WATER RESOURCES MANAGEMENT IN JAPAN

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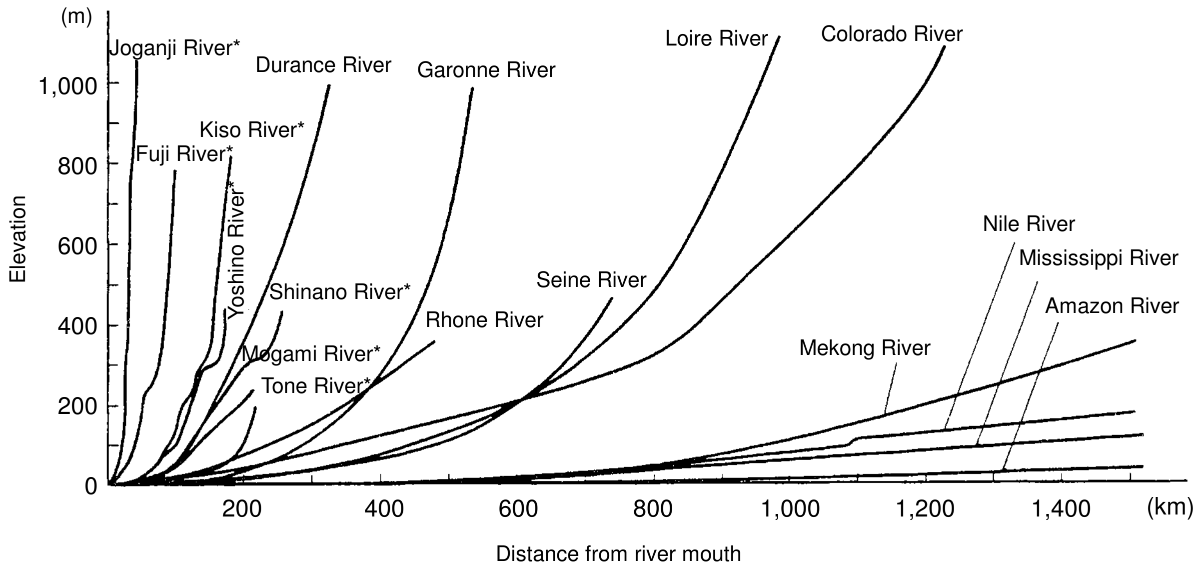
1. Water Resources in Japan

Water is circulated on the earth by solar energy and gravity. Its total quantity is assumed to be about 1.4 billion km^3, about 97.5% of which is sea water, and about 2.5% fresh water. Most fresh water exists as ice in the Arctic and Antarctic regions, with the river water and groundwater that can be used easily by human beings comprising about 0.8% of global water. The river water and groundwater that can be utilized as water resources are delivered mainly as rainfall and snowfall, and due to varied topological conditions and precipitation water resources are not evenly distributed around the globe.

The greater part of Japan is located in the Asian monsoon zone, supplied with sufficient precipitation. Its average annual precipitation is about 1,700 mm/year, almost double the world's average annual precipitation of about 970 mm/year. However, Japan's land area is small compared to its population, which makes the total annual average precipitation per person (the value obtained by multiplying precipitation by national land area and dividing by population) about 5,200 m^3/year/person, about 1/5 of the world average of about 27,000 m^3/year/person.

Japan is a long, narrow nation, extending from north to south, in which spine-like mountain ranges produce a steep topography. Compared to other nations, its major rivers are short with sharp gradients (Fig. 1-1). In addition, rainfall concentrated in the rainy season and typhoon season makes a seasonally uneven distribution of precipitation, and river flow rates fluctuate greatly. Due to these factors, various efforts, including the construction of ponds and dams, have been made to overcome these conditions disadvantageous to the utilization of water resources.



Notes: 1. Source: Yutaka Takahashi, *River Engineering*, University of Tokyo Press, 1990.
2. Asterisks (*) show rivers in Japan.

