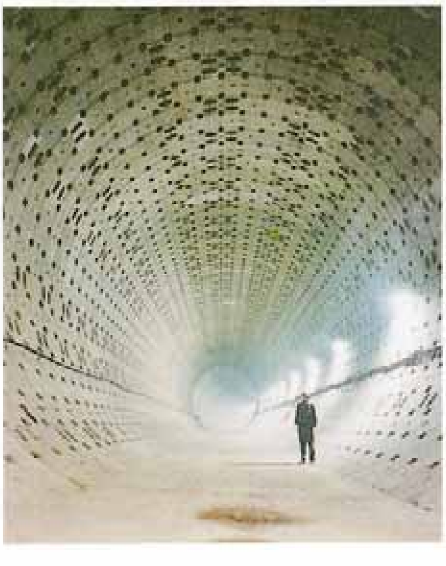




■ Infiltration facilities to mitigate urban floods

Impervious asphalt and concrete over the ground surface reduce permeability and retention capability. By installation of infiltration facilities such as rainwater percolation intakes, stormwater can be allowed to filter into the ground. These facilities help to increase the retention capacity and thereby lessen the loads imposed on rivers by reducing (1) total runoff to rivers and (2) peak discharge.

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



In major cities, it is becoming more difficult to construct new surface floodways. Underground floodways and underground regulating reservoirs are underground "rivers" and "ponds" designed to protect the overlying cities from floods.

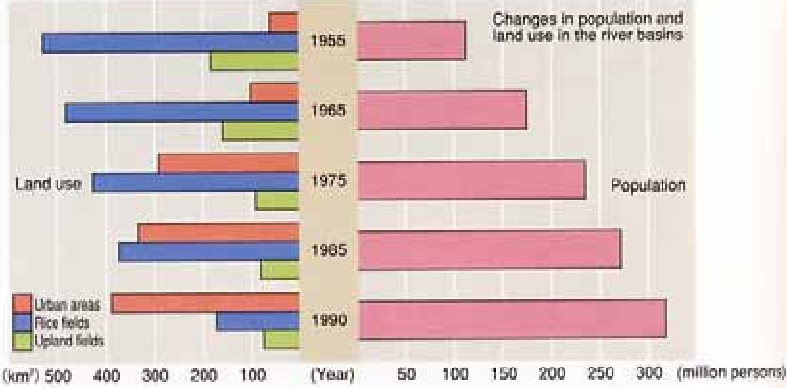
Housing development and flood control

Waves of residential land development are sweeping over alluvial lowlands in the Tokyo metropolitan area.

■ **In the basins of the Naka and Ayase rivers in eastern Saitama prefecture, the last 30 years have seen very rapid development of residential land.**

In response to the growing demand for housing in the Tokyo metropolitan area, residential land is expanding from the more or less elevated western region to the flood-prone eastern region. For instance, the percentage of urbanized areas in the Naka and Ayase river basins in eastern Saitama prefecture more than tripled from 11% in 1965 to 39% in 1991.

The risk of flood damage has increased with urbanization of low-lying areas. There is an urgent need, therefore, for integrating effective flood control with residential land development.

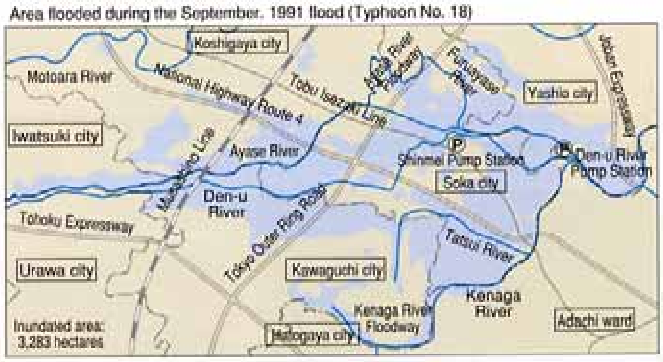


■ **Flood control measures, including the construction of the Ayase River Floodway, have reduced flood damage to about one-third.**

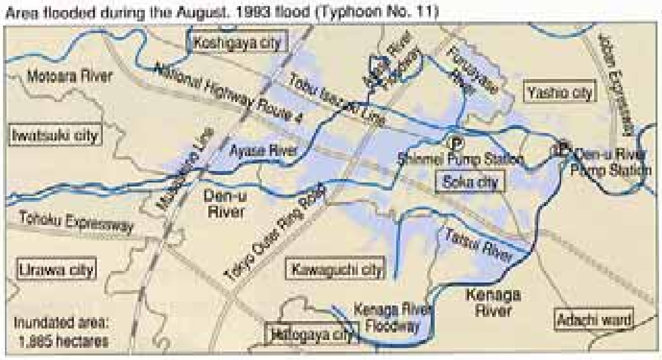
In the Naka and Ayase river basins, Typhoon No. 18 (1991) flooded about 20,000 houses. Thanks to partial completion of the Ayase River Floodway, however, flood damage caused by Typhoon No. 11 (August 1992), which was accompanied by a similar amount of rainfall, was held to a minimum of about 6,800 houses, roughly one-third of that of the 1991 flood.

■ **Comparison of flood damage to houses in the Naka and Ayase river basins: 1991 vs. 1993**

Area flooded during the September, 1991 flood (Typhoon No. 18)



Area flooded during the August, 1993 flood (Typhoon No. 11)



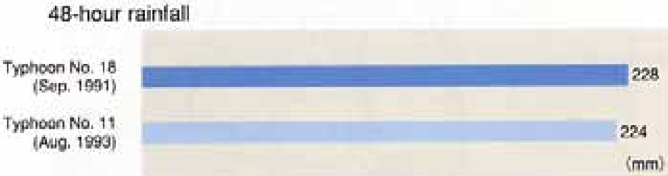
Urbanization is closely coordinated with flood detention and regulation. The goal is not only to reduce flood damage but also to build a comfortable community, making effective use of waterfront space. Increased property value is an added benefit.

Integrating flood detention and regulation with housing development in urban development programs can dramatically enhance the degree of protection from floods. This promotes creation of a living environment and community that makes effective use of waterfront space. This can result in creating an attractive environment and providing higher value-added housing.


Enjoying the riverside.


Chiba New Town (Chiba pref.)

48-hour rainfall



Inundation area

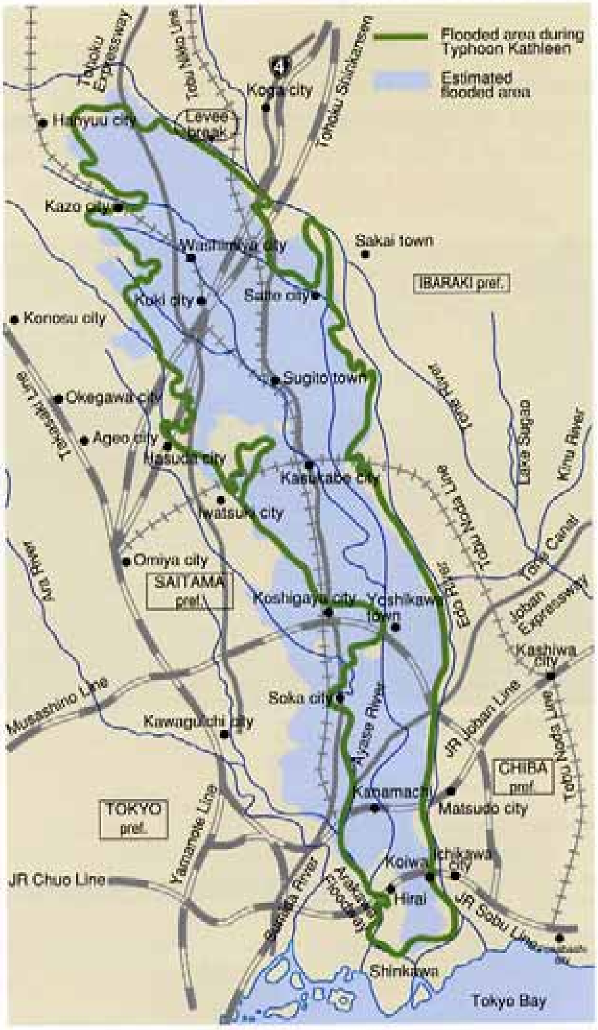
Number of flooded houses

Super levees for flood preparedness and community development

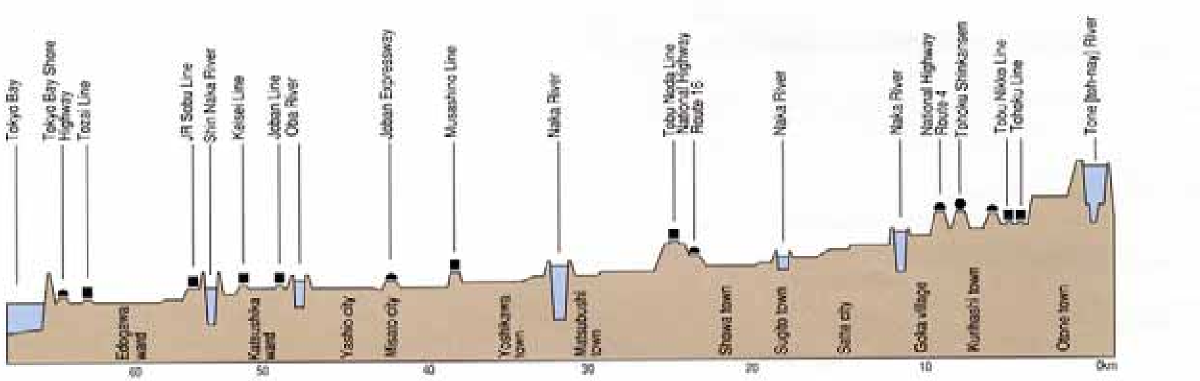
If another Typhoon Kathleen hits Japan today, direct damage alone would amount to 15 trillion, about 150 times as much as the damage caused by the 1947 typhoon.

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 km²	estimated 555 km²	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	



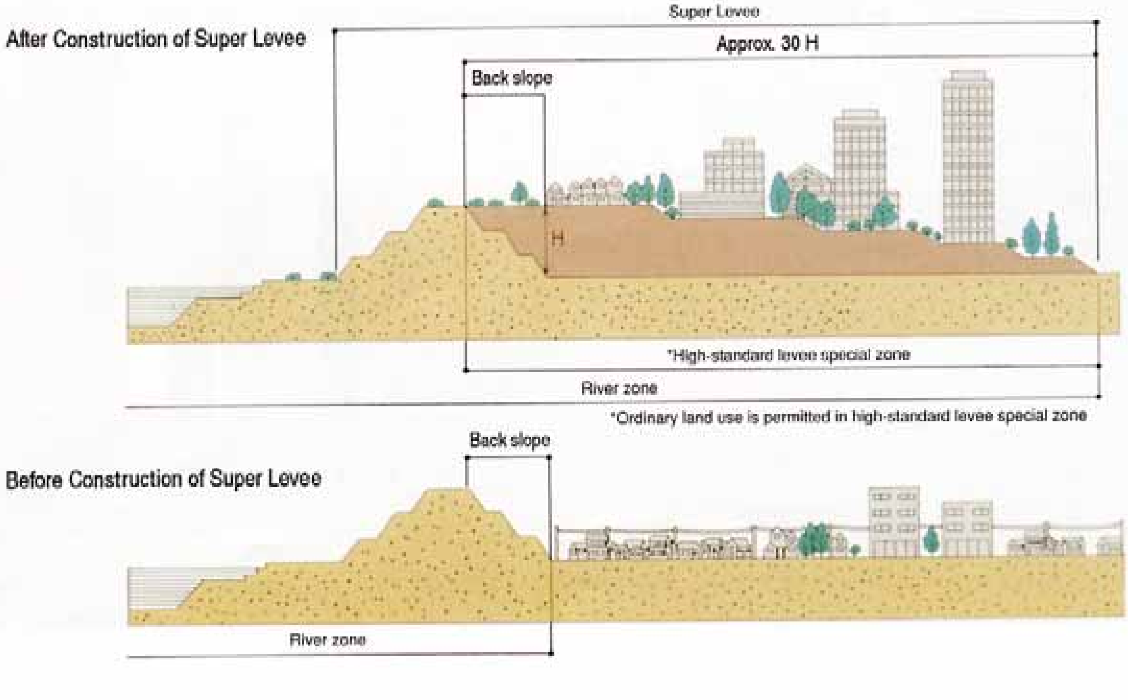
■ **Flooding of the Tone River would inundate the alluvial lowlands.**



"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.

