3

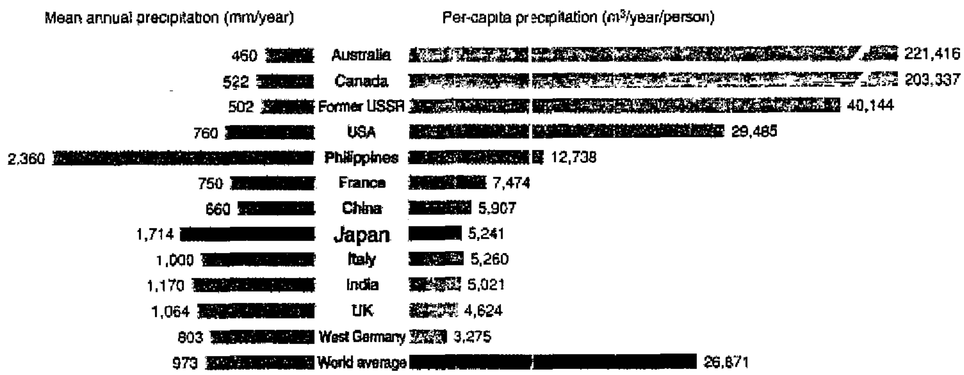
Water Resources

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.

Characteristics water resources

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

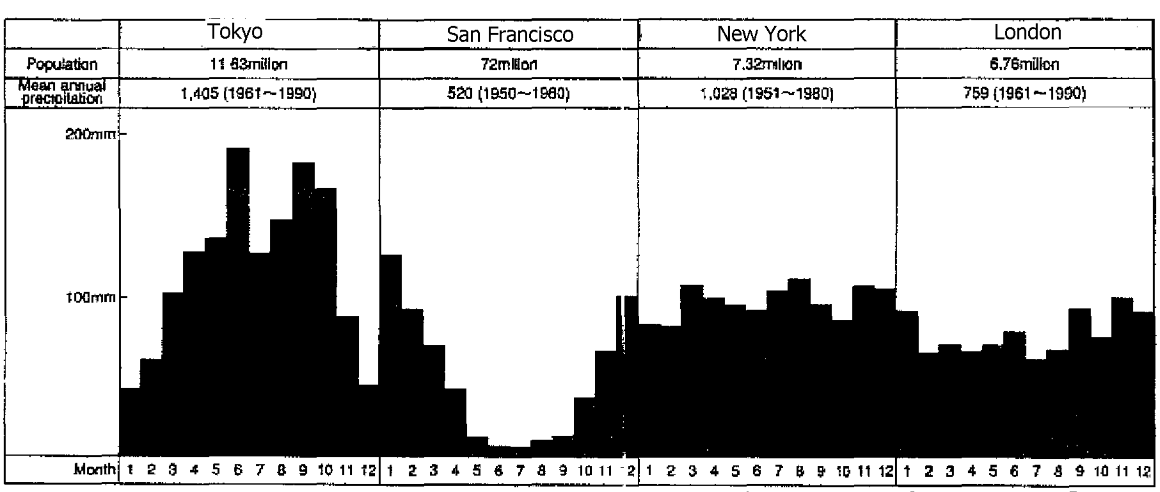
Precipitation in Japan is nearly two times the world average, but per capita precipitation is only one-fifth of the world average. From the viewpoint of available water resources, Japan cannot be considered a water-rich country.



Source National Land Agency

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

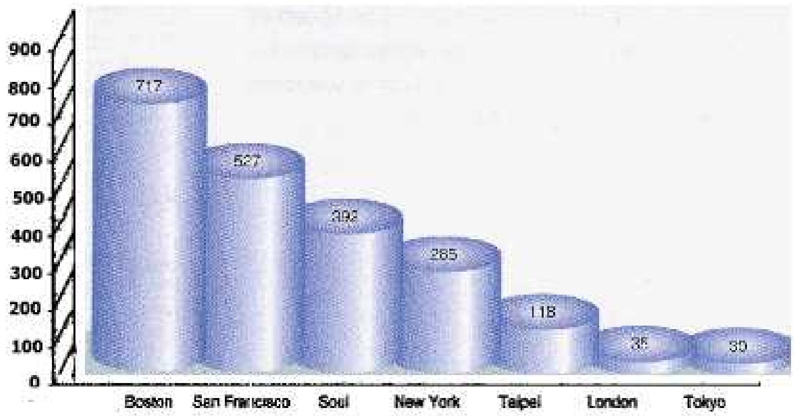
Tokyo, for instance, has considerable rainfall during the rainy season and the typhoon season but has little rainfall in winter. Consequently, even though annual precipitation is relatively high, seasonal variations mean that the amount of water available throughout the year is unreliable and unexpectedly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