Fig. 1-1 Gradients of Major Rivers

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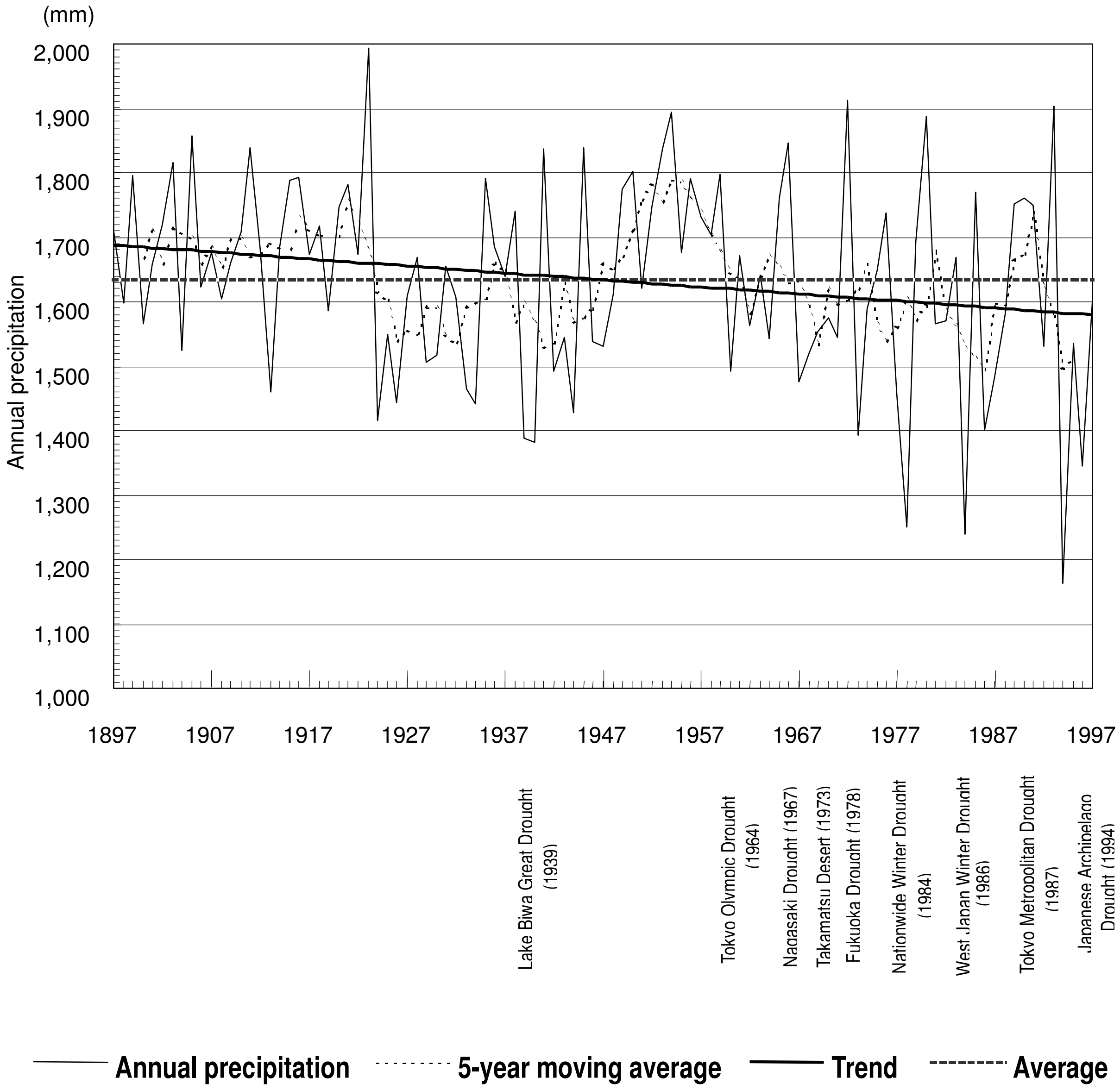