■ Effect of Super levees

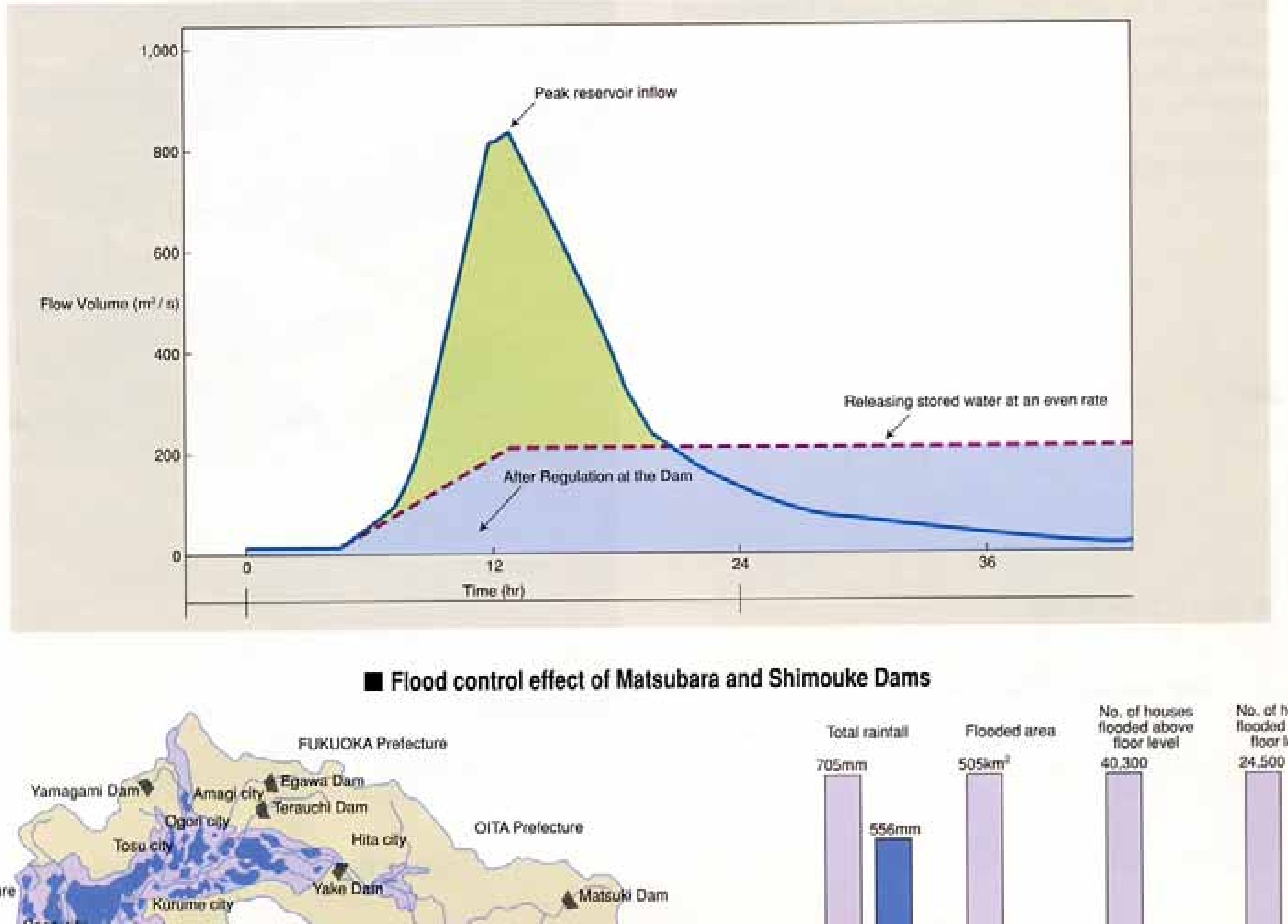


The use of dams for flood control

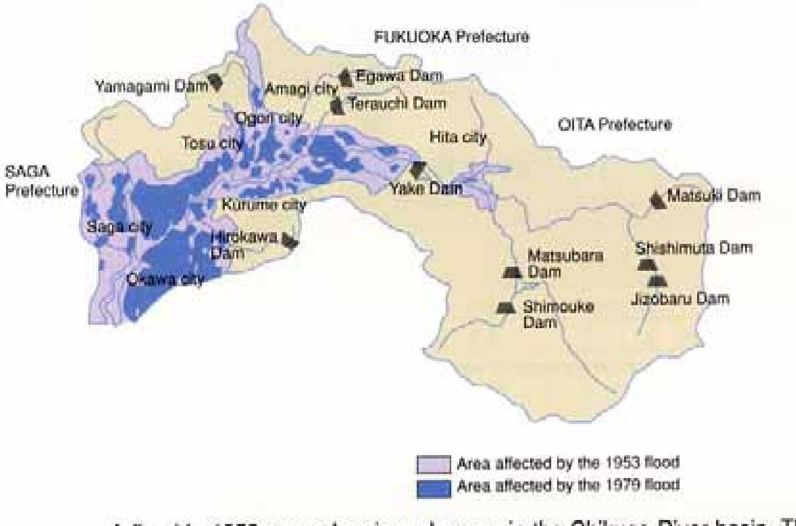
Using a dam to regulate the downstream flood discharge is one of the most effective means of flood damage mitigation.

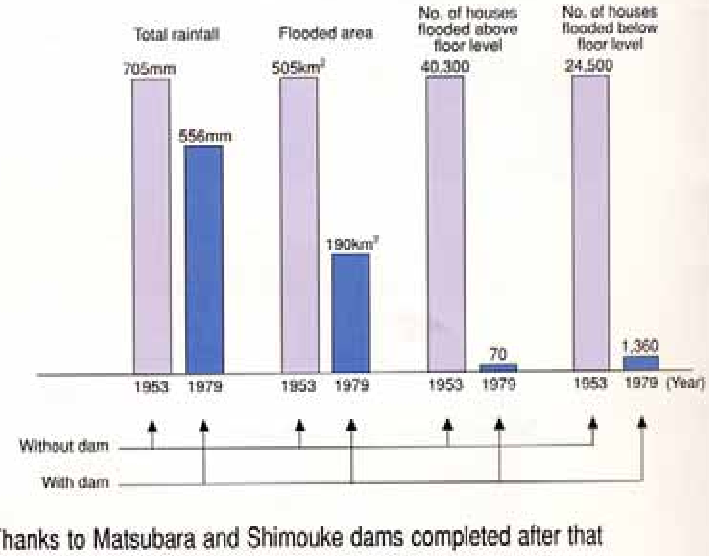
The function of a dam is to regulate the downstream flood discharge by storing storm flood only when flood discharge is high. Thus, dams reduce the peak discharge downstream and prevent a sharp increase in streamflow.

■ Example a dam can regulate flood discharge, Hourly rainfalls were measured at an actual



■ Flood control effect of Matsubara and Shimouke Dams

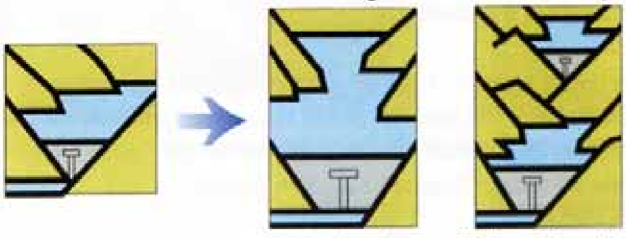




A flood in 1953 caused serious damage in the Chikugo River basin. Thanks to Matsubara and Shimouke dams completed after that flood, the damage caused by a 1979 flood was by far smaller than the 1953 damage.

Raising or coordinating existing dams may be necessary to cope with floods.

Flood control capacity of a dam can be increased by, for example, removing sediment that has accumulated in the reservoir or increasing the height of the dam. Another method of flood control is to construct another dam upstream and integrate the operation of the two dams. Thus, existing dams can be made more effective by redevelopment.



(A) The dam is made bigger to increase its storage capacity.

(B) The number of dams is increased to increase the flood control capacity.

Sediment removal by use of scour pipes

Hiyoshi Dam (Kyoto)

Preventing sediment disasters

Japan is predisposed to sediment disasters.

■ The summer of 1993 saw an outbreak of disasters throughout the country.

In 1993 a plethora of natural disasters included the Kushiro-oki Earthquake, the eruption of Mt. Unzen's Fugendake, the "blown-over tree disaster", the Hokkaido Nansei-oki Earthquake, and the so-called "August heavy rain disaster." Particularly disastrous were the heavy rains in August (including Typhoon No. 13), which, by causing many debris flows and slope failures, left 71 persons dead or missing and 156 injured in Kagoshima prefecture alone. In the city of Kagoshima, about 1,000 houses were damaged, and the national highways and railways were severed at many places.

Guarding against debris flows, tsunami-like waves of sediment

Large volumes of sediment moving in the form of debris flow can crush houses and farmlands instantly. In Japan, there are about 80,000 debris flow hazard sites.

Huge volumes of debris loosened by the great earthquake of 1858 still remain where they were deposited in the Joganji River basin in Toyama Prefecture If washed out by a heavy rain, sediment thus produced would bury the entire Toyama Plain to a depth of about 2 meters. Sediment and erosion control facilities, such as Shiraiwa Check Dam, play an important role in protecting the Toyama Plain from debris flows.

The eruption of Fugendake is still a haunting memory. Volcanically induced flow control is essential in a country where volcanoes account for about 10% of the total land.

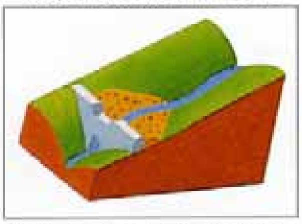
Japan is a volcanically active country. In 1990, Mt. Unzen Fugendake erupted after about 200 years of dormancy and inflicted great damage on the local community. Since there are as many as 83 active volcanoes in the country, there is a need for systematic effort to control volcanic flows.

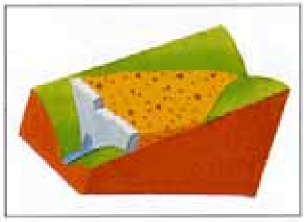
■ Major sediment disasters and damage they caused

Date	Prefecture	Hard-hit areas	Cause of disaster	Damage: Dead or missing	Damage: House damage
Jul. 1967	Hyogo	Omote Rokko	Severe local rain	92 persons	746 houses
Jul. 1967	Hiroshima	Kure city area	Severe local rain	88 persons	289 houses
Jul. 1972	Kumamoto	Amakusa area	Severe local rain	115 persons	750 houses
Aug. 1975	Aomori	Mt. Iwaki	Severe local rain	22 persons	28 houses
Aug. 1975	Kochi	Niyodo River area	Typhoon No. 5	68 persons	536 houses
Sep. 1976	Kagawa	Shodo Island	Typhoon No. 17	119 persons	2,001 houses
May. 1978	Niigata	Myokou-kogen-machi	Snowmelt	13 persons	25 houses
Oct. 1978	Hokkaido	Mt. Usu area	Eruption of Mt. Usu, flow	3 persons	144 houses
Jul. 1982	Nagasaki	Nagasaki city area	Severe local rain	299 persons	10,447 houses
Jul. 1983	Shimane	Misumi town/Hamada city area	Rainy season front	107 persons	17,600 houses
Sep. 1984	Nagano	Otaki-mura	Naganoken Seibu Earthquake	29 persons	604 houses
Jul. 1985	Nagano	Mt. Jitsuki	Severe local rain	26 persons	69 houses
Jul. 1990	Kumamoto	Ichinomiya-machi	Rainy season front	11 persons	308 houses
Jun. 1991	Nagasaki	Shimabara city	Pyroclastic flow	43 persons	179 houses
Sep. 1991	Shizuoka	Shimoda city, etc.	Severe local rain	4 persons	29 houses
Apr. to Aug. 1993	Nagasaki	Shimabara city	Pyroclastic flow	1 person	535 houses*
Jun. to Sep. 1993	Kagoshima city, etc.	Rainy season front	Typhoon No. 7 and No. 13, Severe local rain, etc.	141 persons	1,250 houses**

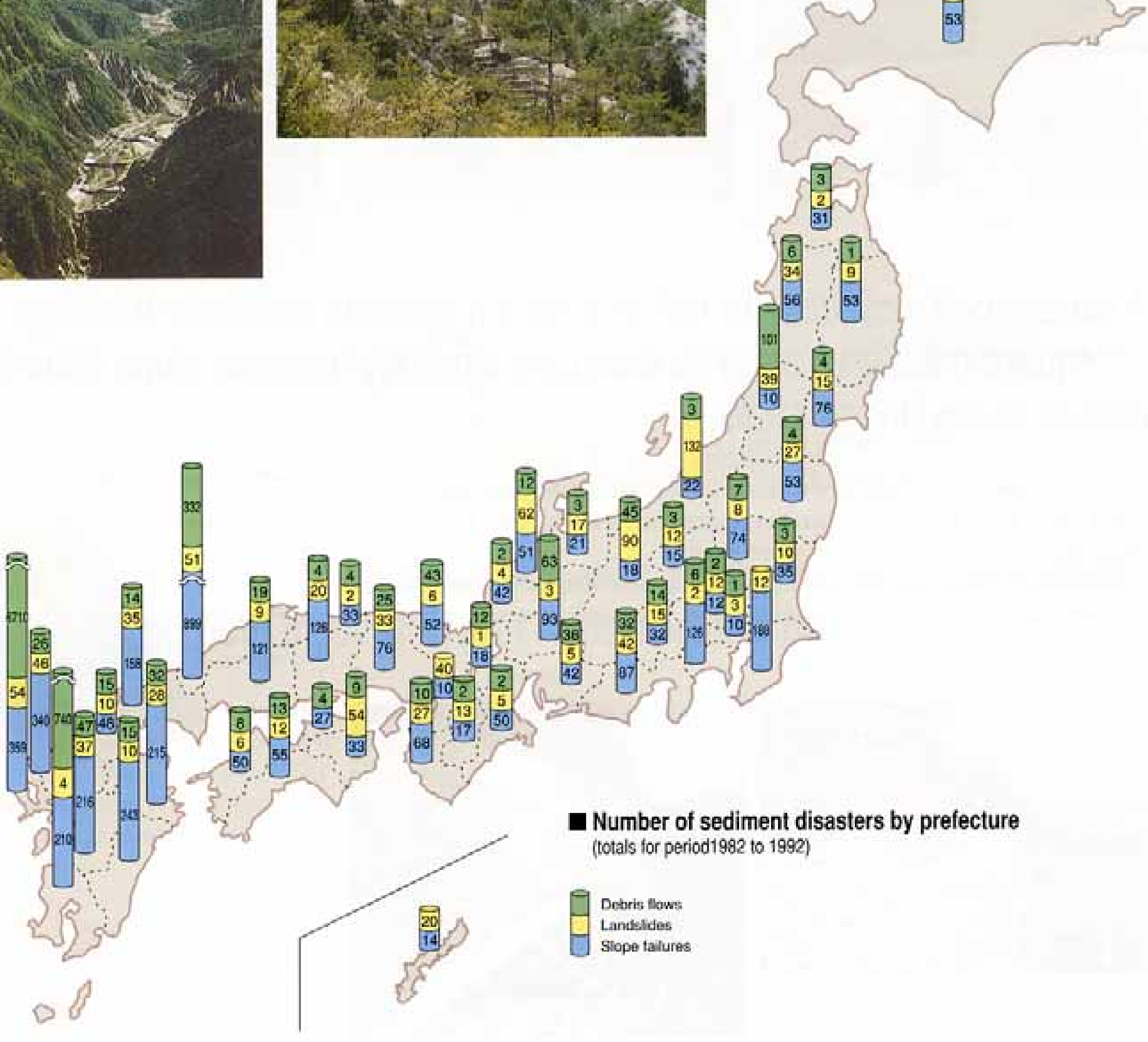
* Total, based on data released by Nagasaki prefectural disaster counter measures headquarters.
** Damage caused by Mt. Unzen Fugendake is not included here.

■ How a check dam works


Sediment has not yet been trapped.


Sediment has been trapped to capacity.