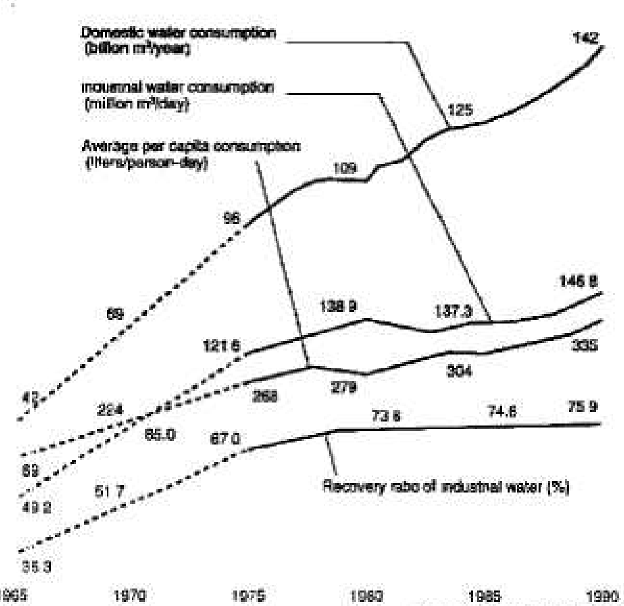
Compared with other cities of the world, Tokyo stores a very small supply of water. Per capita water storage in the densely populated Tokyo is about 29 m³. New York stores about 285 m³ per person, about 10 times as much as in Tokyo.



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.



Source: National Land Agency

■ **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 shortage	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 drough

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	Gamagoun-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	Gamagoun-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"
	Gamagoun-city, etc. (Toyogawa Canal area)	Toyo River	3/24/87-5/23/88	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)

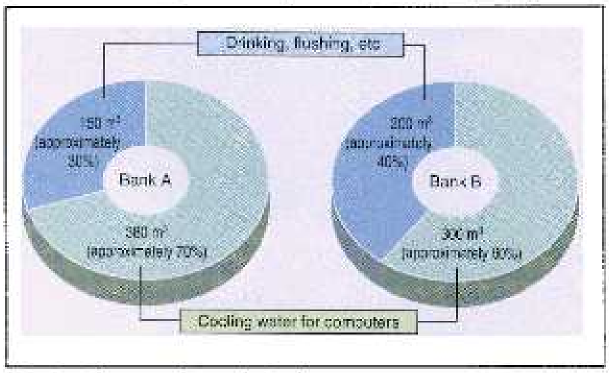
Phase of drought	■ Impact on local residents	■ Social impact
Water supply hours 11 - 18 hours Water supply restriction: 12 - 21% Total period 93 days	- Storage (purchase of plastic containers) - Water supply Interruption at higher-elevations - Red water, turbidity, sedimentation	- Termination of pumping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