Notes: 1. Calculated by the National Land Agency based on data from the Meteorological Agency as arithmetic averages of observation values at 46 locations throughout Japan

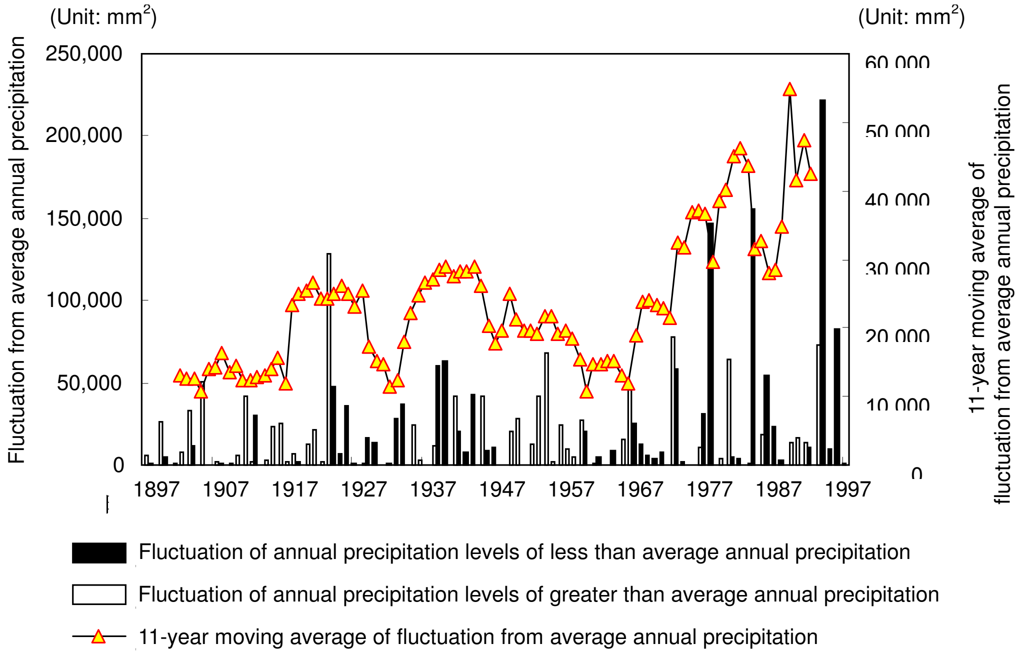
Locations:

Abashiri, Nemuro, Sutsu, Sapporo, Hakodate, Miyako, Yamagata, Ishinomaki, Aomori, Akita, Fukushima, Maebashi, Kumagaya, Mito, Utsunomiya, Kofu, Tokyo, Nagano, Kanazawa, Niigata, Fukui, Hamamatsu,

Fig. 1-2 Yearly Changes in Annual Precipitation in Japan

In statistics for the temporal changes in precipitation in Japan over the 100 years from 1897 to 1997, which were calculated using the annual precipitation values at 46 locations throughout Japan, the average value in these locations shows a decreasing trend during this period. In addition, there is seen a recent increase in differences in annual precipitation levels between years of low precipitation and years of high precipitation (Fig. 1-2). The fluctuations of annual precipitation of less than average value in the past 100 years are prominent, particularly since 1976, with annual precipitation values below 1,300 mm recorded in 1978, 1984 and 1994 (Fig. 1-3).

Further, to see a change in the amount of potential water resources[1] in the 40 years from 1956 to 1995, the amounts of potential water resources in this 40-year period are divided into 2 groups; the first 20 years and the second 20 years. When the 2 groups are compared in due order from the smallest amounts, all of the potential water resources are smaller in the second 20 years (Fig. 1-4) . Also, the amount of potential water resources per person is unevenly distributed by region (Fig. 1-5) .