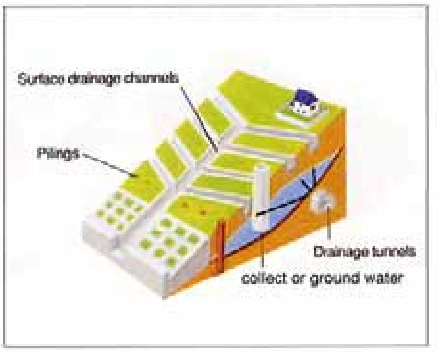

Trapped sediment has been gradually carried downstream.



■ **Number of sediment disasters by prefecture**
(totals for period1982 to 1992)

Preventing sediment disasters

Heavy soils moving downslope carry houses and farmlands away. Measures must be taken to guard against landslides.

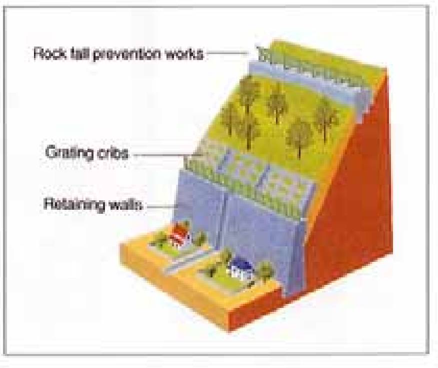


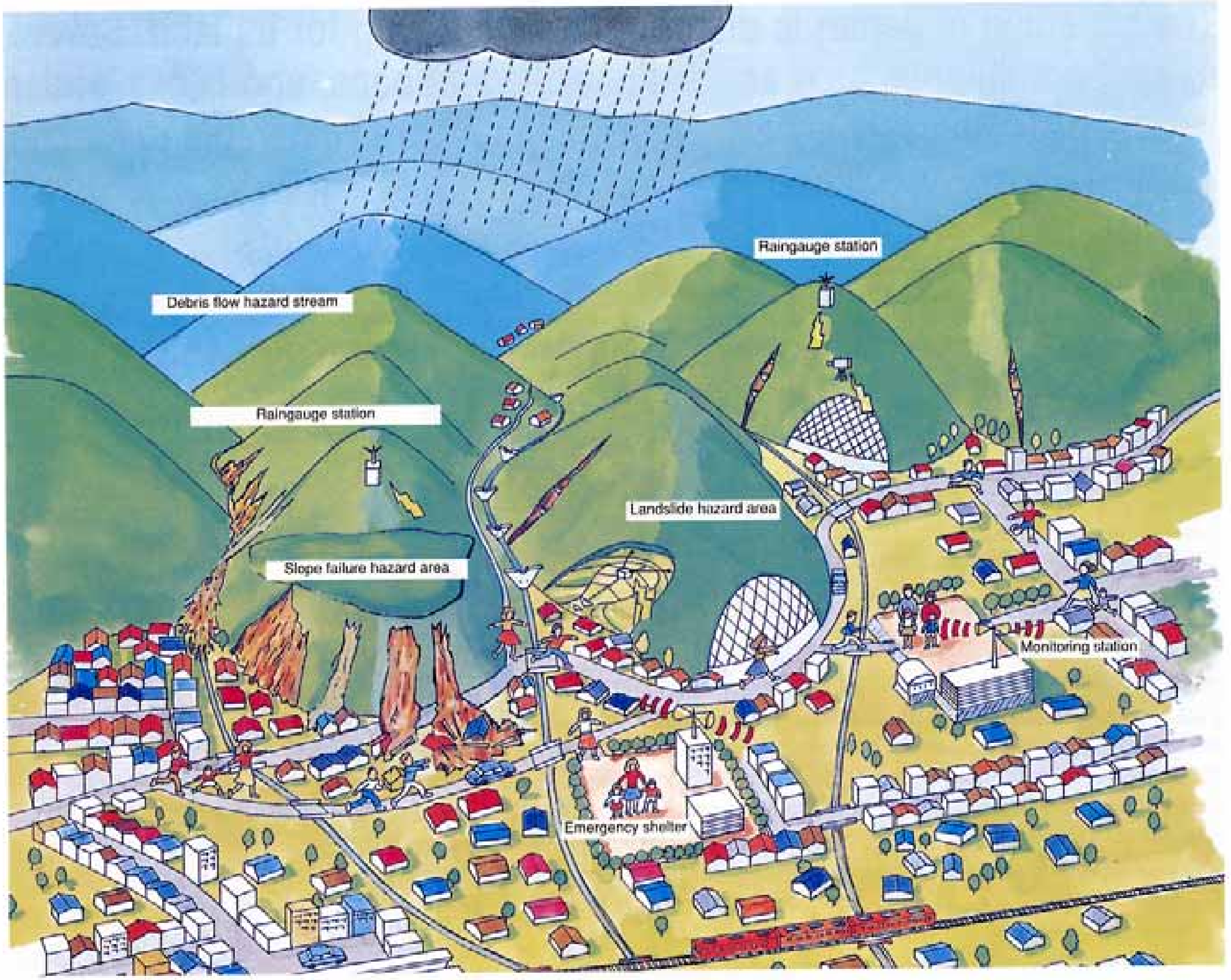
Landslides could be disastrous in that they could not only bury houses, farmlands, railways, or roads, but also cause secondary disasters by damming rivers with sediment. Another characteristic of landslides is that they tend to recur on the same slopes. In Japan, there are more than 10,000 landslide hazard areas.

A waterfall-like cascade of soil and rock fragments suddenly tumbles. Safeguard measures must be designed carefully because slope failure often occurs in developed areas.

There are over 80,000 slope failure hazard areas in Japan, and more than 6 million people live in those areas. Mainly because of urbanization, the numbers living in slope failure hazard areas have increased in recent years.

Slope failure occurs very fast, and it often claims more victims than other types of sediment disasters if it occurs in a populated area. It is therefore necessary to design preventive facilities carefully.





Prevention of sediment disasters requires a comprehensive approach encompassing both structural and nonstructural measures.

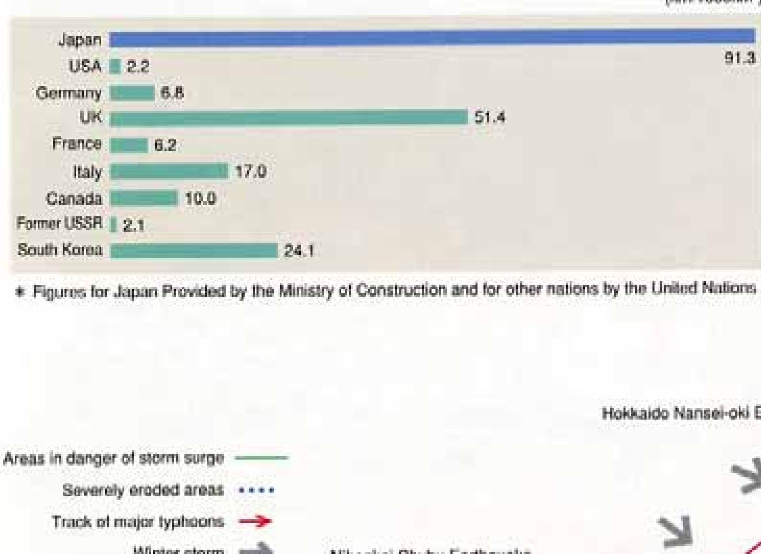
In order to prevent sediment disasters, it is necessary to organize a comprehensive set of measures combining various sediment and erosion control facilities and warning and evacuation systems. For example, comprehensive set of preventive measures to safeguard a river basin may include hillside slope rainforcements to prevent sediment runoff from collapsed slopes, inspection dams to control sediment runoff, and channel works to prevent scouring of the river banks and beds with, and may also establish a warning system to detect signs of imminent debris flows.

Coastline protection

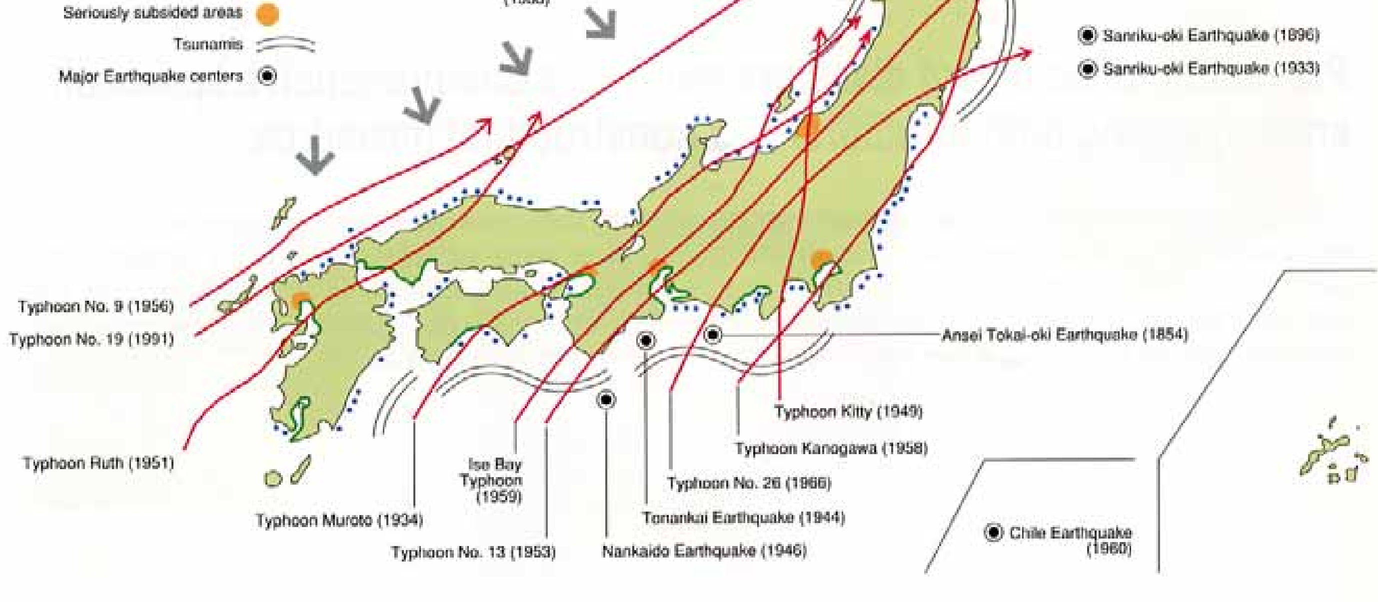
The coastline of Japan is disproportionately long for its land. Severe natural conditions, such as earthquakes, typhoons, and heavy winter waves, make the Japanese coastline all the more vulnerable to natural disasters.

The total length of the Japanese coastline is about 34,500 km. 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. About 2,400 hectares of land have been lost in the past 15 years.

■ **Length of coastline per unit of land**



* Figures for Japan Provided by the Ministry of Construction and for other nations by the United Nations



■ **Erosion and accumulated land**
(compiled over about 15 years)

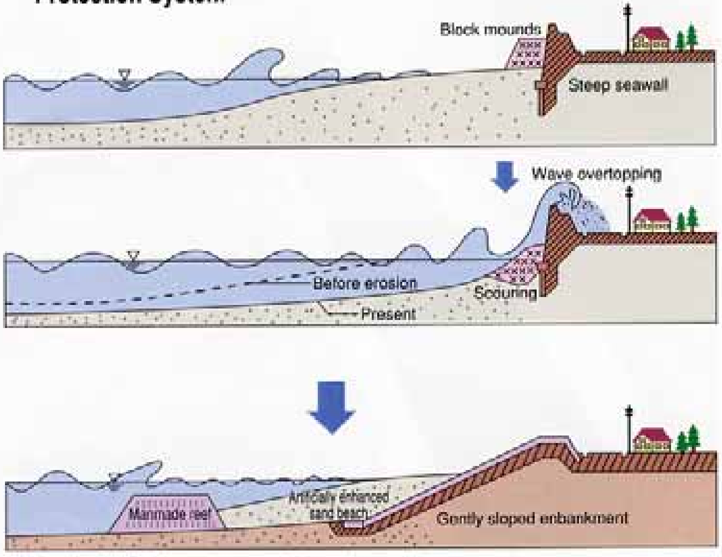
	Eroded area (hectares)	Accumulated area (hectares)
Hokkaido	1,921	631
Aomori	182	94
Akita	153	43
Yamagata	65	43
Iwate	8	9
Miyagi	79	52
Niigata	221	121
Fukushima	65	73
Ibaraki	114	176
Chiba	240	127
Tokyo	36	79
Kanagawa	37	28
Shizuoka	21	43
Toyama	26	16
Ishikawa	38	26
Fukui	100	19
Aichi	40	25
Mie	51	26
Wakayama	16	20
Kyoto	10	12
Osaka	1	17
Hyogo	36	89
Tottori	106	42
Shimane	80	19
Okuyama	31	5
Hiroshima	79	3
Yamaguchi	55	10
Ehime pref.	53	24
Kagawa	21	20
Tokushima	28	11
Kochi pref.	78	75
Fukuoka	3	10
Saga pref.	3	1
Nagasaki	134	22
Kumamoto	7	3
Oita pref.	90	8
Miyazaki	95	48
Kagoshima	264	144
National total	4,605	2,210

prefecture

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 seawall's 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**



Disaster recovery

Emergency response is an important component of flood control measures

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

Seki river (Niigata prefecture)

III

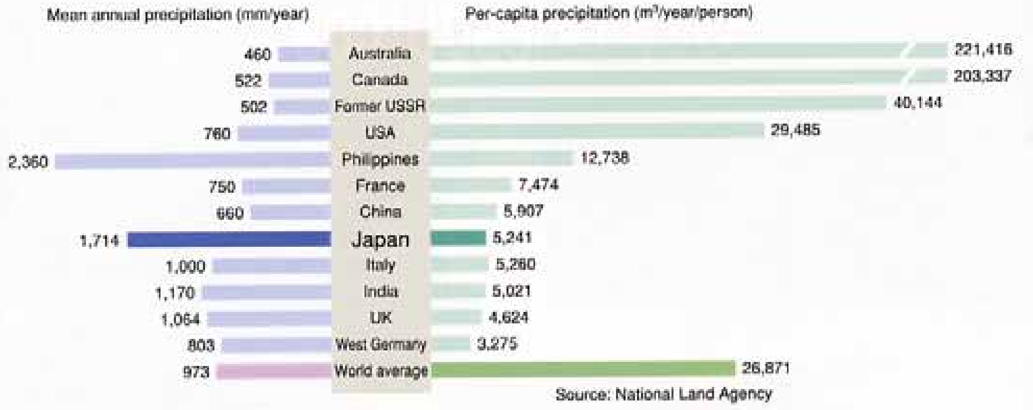
Water Resources

Japan gets plenty of rain. Nevertheless, to ensure a stable and reliable water supply is difficult because precipitation varies so much from season to season. Furthermore, water requirements have increased in recent years because of factors such as the increased percapita demand in densely populated areas. Consequently, since water availability is rather unreliable even under ordinary conditions, even a short dry spell can cause shortages. Comprehensive water resources development through various measures such as construction of multipurpose dams helps to prevent such emergencies.