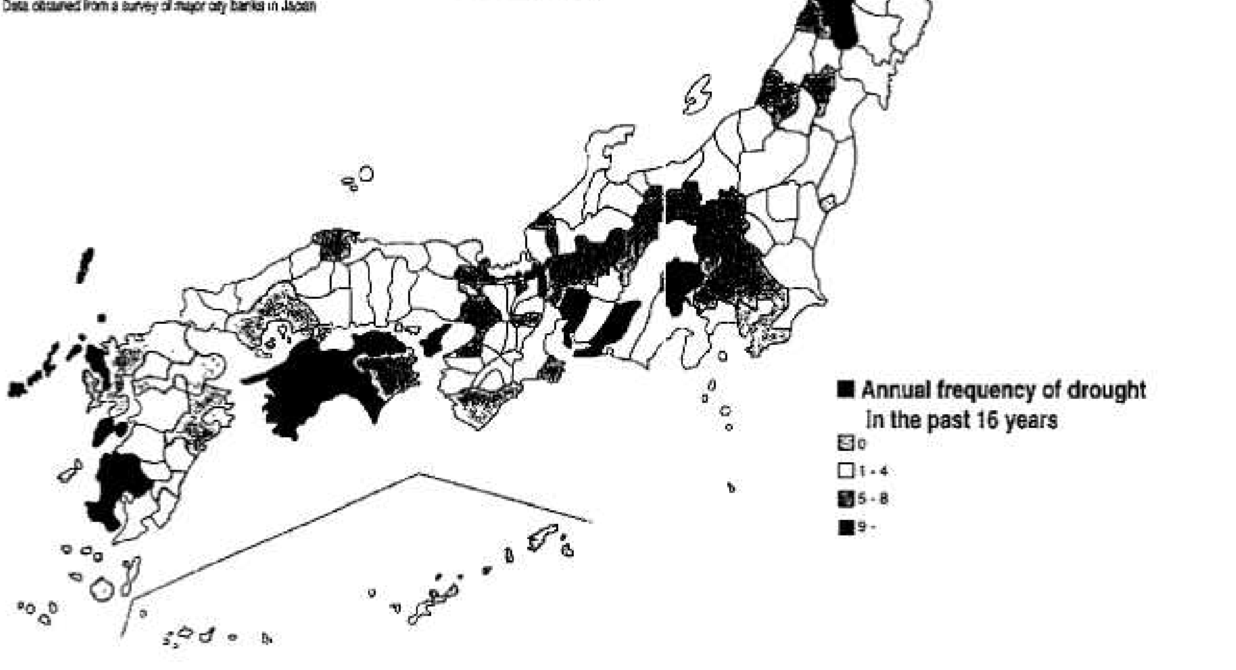
Large computers require strict control of ambient temperature and humidity and therefore need a large quantity of cooling water. A survey of major city banks showed that about 60 to 70% of water consumed in one day at a city bank is used for cooling.

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

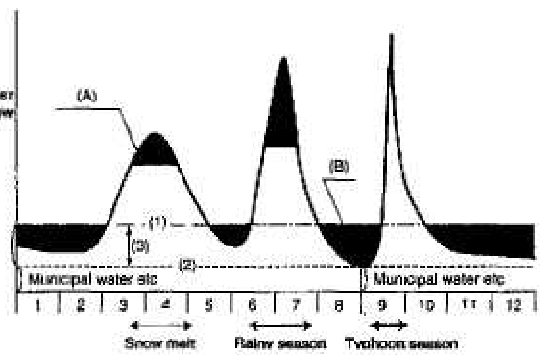
Source: National Land Agency
Note. Shown above are the numbers of yearly interruptions or restrictions of water supply systems and small water supply systems during the period from 1977 to 1995

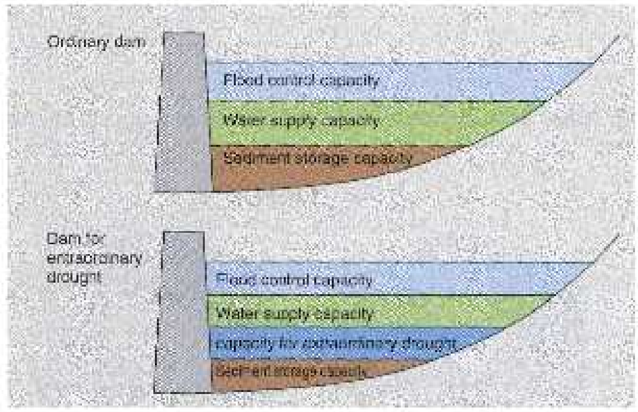
Diverse approaches to water resources development

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.

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.

Canals handle Interbasin transfer of water

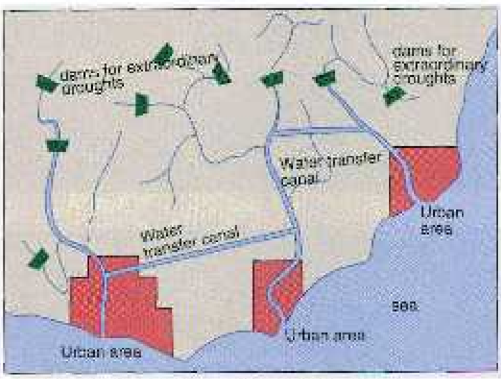
Canals are used as an emergency countermeasure to supply water to a drought-hit river basin from another river basin . Drought-resistant cities can be built if a system can be established under which interbasin water transfer can be made between major river basins.

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**