Note: Average annual precipitations are averages of annual precipitations at 46 locations throughout Japan from 1897 to 1997.

Fig. 1-3 Fluctuations in Annual Precipitation

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[1] Amount of potential water resources: A part of rainwater returns to the air by evaporation, so the amount of potential water resources is one of the indices used when evaluating precipitation as a water resource. This index is obtained by deducting the evaporation volume from annual precipitation for each region, then multiplying by the area of the region concerned . The average amount of potential water resources in the 40 years from 1956 to 1995 was 430 billion m^3/year, and the amount of potential water resources in the dry year, which occurs about once in 10 years, is about 300 billion m^3/year; this is about 2/3 of the average amount of potential water resources.

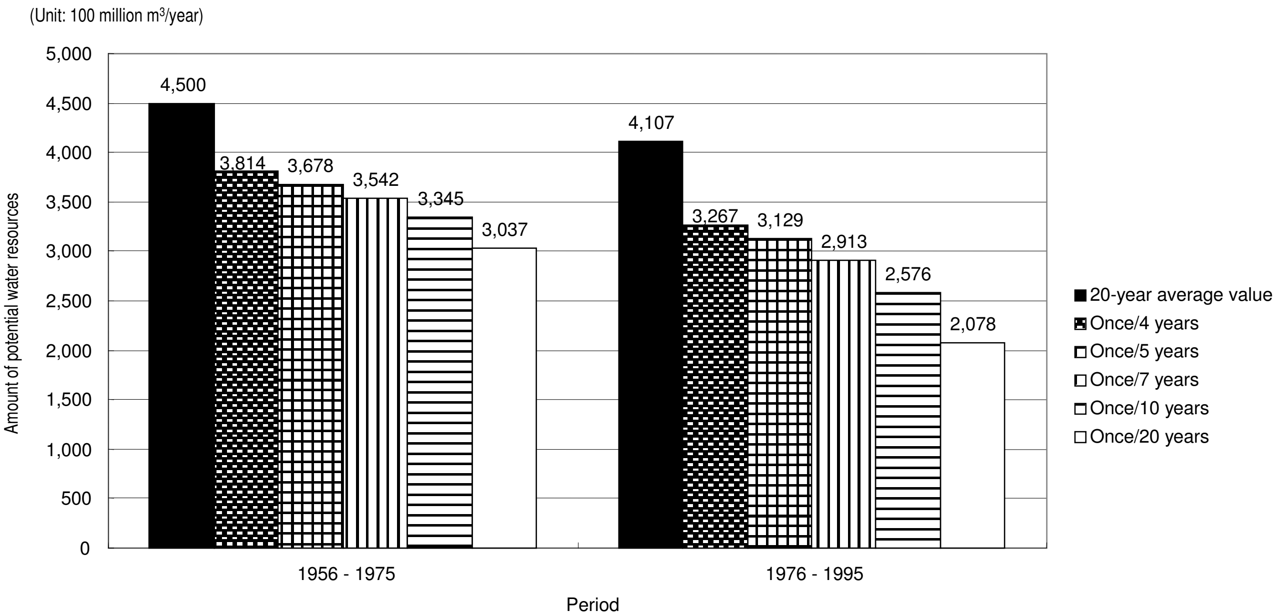
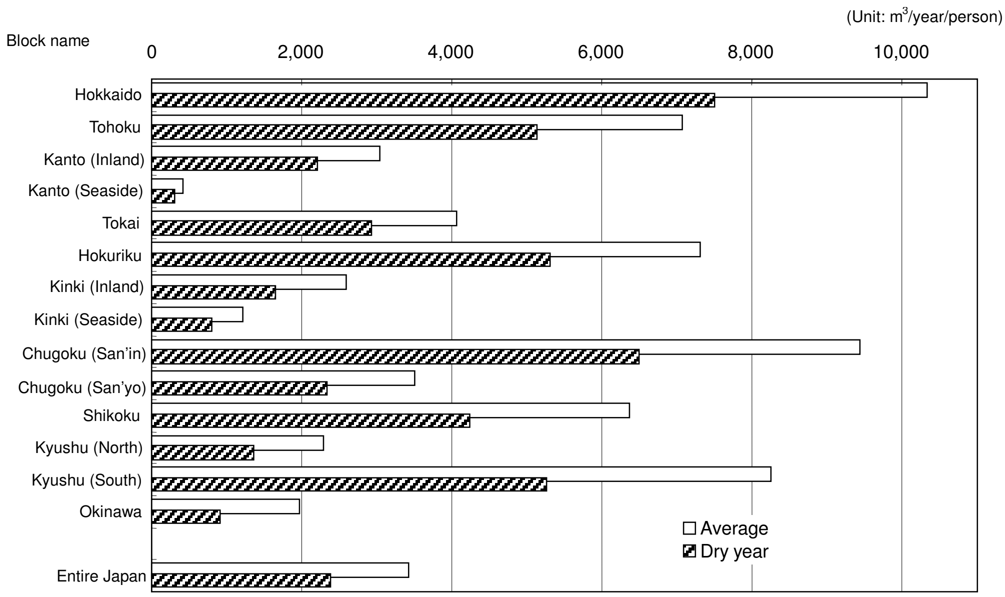