Characteristic water resources

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

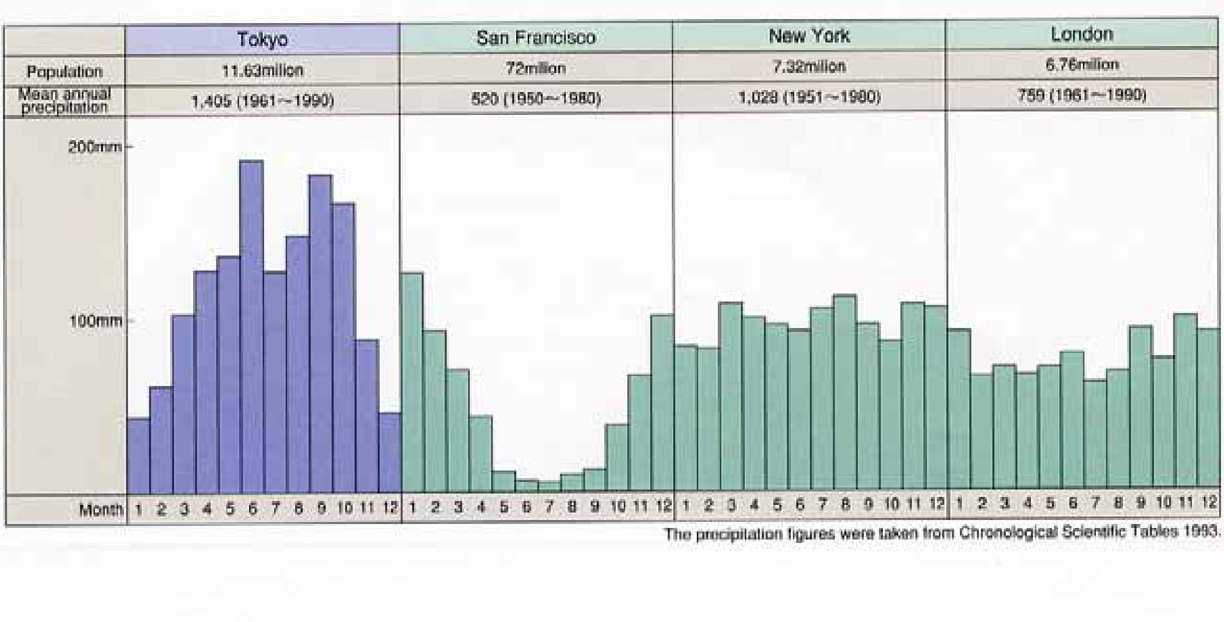
Precipitation in Japan is nearly two times the world average, but per capita precipitation is only one-fifth of the world average. From the viewpoint of available water resources, Japan cannot be considered a water-rich country.



Source: National Land Agency

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

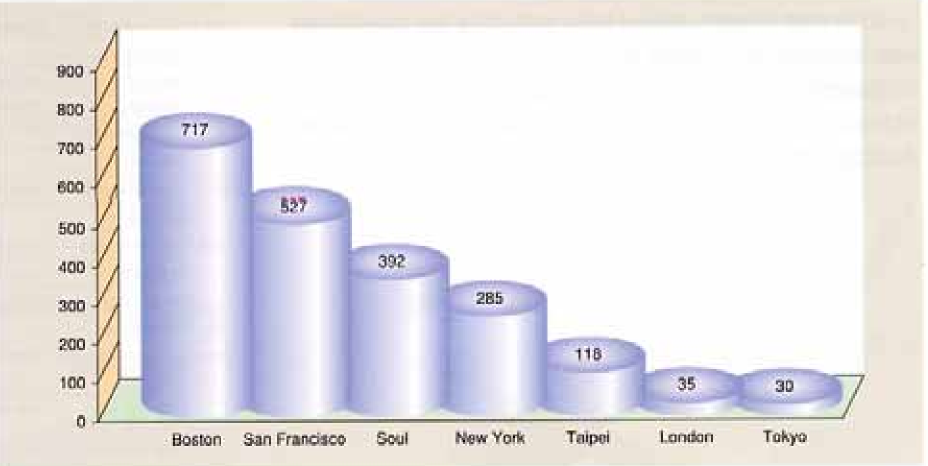
Tokyo, for instance, has considerable rainfall during the rainy season and the typhoon season but has little rainfall in winter. Consequently, even though annual precipitation is relatively high, seasonal variations mean that the amount of water available throughout the year is unreliable and unexpectedly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



The precipitation figures were taken from Chronological Scientific Tables 1993.

Per capita storage of water in Tokyo is only one-tenth of that in New York.

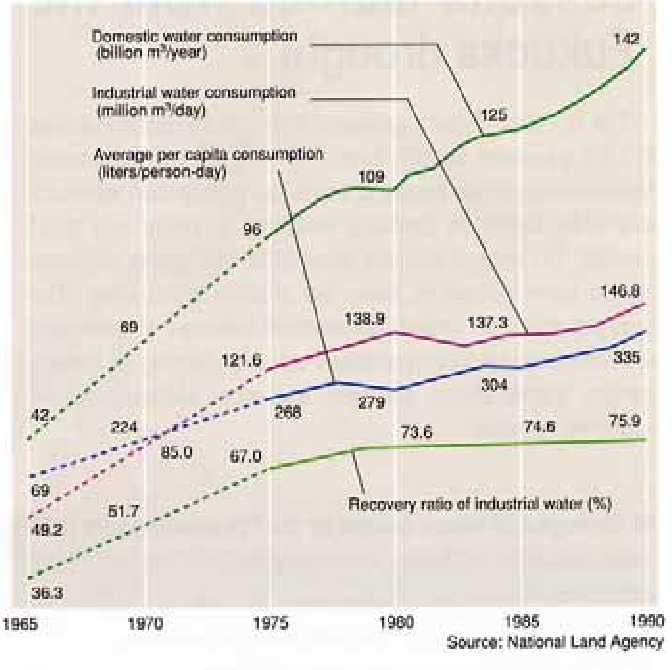
Compared with other cities of the world, Tokyo stores a very small supply of water. Per capita water storage in the densely populated Tokyo is about 29 m³. New York stores about 285 m³ per person, about 10 times as much as in Tokyo.



Water consumption continues to grow.

Domestic water consumption has almost doubled since 1965. The reason is that as the population needing water supply has increased, there have occurred changes in lifestyles, such as the widespread use of showers and flush toilets, and changes in social customs, such as the growing number of nuclear families and the emergence of around-the-clock urban activities. With these changes has come a corresponding increase in per capita daily consumption of water.

Industrial water consumption has also increased in keeping pace with the increase in industrial production. Recycling of industrial water has almost leveled off.



■ **Tokyo goes dry every three years.**

Ever-increasing water demand and inadequate quantities of stored water: Tokyo experiences a water shortage, on average, every three years. In contrast, water shortage cycles are roughly 7 to 15 years in New York and London.

City	Present cycle of water ortage	Target level
Tokyo	3 years	10 years
San Francisco	11 years	Maximum water shortage to date
New York	7 years	Maximum water shortage to date
London	15 years	50 years

Serious consequences of drought

Every year drought occurs in many parts of the country.

In the past 16 years, almost every prefecture has experienced water shortage. Some areas which experienced 15 or 16 periods of drought, or 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	8/12/84-3/13/85	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	6/26/87-8/25/87	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	
1994	Tokyo, etc.	Tone River	7/22/94-9/19/94	60 days	
1994	Tokai city, etc.	Kiso River	6/1/94-11/4/94	167 days	
1994	Kyoto city, Osaka city, Kobe city, etc.	Yodo River	8/22/94-10/4/94	44 days	
1994	Matsuyama city, etc.	Yoshino River	6/25/94-5/2/95	312 days	
1994	Fukuoka city, etc.	Chikugo River	7/7/94-6/1/95	330 days	

Source: National Land Agency

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

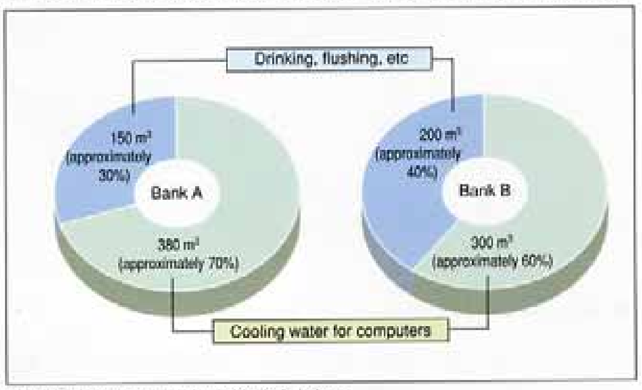
Phase of drought	■ Impact on local residents	■ Social impact
Water supply hours: 11 - 18 hours Water supply restriction: 12 - 21% Total period: 93 days	- Storage (purchase of plastic containers) - Water supply interruption at higher-elevations - Red water, turbidity, sedimentation	- Termination of pumping 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

The information society is vulnerable to drought.

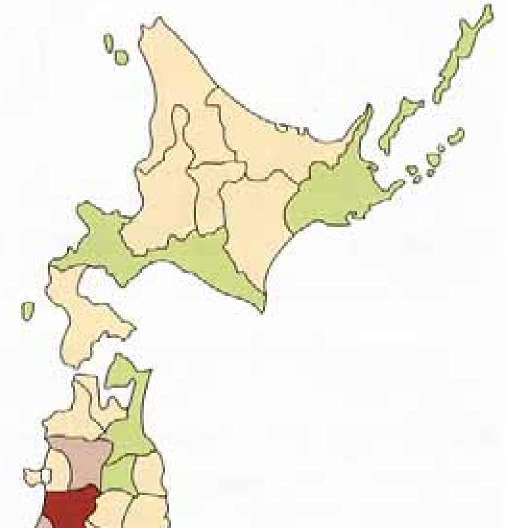
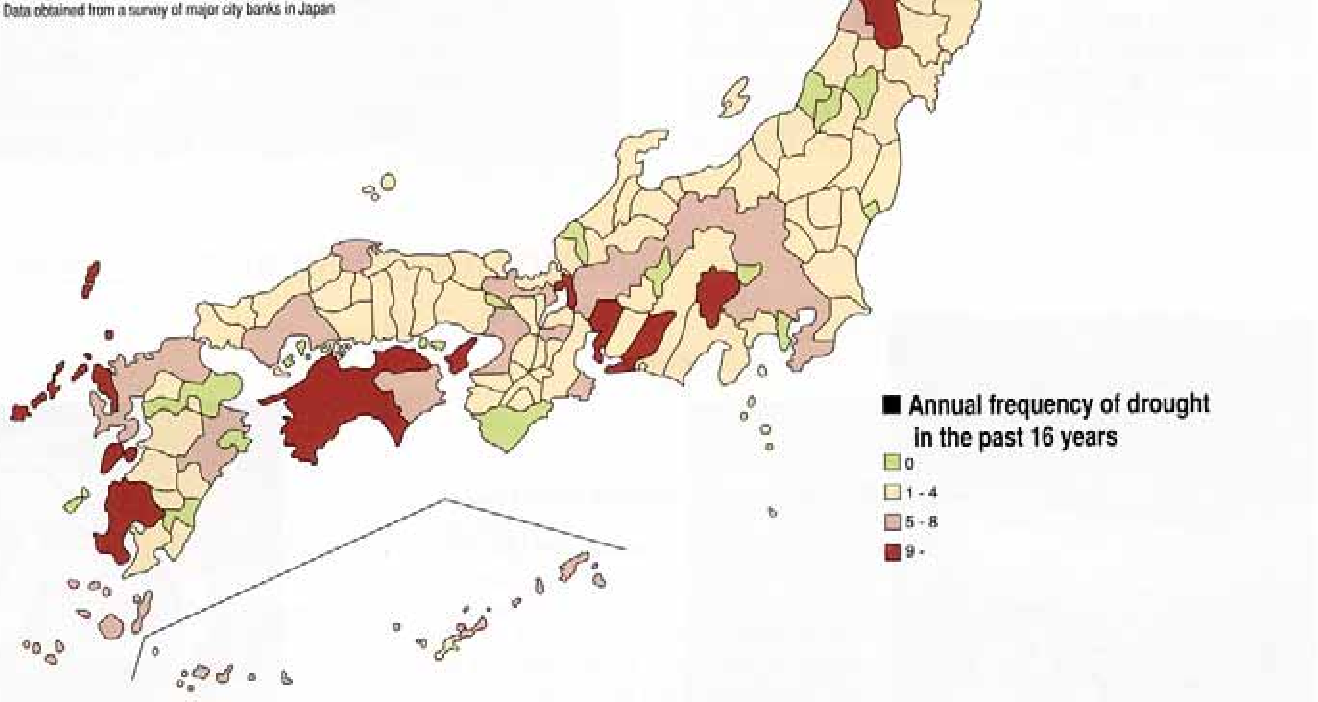
Large computers require strict control of ambient temperature and humidity and therefore need a large quantity of cooling water. A survey of major city banks showed that about 60 to 70% of water consumed in one day at a city bank is used for cooling.

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.

■ Water consumption at computer centers of major city banks



* Data obtained from a survey of major city banks in Japan

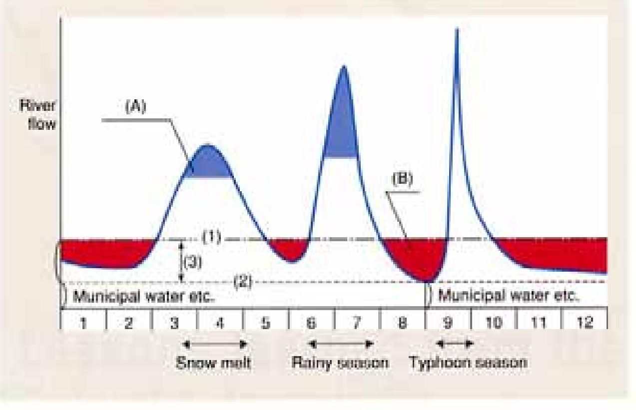
Source: National Land Agency
Note: Shown above are the numbers of yearly interruptions or restrictions of water supply systems and small water supply systems during the period from 1977 to 1995.