Fig. 1-4　Amount of Potential Water Resources for Each Period

Our major task is to ensure stable water resources in accordance with the actual situation of each region, with consideration given to changes in medium-to-long-term weather trends such as the uneven distribution of regional precipitation and the recent general decreases in precipitation. Further, we must overcome the conditions that are disadvantageous to the utilization of water resources, such as seasonal fluctuations of precipitation and the previously-mentioned topographic characteristics of Japan.



Notes: 1. “Average” means the average value in the 40 years from 1956 to 1995.
2. “Dry year” means the 4th-smallest value in the 40 years from 1956 to 1995.

Fig. 1-5　Amount of Potential Water Resources per Person

2. Recent Water Shortages, and Reliability of Water Supply

Since 1955, water demand has been increasing throughout Japan due to improvements in living standards and the expansion of production activities, etc. Although water resources development has been intentionally promoted in order to cope with this increased demand and to stabilize water supplies, even today the water shortages occurring in many regions have a great impact on daily life, the economy, and society as a whole (Fig. 1-6). The causes of these frequent water shortages vary, but the major issues can be considered to be that the water resources development facilities needed for stable water supply have not yet been sufficiently improved. This includes a case in which the practice of unstable water intake using "tentative wet season water rights" [2] permitting water intake only in a river's wet season[3], still continues. In addition, weather conditions are now different from those envisaged when the plans for such water resources development facilities were framed.

The majority of water resources development facilities is planned based on the hydrological regime of a water utilization standard year[4]. (Japan uses a dry year that generally occurs about once in 10 years for standards, while other nations use the year on a 50-year basis, or even a year with the worst water shortage in the past (Table 1-1)). Therefore, a water resources development facility cannot fulfil its planned water supply capacity in years in which rainfall is too scarce and the hydrological regime does not reach the standard year level. Most water utilization standard years for dams operated by the Ministry of Construction and the Water Resources Development Public Corporation have been established using data of years between 1956 and 1975 as a basis; a water utilization standard year using data from 1976 onwards was set for only 2% of all dams (Fig. 1-7).

Compared with the period in and before 1975 in which water utilization standard years were set for many water resources development facilities, there have been more frequent occurrences of diminished rainfall and the accompanying drastic decline of the amount of potential water resources in and after 1976. The conditions needed for water resources development facilities to provide stable water supply are thus considered to be in a state of change.

Actions for recovering reliability of water supply[5] that has declined due to such changes of conditions have therefore become very important.