Diverse approaches to water resources development

Dams play a pivotal role in securing a stable source of water.

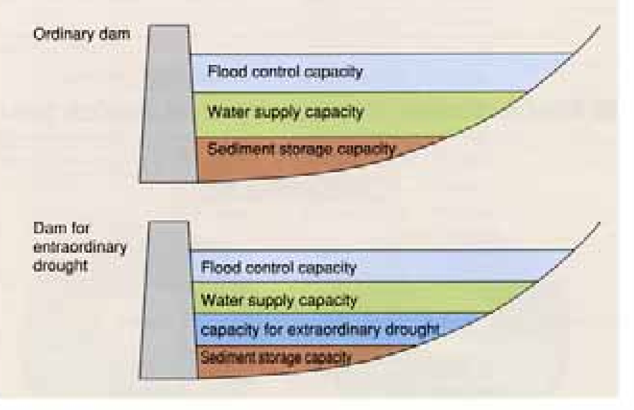
In Japan, where there are considerable fluctuations of precipitation, river flow also fluctuates widely from season to season. Therefore, if we depended on natural rivers for water, it would be impossible to supply sufficient quantities of water during the dry season. Withdrawing too much groundwater would result in ground subsidence.

By damming rivers to store water, river flow can be augmented so that water can be supplied reliably throughout the year.



■ Mechanism of water resources development by reservoirs

The reservoir stores water while river flow is high. As the river flow decreases, stored water [(A) in the graph above] is released to replenish river flow [(B)]. By this method, the river flow (1) can be secured throughout the year. This means that the difference (3) between (1) and the low water flow (2) that would occur if there were no dam, that is, (1)—(2)=(3), has now been developed.



■ Reservoirs for extraordinary drought

Even in the event of an extraordinary drought exceeding the design drought, it is necessary to secure a minimum amount of water to maintain social and economic activities. The function of a reservoirs for is to store water for emergency use in case of an extraordinary drought.

In the event of an extraordinary drought, water is supplied first by ordinary dams and then, as water use is coordinated, by low-flow augmentation dams.

Zamami Dam (Okinawa prefecture)

■ Small dams for domestic water supply

From olden times, water shortage has been a serious problem on islands, peninsulas, and in mountain regions. As improvement of sewer systems is in progress in many parts of the country, it is likely that water demand will increase due to water needs for toilet flushing.

There is a need for construction of small dams for local water supply.

(Aichi pref.)

Naramata Dam (Gunma pref.)

Developing lakes to use as reservoirs

Lakes are, so to speak, natural reservoirs. Availability of water resources increase if lake water can be utilized. Lakes, therefore, are made to function as reservoirs in order to make effective use of lake water.

(Ibaraki pref.)

Weirs enable stable withdrawal of river water

When dammed, rivers function as reservoirs. If saltwater intrusion is prevented, it is possible to withdraw water for domestic use from waters near river mouths. Barrages installed on rivers though make efficient use of river water.

(Mie pref.)

Canals handle Interbasin transfer of water

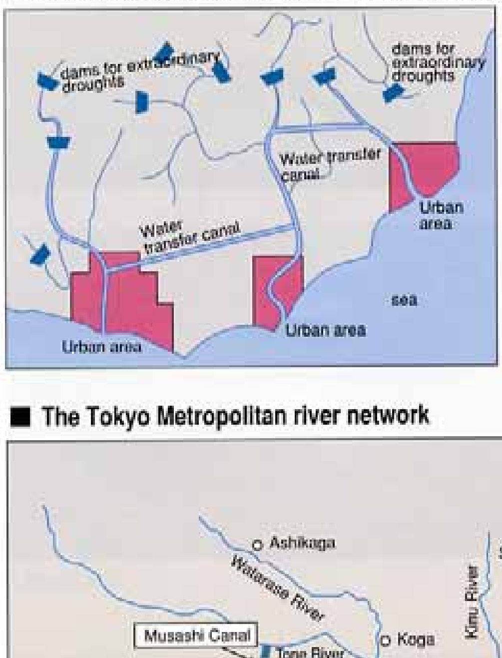
Canals are used as an emergency countermeasure to supply water to a drought-hit river basin from another river basin . Drought-resistant cities can be built if a system can be established under which interbasin water transfer can be made between major river basins.

Diverse approaches to water resources development

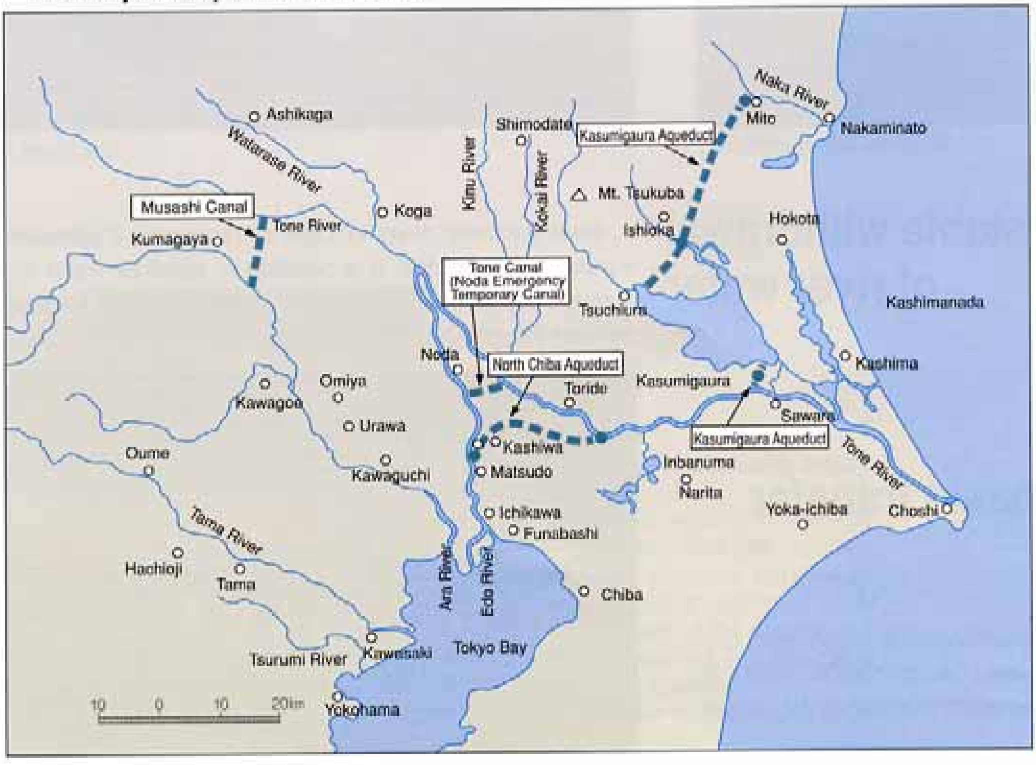
Preparing for extraordinary droughts by combined use of various facilities and flexible water transfer.

Drought seriously impairs city functions and has considerable negative impact on economic activities. Efforts are under way, therefore, to construct dams for extraordinary droughts and establish interbasin water transfer networks to prepare communities for extreme situations. In the Tokyo Metropolitan for example, construction of a river network interconnecting canals, such as the Tone Aqueduct and the North Chiba Canal, is now in progress in addition to the development of Lake Kasumigaura.

■ **Concept of extraordinary drought countermeasures**



■ **The Tokyo Metropolitan river network**



IV

Ecolorgical Consideration

Previous flood control and water resources development projects have concentrated on function, often at the expense of nature and our environment,

Newly affluent and disenchanted with urbanization, many people have begun to search more actively for places to enjoy nature. Thus more effort must be made to create communities where the places in which people work and live are integrated with the natural river environments.

Improving water quality

Twenty million people think tap water smells musty.

River water quality has generally improved. Some urban rivers and lakes, however, remain so contaminated that even the quality of drinking water is often affected and people give up the opportunity to get acquainted with nature.

According to a Ministry of Health, Labour and Welfare survey, about 20 million people think that tap water they drink smells musty. Of these people, more than 90 percent live in the Tokyo Metropolitan or the Osaka-Kyoto area. This indicates that there is an urgent need to improve the water quality of rivers running in or near urban areas.

■ Number of people who think tap water smells musty

(Numbers in thousands)

Fiscal year	1987	1988	1989	1990	1991
Hokkaido	0	242	233	128	1
Tohoku	113	20	46	183	0
Kanto	2,671	2,612	4,859	8,044	6,701
Chubu	5	1	10	4	24
Kinki	10,865	10,193	11,902	12,440	11,962
Chugoku	23	1	94	32	480
Shikoku	79	99	101	119	113
Kyushu	99	463	293	674	284
Total	13,875	13,632	17,538	21,625	19,567

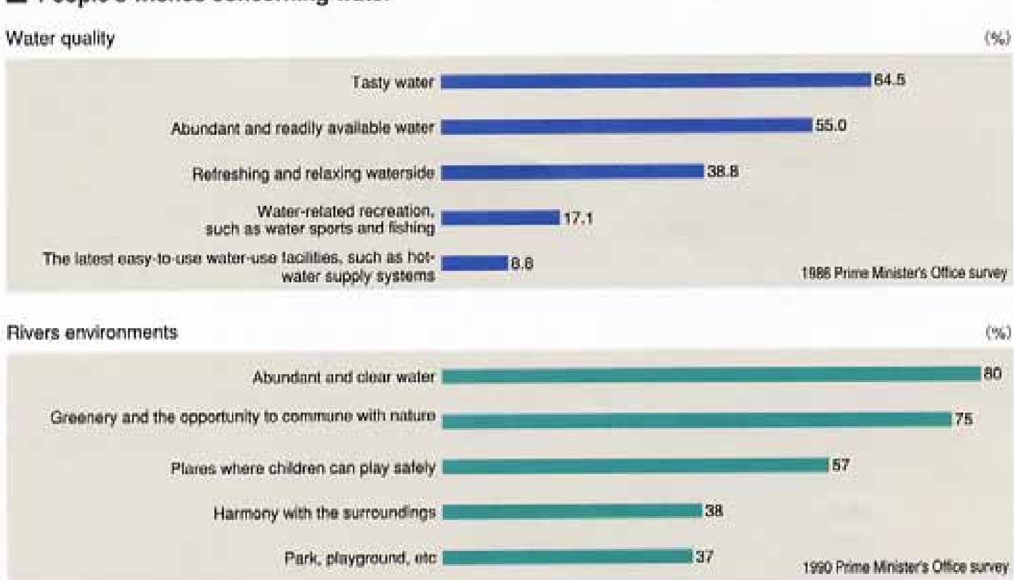
* Source: Ministry of Health & Welfare, "Survey on Undesirable Taste and Smell of Drinking Water".

■ Every one wishes for "safe," "tasty," and "clear" water.

Surveys about rivers and water show that many people yearn for water that is "safe," "tasty," and "clear."

We are working to secure "tasty" and "clear" water, which makes life safe and comfortable.

■ People's wishes concerning water



We want to restore clear streams and lakes by the year 2000: Clear Water Renaissance 21.

Emergency Action Plan for Improvement of Water Environment (Clear Water Renaissance 21) aims to improve, by the year 2000, the water environments of rivers, lakes, and dam reservoirs which have particularly severe adverse effects on the environment or drinking water. Joint efforts of the municipalities, residents, and concerned government agencies to organize and implement comprehensive measures are expected to make a big difference. Measures include river projects such as river purification and water flow preservation channel projects, sewerage projects such as basin-based sewer systems, and other related measures such as water purification projects for waterways, installation of combined wastewater treatment tanks, and drainage regulation.

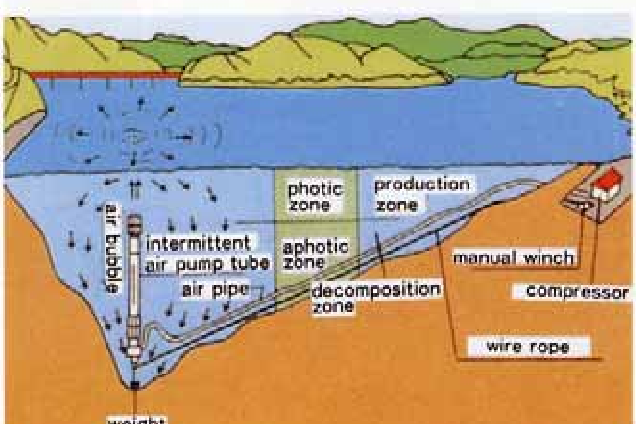
Ikemachi River (Fukuoka pref.)

■ **Before purification**

■ **After Purification**

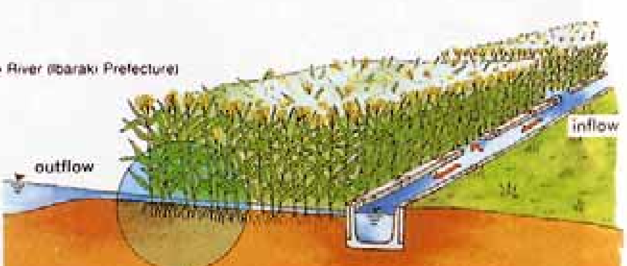
■ Examples of purification measures now in progress

Various measures to improve water quality are now under way. Shown here are selected examples of such measures.



Cross-Section of Kogasaki Purification Plant (Chiba Prefecture)

Plant Purification on Sanno River (Ibaraki Prefecture)



Removal of Nitrogen and Phosphorus

Conservation

Protection of humankind sometimes inevitably affects nature. That's where creation of nature-friendly river comes in.

Most people if given a choice would like rivers to remain natural and nature-rich. Yet to guard against the violence of nature, people have, from ancient times, tried to control nature. Flood control projects are a typical example of such efforts.

Since the purpose of flood control projects is to deal with nature in the form of rivers, it is impossible to implement flood control projects without affecting nature. Nevertheless, efforts must be made to find ways to live with nature by restoring the natural environment or creating a better one.

Nature is bountiful to human and nonhuman creatures alike. The "nature-friendly river" scheme we are proposing is an approach based on our technology and philosophy which have evolved from that understanding.

(Mie pref.)