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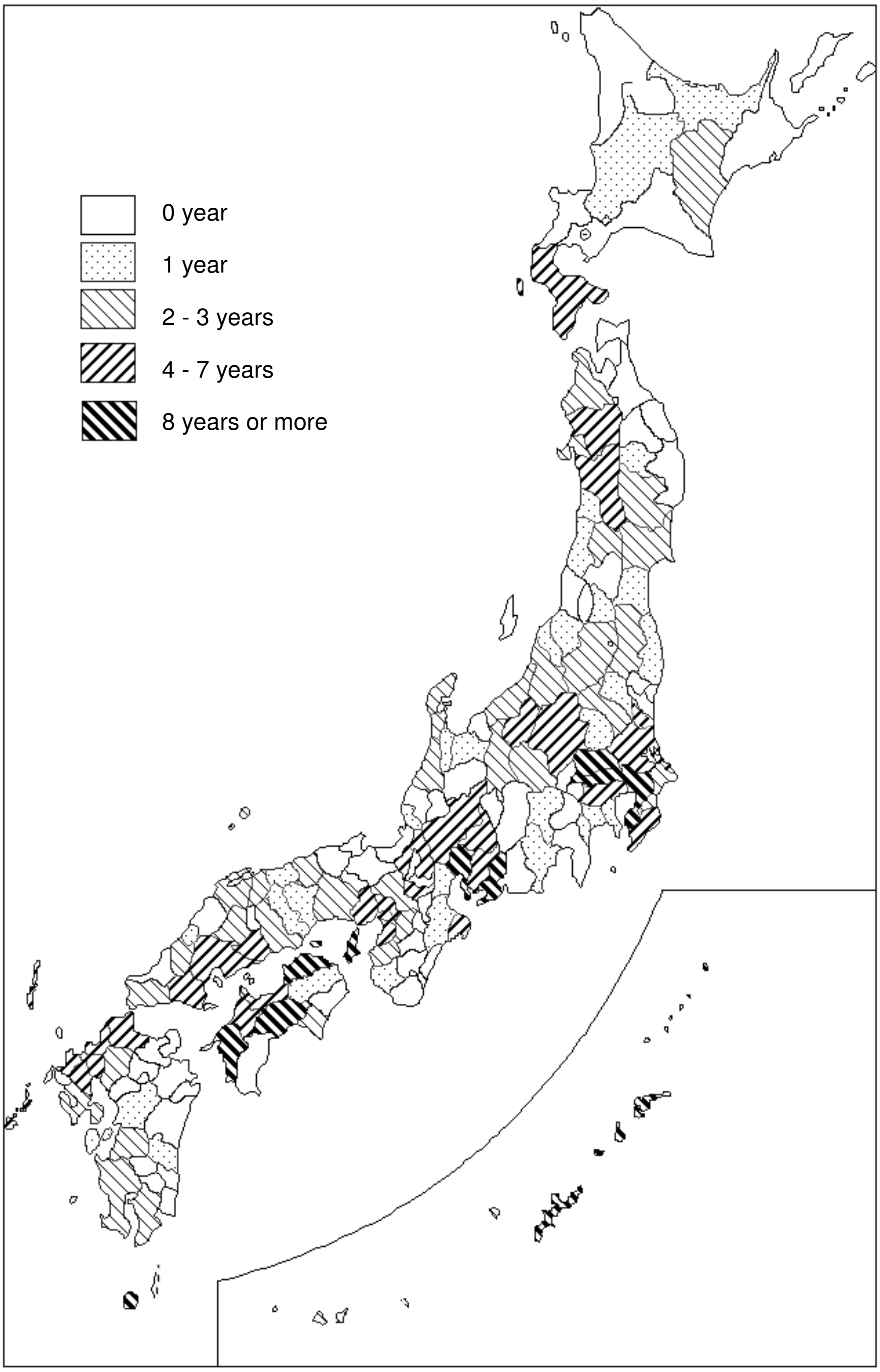
2 Tentative wet season water rights: Water rights allowing water intake only in a river's wet season, on the assumption that a water resources development facility will be completed in the future.

3 Wet season: The period in which the flow rate (volume) of a river is abundant.

4 Water utilization standard year: The year considered as the standard prior to framing water utilization plans such as those for water resources development facilities.

5 Reliability of water supply: refers to the certainty of being able to stably supply the quantity of water needed to meet water demands.

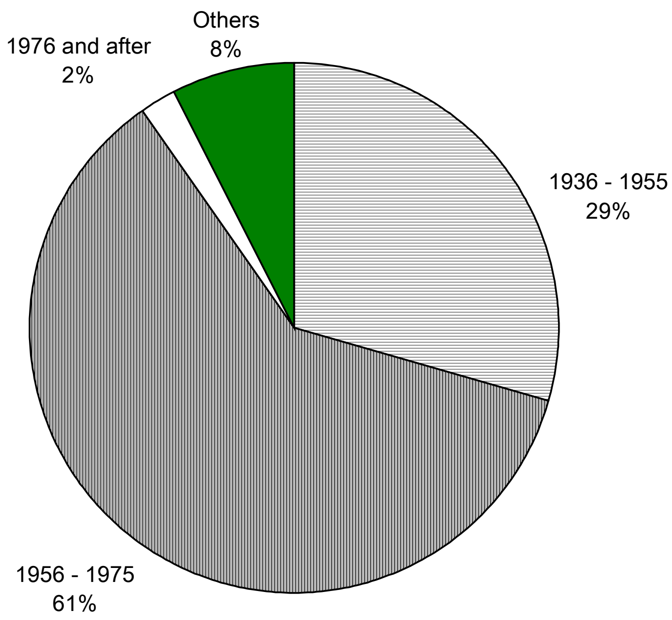


Notes: 1. Survey by the National Land Agency
2. Shows the number of years in which the water supply was reduced or suspended between 1978 and 1997.

Fig. 1-6 Number of Years in Which Water Shortages Have Occurred for the 20 Years

Table 1-1 Examples of Targets in Water Utilization Plans of Other Nations

Nation	Targeted water shortages in each plan	Document, etc.
USA	Worst water shortage in the past	"Project Plan for Water Resources Development" U.S. Bureau of Reclamation 1971
	Normal years and dry years are targeted. Dry years were 1990 - 1991.	"Water Resource Planning in California" California Department of Water Resources 1998
United Kingdom	Water shortage with a return period of 50 years	"Wessex Water Agency Report" 1985
	Worst water shortage in the past	"Anglian Water Agency Report" 1985
France	Water shortage with a return period of 10 years	"White Paper on Water in France" 1977



Notes 1. Prepared by the National Land Agency
2. Shows dams operated by the Ministry of Construction and the Water Resources Development Public Corporation, and completed by fiscal year 1997.