The goal "living with nature" may sound too ambitious, but there are many things we can do in everyday life.

Rivers and lakes are invaluable habitats for a variety of life forms including animals, such as fishes, birds, and insects, and numerous plant species.

Today, "quality of life" is a major concern. That, however, does not justify turning our eyes away from nature. On the contrary, that is the reason we should turn loving eyes to nature. In order to attain the goal of living with those plants and animals, it is necessary to continue our efforts to conserve and create nature-rich river environments.

Restoring livable environments

From olden times, rivers have universally been thought of as community symbols. The challenge is to make rivers attractive enough to be called community symbols again.

The Seine, the Themes, the Sumida, The Cheng Kiang—these are all rivers which have, from olden times, been regarded as places for everyday activities, as community space, as main streets, and as community symbols. In recent years, however, deterioration of water quality has made rivers less attractive, and rapid urbanization has made rivers less accessible, thereby tarnishing the river's image as a community symbol. There is a need, therefore, to restore the functions of rivers, such as landscape, natural environment, and culture, and make them attractive enough to be called community symbols.

Creation of a river harmoniously integrated with the community. That is the goal of "Hometown Rivers" .

Creation of an attractive and culturally sophisticated community seamlessly blending with a river : Hometown Rivers projects provides support to municipalities which are both enthusiastic and creative in their pursuit of community development harmoniously integrating with river space development. In order to encourage volunteer efforts in the local community, the plan for these projects, usually a 5-year undertaking, is formulated by a committee of scholars, representatives of the concerned prefectural and municipal governments, and community representatives.

Restoring livable environments

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 and their more, effort is under way to improve the environmental quality of dam areas.

"Home town Erosion Control" projects, prevent sediment disasters and support community development efforts.

A community that has been exposed to the danger of sediment disasters begins to work to become a safe and culturally sophisticated area. "Hometown Erosion Control" projects support such effort.

(Okinawa pref.)

Slope preservation projects prevent sediment disasters and make effective use of slopes as green parks.

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. "Specified Use Slope Preservation" projects provide support to municipalities that are working toward both disaster prevention and public land use.

Several years after the building of prevention works

Jizukiyama Landslide (june 5,1990)

Restoring livable environments

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

■ Coastal Community Zone (CCZ) project

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. The Coastal Community Zone project scheme is one such approach. The goal of CCZ is, by combining public works such as coasts, parks, roads, and sewer systems, and private sector vitality, to create an environment that will encourage people to enjoy the sea.

V

The 1997 Amendment to the River Law

This amendment was made in response to growing citizen awareness of environmental issues and to the need for river development that is suited to regional conditions. The amendment, which defines the purpose of the River Law as improvement and conservation of the environment, carries out a fundamental review of the planning system and devises measures to facilitate efficient water use during extreme water shortages.

Outline of the 1997 Amendment to the River Law

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.

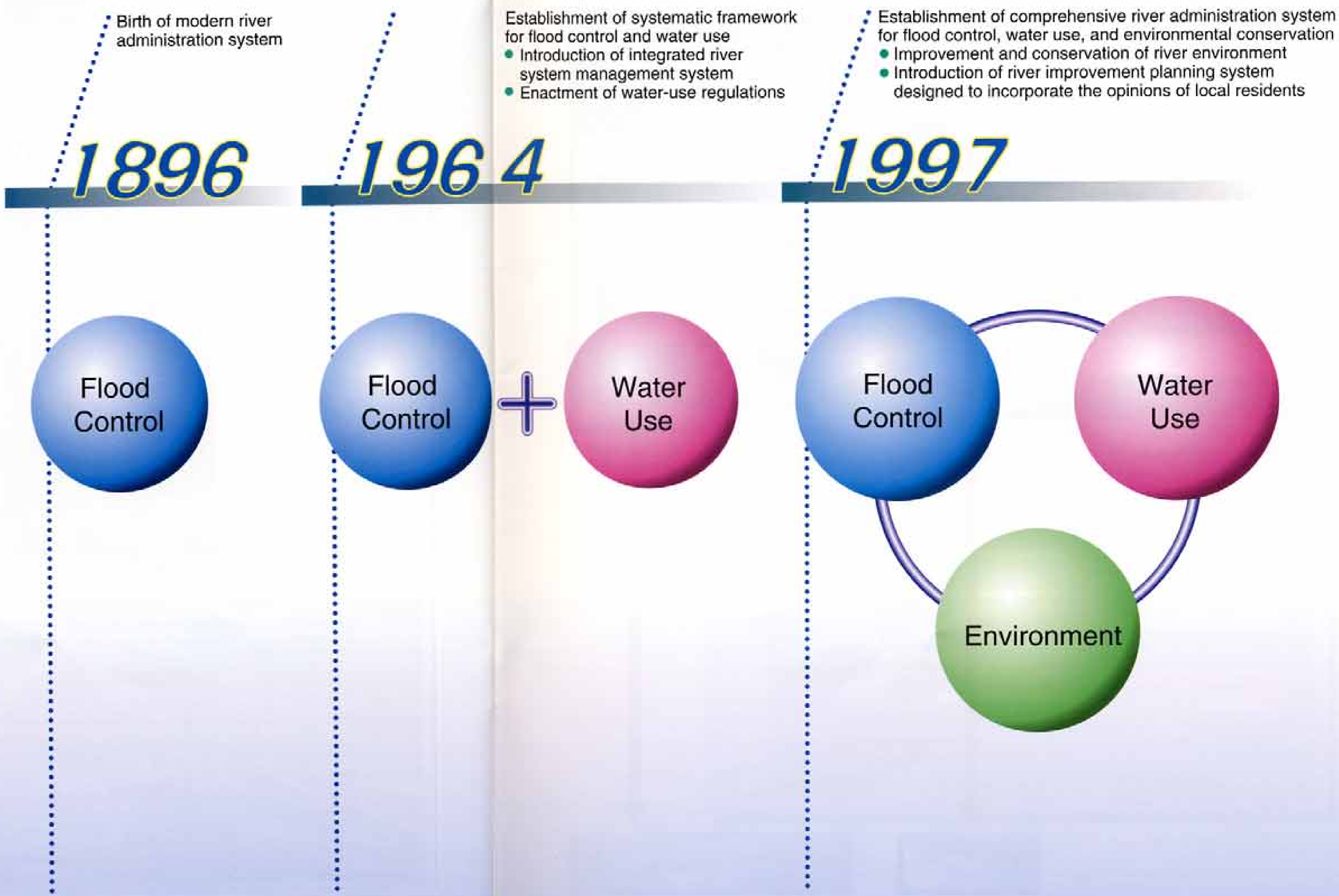
However, as the economic and social conditions have changed in the subsequent years, the conditions surrounding the river administration system have changed dramatically. Today, Projects are expected not only to perform flood control and water use functions but also to provide an attractive waterside 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

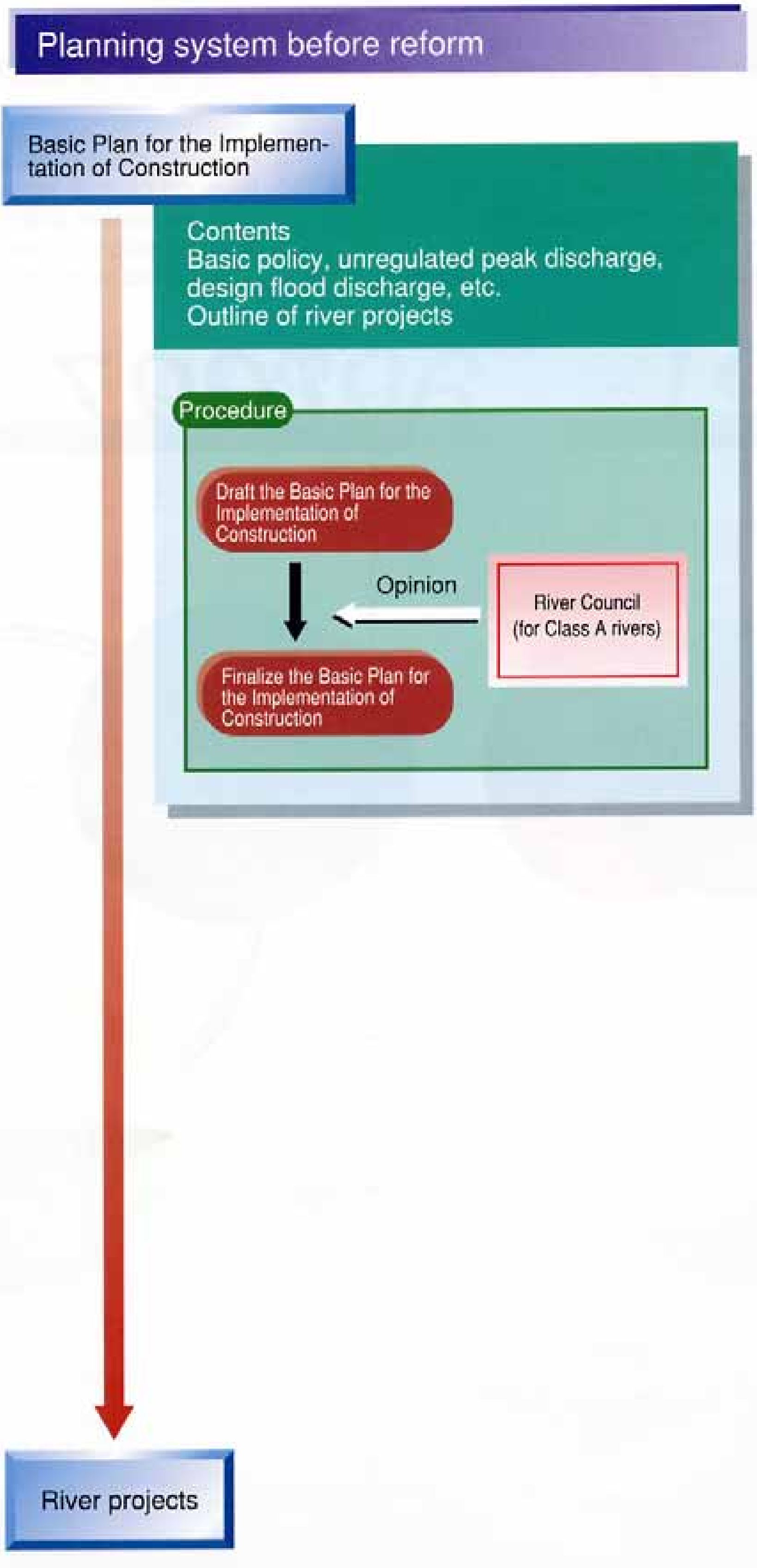


New system for planning river improvement

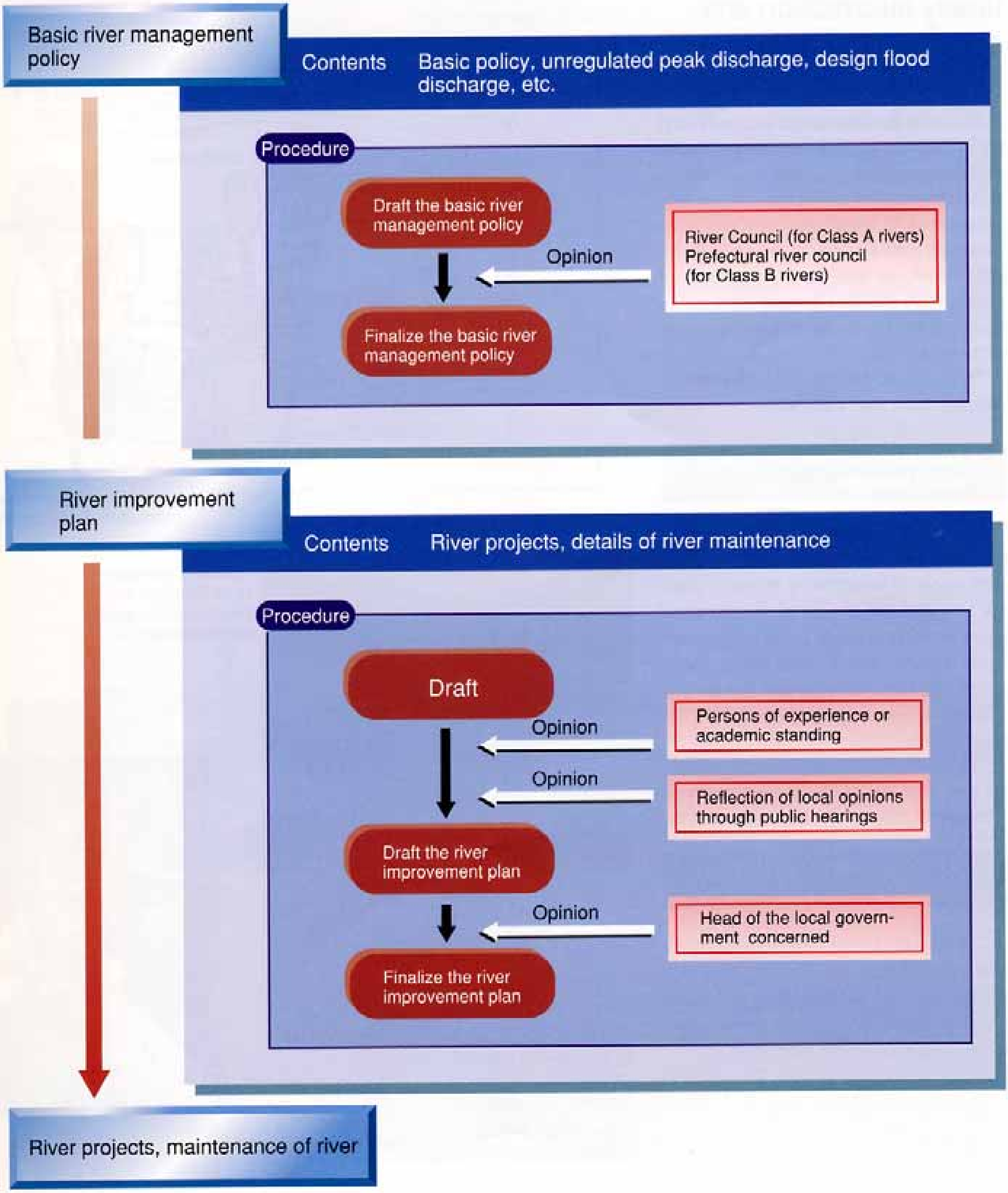
Promoting river improvement incorporating local opinion

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 after reform



Drought conciliation

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

① Facilitating consultation for water-use conciliation during droughts

- Speedier water-use conciliation during droughts
- Provision of information by river administrator

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.