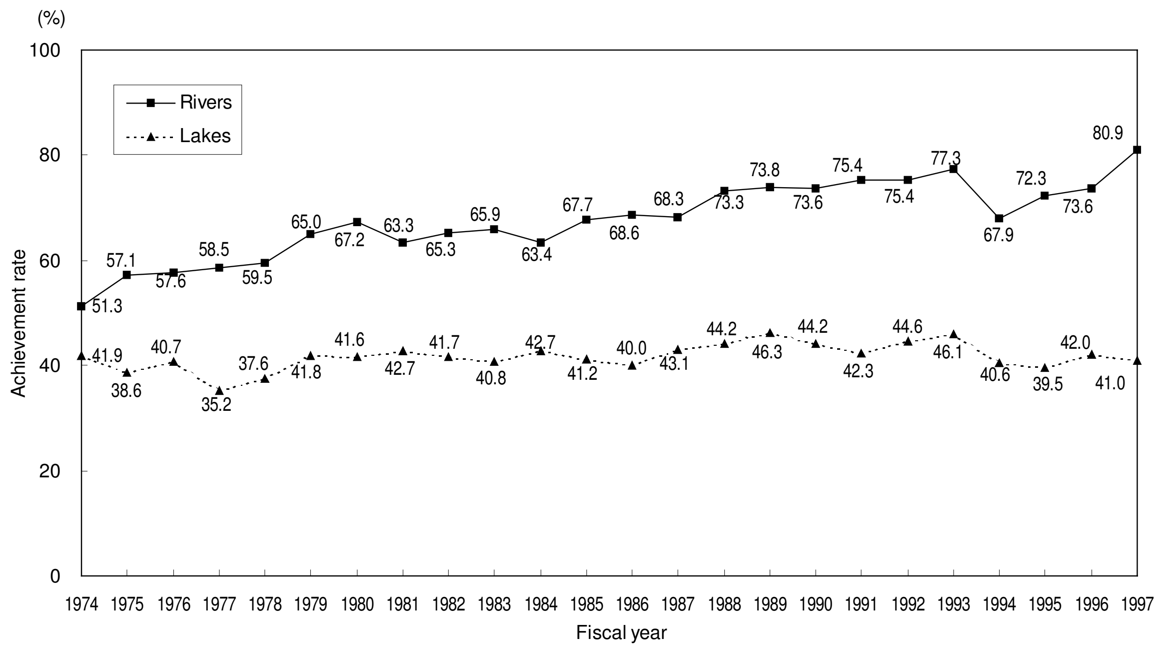
Fig. 1-7 Circumstances of Establishment of Water Utilization Standard Year for Water Resources Development Facilities

3. Water Quality Problems

Water resources are utilized in various ways such as for domestic/business water supplies, and also play important roles in forming the overall water environment. It is therefore necessary to maintain the water quality appropriate for each use and role.

The rate of environmental quality standard achievement of BOD[6] for most rivers has been increasing slightly in recent years, although it declined temporarily due to the influence of the Japanese Archipelago Drought in 1994 (Fig. 1-8). However, the water quality in some urban rivers has not been improved due to the continuing inflow of domestic wastewater into them. The worsening water quality in rivers and irrigation and drainage canals due to the inflow of domestic wastewater, can also be seen in some farming villages. The achievement rate of COD[7] environmental quality standards for lakes is still at a low level (Fig. 1-8). Problems related to water utilization and water environment, such as the generation of water bloom that accompanies eutrophication, have also been occurring in some lakes.

Groundwater quality is generally good, but the expansion of water pollution caused by chemicals such as trichloroethylene has been identified from around 1980. Water pollution by nitrate nitrogen has also been reported recently to affect the health of infants and young children.



Notes: 1. According to the Environmental Agency's data
2. BOD (Biochemical Oxygen Demand) for rivers, COD (Chemical Oxygen demand) for lakes
3. Achievement rate (%): (number of areas achieving environmental standard/number of areas to which environmental standard applied) × 100

Fig. 1-8 Transition of Environmental Standard Achievement Rate of Rivers and Lakes (National Average)

6 BOD: Biochemical Oxygen Demand
7 COD: Chemical Oxygen Demand

In addition, new problems related to the safety of tap water have been raised. For example, trihalomethane, a known carcinogen formed when chlorine treatment is carried out in water purification plants that take in water from rivers polluted by domestic wastewater, etc.; the pathogenic protozoan called Cryptosporidium, which resists chlorine disinfection; and trace chemical substances suspected to be endocrine disrupters ("environmental hormones").

Such water quality problems cause increases in water treatment costs concerning water supplied for use, and have caused other problems such as producing offensive odors and bad tastes, in the water from water supply systems in some areas almost every year. Water quality problems have also affected the ecology of water environment inhabited by aquatic life forms.

Therefore, maintaining water quality appropriate to its use and roles and maintaining a sufficient quantity of water have become very important tasks for the completion of a system that will supply safe water that can be used without worry, as well as for the conservation of and improvement in clean water environment.