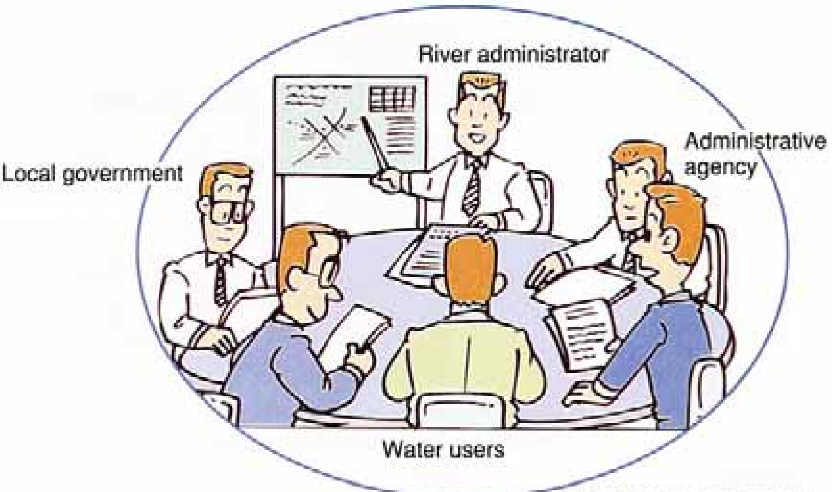
①Facilitating water-use conciliation during droughts

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 administrator make effort to provide information necessary for water-use conciliation.

②Facilitating 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)

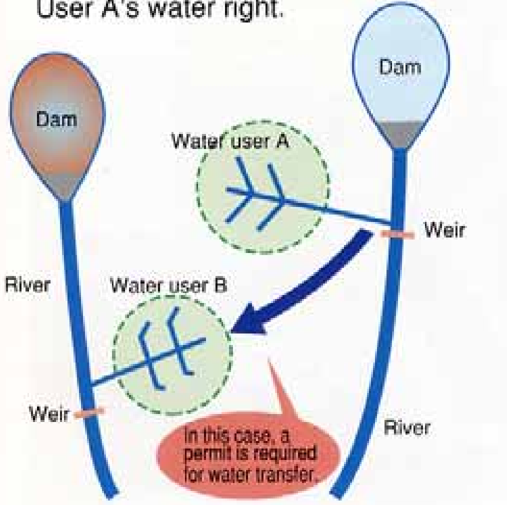
Drought water-use conciliation councils established (as of March 31, 1997)		
Class A river systems	62 river systems	87 organizations
Class B river systems	26 river systems	26 organizations

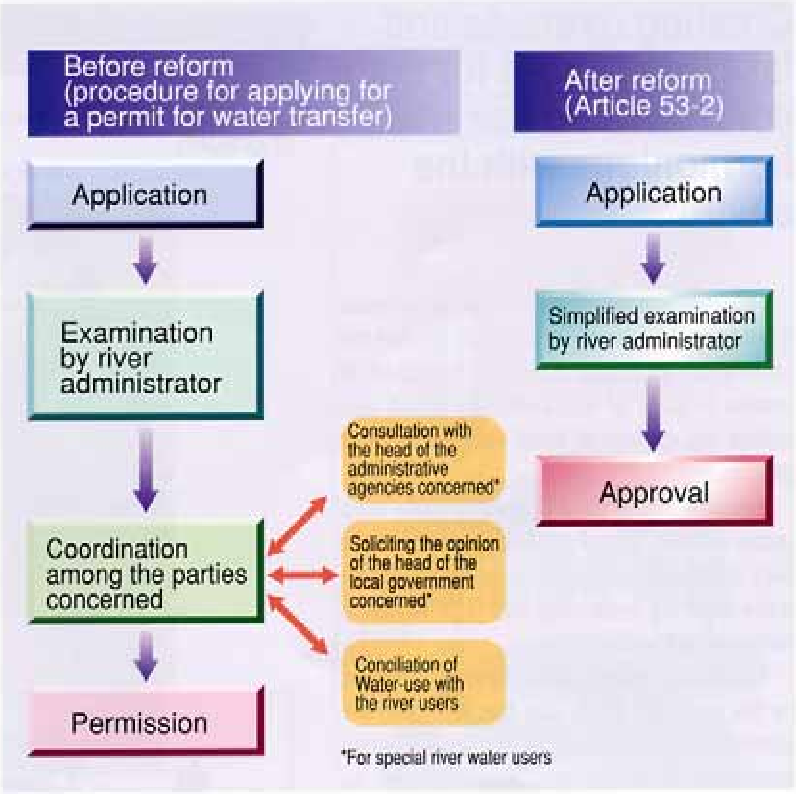
A household storing up water during the 1994 drought (Yomiuri Shimbun, September 2, 1994)

② Facilitating water transfer between water users

- Simplifying the procedure for obtaining permission (if necessary) for water transfer (see the illustration.)

- In case of an unusual drought, User A may let User B exercise all or part of User A's water right.






Dried up reservoir bottom
(Nishi-Nippon Newspaper, July 3, 1994)

Fluvial forestation

Creating riverside and lakeside forests for flood control and water use harmonious with the environment

The flood-control effect of river-side forests is being rediscovered. They help to prevent the occurrence and also growth of breaches in levees in case of extraordinary flood and reduce the outflow of flood water in case of overtopping.

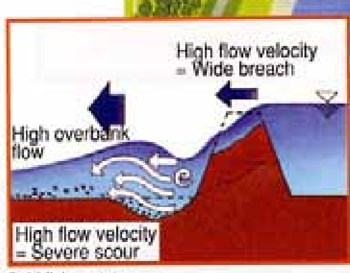
Forests along dam reservoirs are also useful in flood control and water use because they control the outflow of sediment-laden water entering reservoirs and filter inflowing contaminated water.

The "fluvial woods zone" system instituted by the amended River Law has enabled river administrators to create or conserve riparian woodlands as river management facilities so that flood control and water use harmonious with the environment can be promoted by means of riverside and lakeside forests.

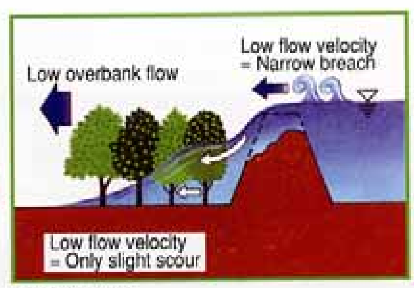
1 Wooded areas along a levee

Created in river sections where levees need to be reinforced or upgraded

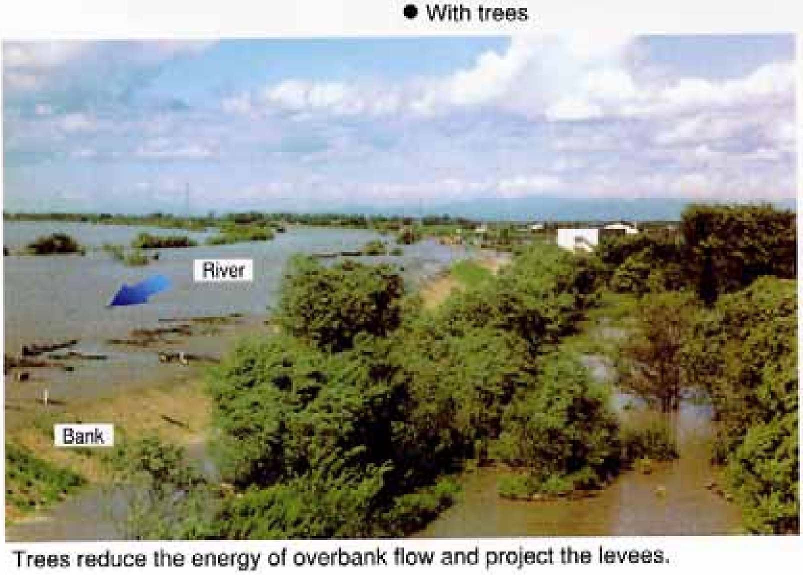
Image of riverside wooded areas



● Without trees



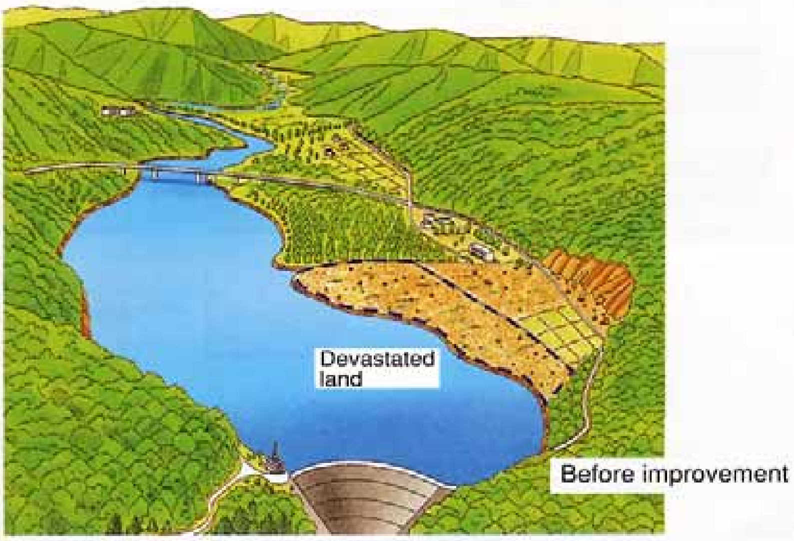
● With trees

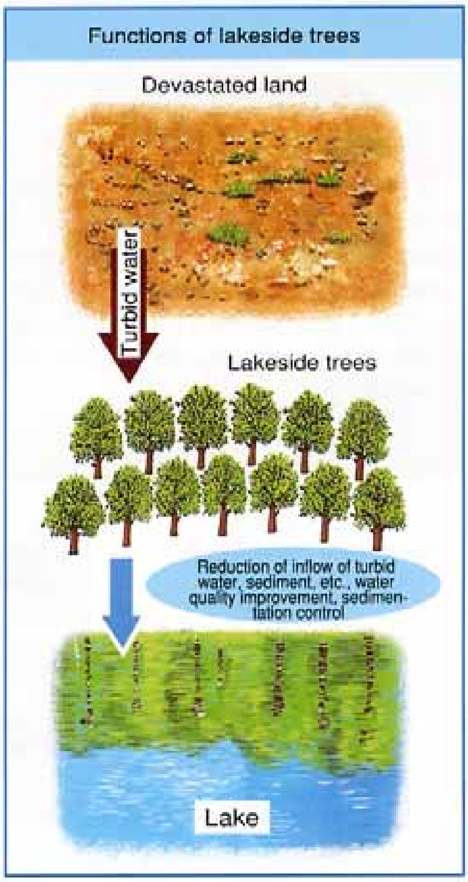


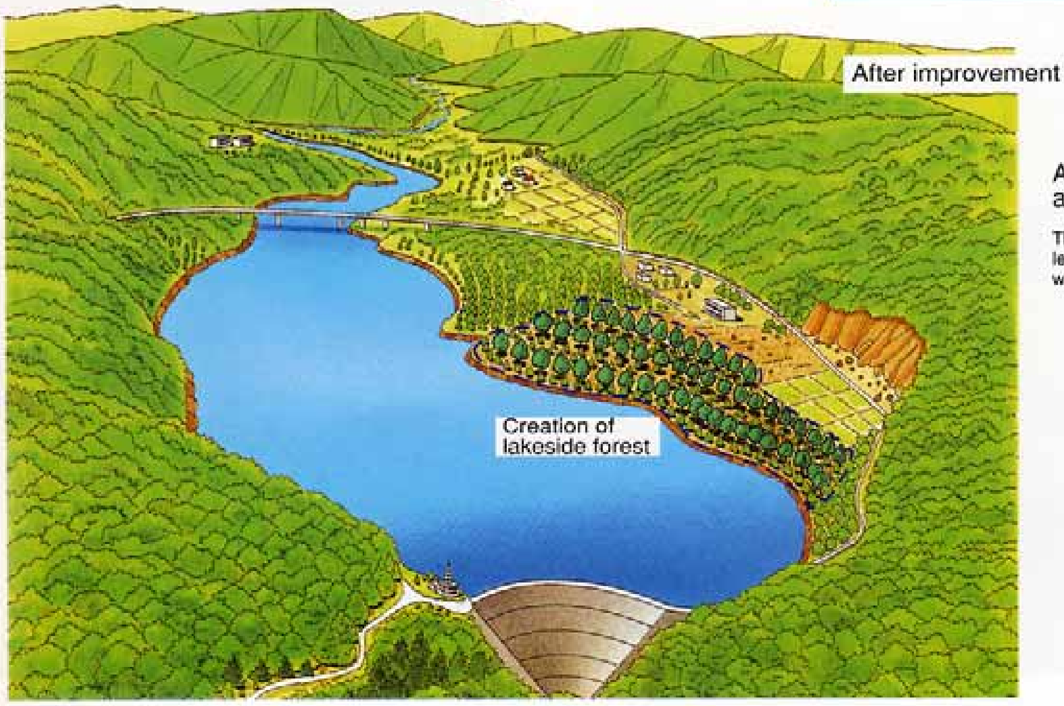
Trees reduce the energy of overbank flow and project the levees.

2 Riparian woodland along a lakeshore

Prevention of the inflow of sediment and turbid water into the reservoir (particularly on devastated land)







Artist's impression of a lakeside forest

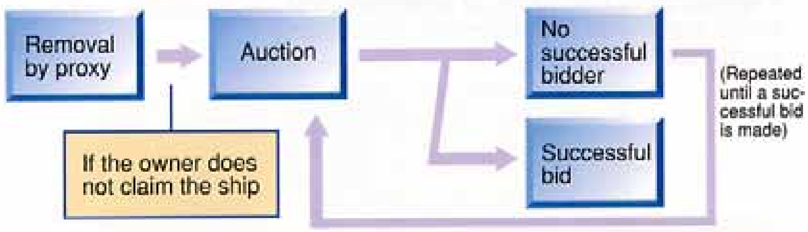
The devastated land on the left bank has been planted with trees.

Preventing illegal mooring

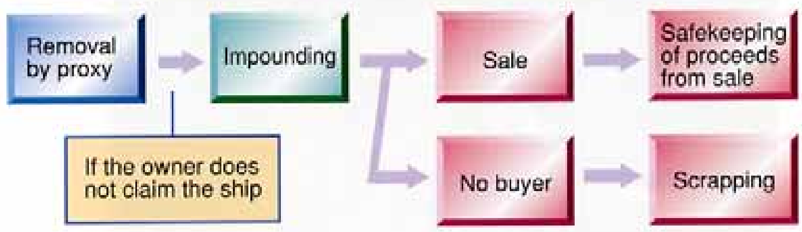
Establishing procedures for selling and scrapping illegally-moored ships after removed

To promote the removal of illegally moored ships, the amended River Law stipulates procedures for selling and scrapping of illegally moored ships which have been removed from the mooring sites and have not been claimed and for managing the proceeds from the sale of the ships.

Procedure before amendment



Procedure after amendment



Impounded ships

Illegal mooring

Preventing accidental water pollution

Making polluters implement and pay for corrective measures against accidental water pollution

Under the amended River Law, in the event of accidental water pollution such as an oil spill, the polluter is obligated to carry out or pay for corrective measures (e.g., placement of oil fences, oil mats, etc.) .

(Before the amendment, the River Law provided only for "river works" to be carried out or paid for by polluters. As a result of the amendment, the River Law now provides also for "maintenance of river.")

Water analysis vehicle equipped with measuring instruments, power generators, and radio systems.

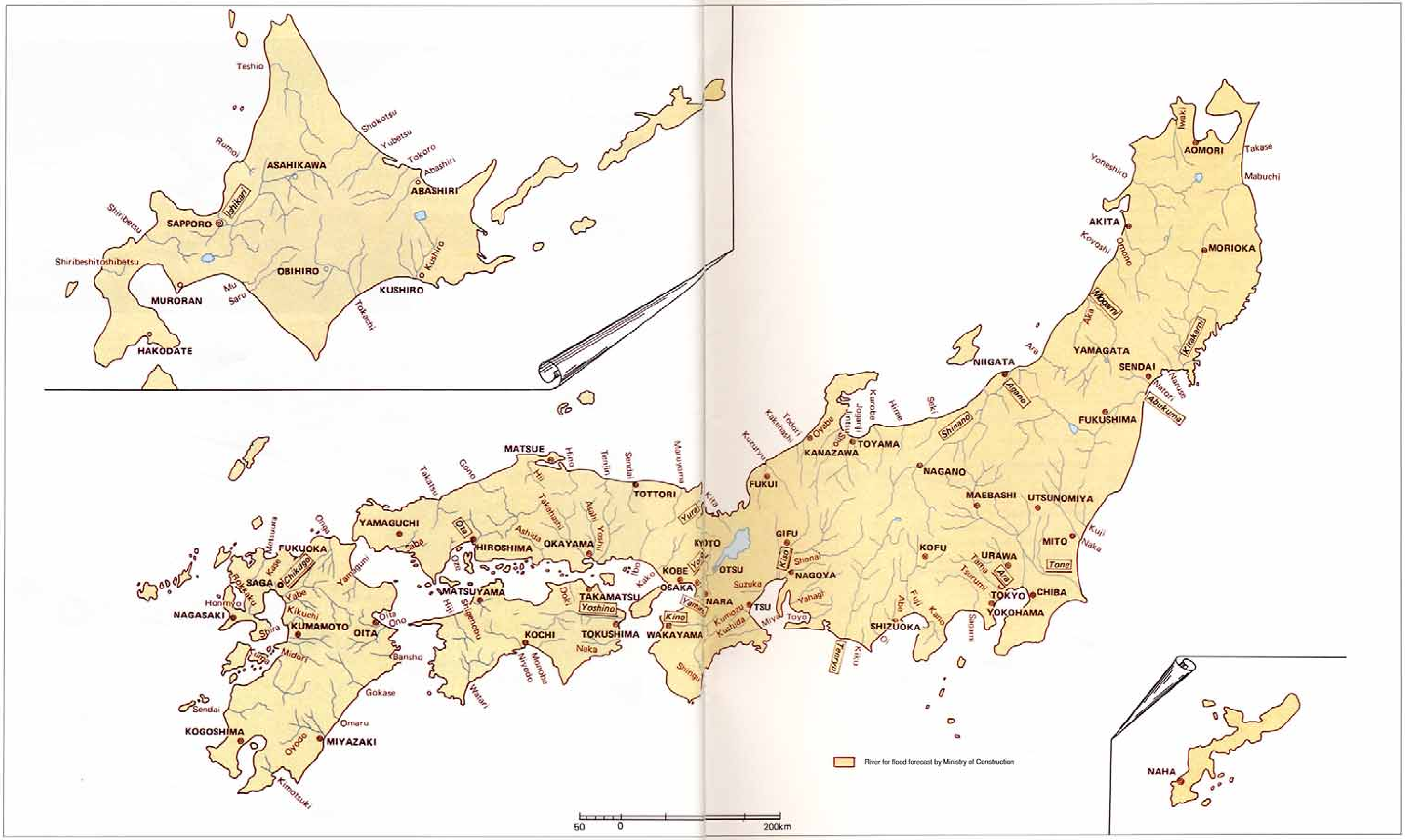
Contaminated water is collected and treated with oil collectors and oil separators, and treated water is returned to the river.

The oil slick is contained temporarily with oil fences and is removed by absorbing it with oil mats.

● **Accidental water pollutions** (number of accidents involving a Class A river)

	1993	1994	1995
Oil spills	188	184	199
Chemical spills	19	25	20
Non-oil, non-chemical spills	21	22	16
Other	35	42	21
Subtotal	263	273	256
Natural phenomena	10	43	19
Total	273	316	275
Accidents that resulted in suspension of drinking water supply	6	10	21

*The number of accidents that resulted in suspension of drinking water supply is included in the subtotal for each year.


Teshio
Shokotsu
Yubetsu
Tokoro
Abashiri
Rumoi
ASAHIKAWA
ABASHIRI
Shiribetsu
SAPPORO
Ishikari
Shiribeshitoshibetsu
OBIHIRO
Kushiro
KUSHIRO
MURORAN
Mu
Saru
Tokachi
HAKODATE
AOMORI
Iwaki
Takase
Mabuchi
Yoneshiro
AKITA
Omono
Koyoshi
MORIOKA
Mogami
Aka
Kitakami
YAMAGATA
SENDAI
Naruse
Natori
Abukuma
Ara
NIIGATA
Agano
FUKUSHIMA
Shinano
Seki
Hime
Kurobe
Joganji
Jintsu
Sho
Oyabe
Tedori
Kakehashi
Kuzuryu
TOYAMA
KANAZAWA
NAGANO
FUKUI
MAEBASHI
UTSUNOMIYA
MITO
Kuji
Naka
GIFU
KOFU
URAWA
Tone
Kiso
Shonai
NAGOYA
Tama
Tsurumi
Ara
TOKYO
CHIBA
YOKOHAMA
Yahagi
Toyo
Fuji
Abe
Kano
Sagami
SHIZUOKA
Oi
Tenryu
Kiku
TSU
Suzuka
Miya
Kumozu
Kushida
MATSUE
Hino
Hii
Tenjin
Sendai
Maruyama
Kita
TOTTORI
Yura
KYOTO
Takatsu
Gono
Takahashi
Asahi
Yoshii
Ashida
OKAYAMA
HIROSHIMA
Ota
Oze
YAMAGUCHI
Saba
Onga
Mitsusura
FUKUOKA
Yamakuni
Chikugo
Kase
SAGA
Rokkaku
Honmyo
NAGASAKI
Yabe
Kikuchi
KUMAMOTO
Shira
Kuma
Midori
OITA
Oita
Ono
Bansho
Gokase
Sendai
KOGOSHIMA
Omaru
MIYAZAKI
Oyodo
Kimotsuki
MATSUYAMA
Hiji
Shigenobu
Doki
TAKAMATSU
Yoshino
KOCHI
Niyodo
Monobe
Watari
TOKUSHIMA
Naka
KOBE
Yodo
OSAKA
Kako
Ibo
OTSU
NARA
Yamato
Kino
WAKAYAMA
Shingu
NAHA
50
0
200km
River for flood forecast by Ministry of Construction

Appendix

- Ministry of Land, Infrastructure and Transport
  - Minister's Secretariat
  - Policy Bureau
  - National and Regional Planning Bureau
  - Land and Water Bureau
  - City and Regional Development Bureau
  - **River Bureau**
  - Road Bureau
  - Housing Bureau
  - Railway Bureau
  - Road Transport Bureau
  - Maritime Bureau
  - Ports and Harbours Bureau
  - Civil Aviation Bureau
  - Hokkaido Bureau
  - Regional Bureaus(8) — Work Offices
    [Tohoku, Kanto, Hokuriku, Chubu, Kinki, Chugoku, Shikoku, Kyushu]
- Cabinet Office
  Prefectures (47)
  - Okinawa General Bureau

- River Bureau
  (Director-General
  Deputy Director-General)
  - General Affairs Division
  - Water Administration Division
    - Water Use Coordination Office
  - River Planning Division
    - River Planning Coordination Office
    - River Information Office
  - River Environment Division
    - Water Management Office
  - River Improvement and Management Division
    - Urban River Office
    - Project Supervision Office
  - Disaster Prevention and Relief Division
    - Disaster Risk Management Office
  - Erosion and Sediment Control (Sabo) Department (Director General)
    - Erosion and Sediment Control (Sabo) Planning Division
    - Land Conservation Division
      - Seacoast Office

- 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 (Evosion 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
  - (Flood Fighting)
    - Flood Fighting Law
    - Flood Defense Association Law
  - (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)
    - Canal Law

Landslide Prevention Law (1958)

Seacoast Law (1956)

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)

Appendix

The 10 Largest Reservoirs in Japan: (Source: Development Division., Ministry of Construction)

Rank	Total Reservoir Capacity (x 10^4 m^3)	Dam	*Type	Location (Prefecture)	Developer	Year of Completion
1.	660	Tokuyama Dam	R	Gifu	Water Resource Development Pub. Corp.	Under Construction
2.	601	Okutadami Dam	G	Fukushima	Electric Power Development Co., Ltd.	1961
3.	494	Tagokura Dam	G	Fukushima	Electric Power Development Co., Ltd.	1959
4.	391	Yubari Syuparo Dam	G	Hokkaido	Hokkaido Development Agency	Under Construction
5.	370	Miboro Dam	R	Gifu	Electric Power Development Co., Ltd.	1961
6.	353	Kuzuryu Dam	R	Fukui	Electric Power Development Co., Ltd. and Ministry of Construction	1968
7.	338	Ikehara Dam	A	Nara	Electric Power Development Co., Ltd.	1964
8.	327	Sakuma Dam	G	Shizuoka	Electric Power Development Co., Ltd.	1956
9.	316	Sameura Dam	G	Kouchi	Water Resource Development Pub. Corp.	1977
10.	261	Hitotsuse Dam	A	Miyazaki	Kyushu Electric Power Co., Ltd.	1963

(as of 1994)

* Type of Dam
A: arch dam
G: concrete gravity dam
R: rockfill dam

The 10 Highest Dams in Japan: (Source: Development Division., Ministry of Construction 1994)

Rank	Dam Height (m)	Dam	*Type	Location (Prefecture)	Developer	Year of Completion
1.	186.0	Kurobe Dam	A	Toyama	Kansai Electric Power Co., Ltd.	1963
2.	176.0	Takase Dam	R	Nagano	Tokyo Electric Power Co., Ltd.	1981
3.	161.0	Tokuyama Dam	R	Gifu	Water Resources Development Pub. Corp.	Under Construction
4.	160.0	Kawafuru Dam	G	Gunma	Kanto Regional Construction Bureau, MOC.	Under Construction
5.	158.0	Naramata Dam	R	Gunma.	Water Resources Development Pub. Corp.	1990
6.	157.0	Okutadami Dam	G	Fukushima	Electric Power Development Co., Ltd.	1961
7.	156.0	Miyagase Dam	G	Kanagawa	Kanto Regional Construction Bureau, MOC.	Under Construction
7.	156.0	Urayama Dam	G	Saitama	Water Resources Development Pub. Corp.	Under Construction
9.	155.5	Sakurma Dam	G	Shizuoka	Electric Power Development Co., Ltd.	1956
10.	155.0	Nagawado Dam	A	Nagano	Tokyo Electric Power Co., Ltd.	1969
10.	155.0	Nukui Dam	A	Hiroshima	Chugoku Regional Construction Bureau, MOC.	Under Construction

* Type of Dam
A: arch dam
G: concrete gravity dam
R: rockfill dam

Major Rivers in Japan (Source: Chronological Scientific Tables 1995)

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 [toh-nay]	16,840	322	Kurihashi	8,588	190	1,207	68	1938~92*
Ishikari	14,330	268	Ishikari Bridge	12,697	520	4,482	99	1954~92
Shinano	11,900	367	Ojiya	9,719	451	2,094	23	1951~92
Kitakami	10,150	249	Tome	7,868	252	1,788	252	1952~92*
Kiso	9,100	227	Inuyama	4,684	211	1,984	67	1951~92*
Tokai	9,010	156	Moiwa	8,277	206	2,938	45	1954~92
Yodo	8,210	75	Hirakata	7,281	210	2,308	58	1952~92
Agano	7,710	210	Maoroshi	6,997	328	2,200	59	1951~92
Mogam	7,040	229	Takaya	6,271	296	2,446	64	1959~92*
Teshio	5,590	256	Maruyama	4,685	223	2,302	57	1971~92
Abukuma	5,400	239	Tateyama	4,133	112	2,389	42	1956~92
Tenryu	5,090	213	Kashima	4,880	190	1,054	65	1939~92*
Omono	4,710	133	Tsubakigawa	4,035	194	1,765	67	1938~92*
Yoneshino	4,100	136	Futatsui	3,750	183	1,609	28	1956~92*
Fuzi	3,990	128	Kitamatuno	3,536	47	619	0 [2]	1960~92

(1) Class A rivers whose catchment area is 2,000 km^2 or more whose main stream channel length is 100 km or more, and for which continuous discharge observation data are available. Discharge values are 1992 data.

(2) Rounded the actual value to the nearest integer.

(3) Others

* Data obtained during the observation period are not completely continuous.

** The length of the channel which has the greatest discharge. In Japan, this is roughly the same as the length of main stream.

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