Water Resources Development:
Yodo River System, Okinawa Prefecture and Fukuoka City

Water tanker for the drought of 1978

Source: Fukuoka City Waterworks Bureau, "Waterworks Technologies of Fukuoka City; Overcoming Water Shortages"
http://www.city.fukuoka.lg.jp/data/open/cnt/3/1796/1/English.pdf

No. C2 Ver. 1

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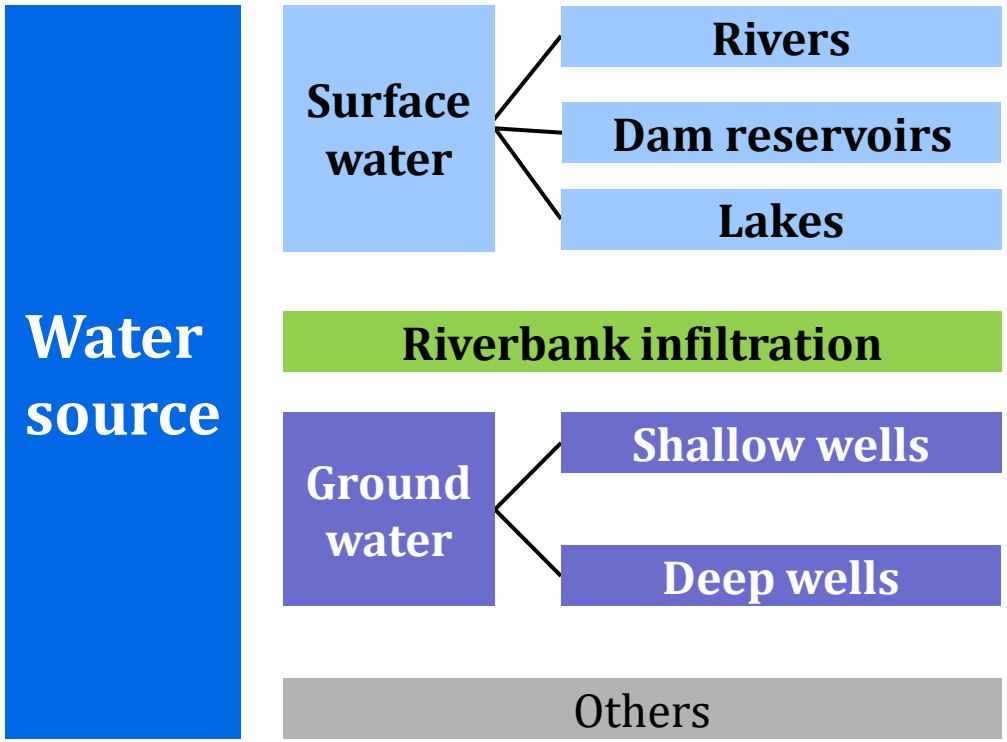

Rivers	25.5%	(3.91 billon m^3/year)
Dam reservoirs	47.3%	(7.25 billon m^3/year)
Lakes	1.4%	(0.22 billon m^3/year)
Riverbank infiltration	3.6%	(0.54 billon m^3/year)
Shallow wells	6.6%	(1.01 billon m^3/year)
Deep wells	12.7%	(1.95billon m^3/year)
Others	2.9%	(0.45 billon m^3/year)
Total	100.0%	(15.33 billon m^3/year)

Breakdown of water sources in Japan(2014)

Source : Japan Water Works Association
http://www.jwwa.or.jp/shiryou/water/water02.html

2. Background of Water Resources Development

(1) Water Rights

Cylindrical Siphon to allocate water equally, built in 1938 at Rokugou town, Akita Prefecture
http://www.pref.akita.jp/fpd/tuchi/nanataki.htm

Early Japanese society depended on rice crops so it was a serious problem to allocate water resources to drinking water use

Conflict with agricultural water use

Early understanding of the importance of well-ordered water allocation

1896 Former River Act →The concept of licenses for water use

1961 Maturity of water rights with enactment of Act on Advancement of Water Resources Development

2. Background of Water Resources Development

(2) Comprehensive River Development

In Japan, in order to increase the capacity for water supply to meet increasing demand, water resources development was implemented centering on multipurpose dams under the Comprehensive River Development Project, which took a holistic approach to water use and flood control.

1930s

River Water Control Plan

Flood control, Irrigation and Power generation

1937

River Water Control Project

Target the seven rivers

1951

Comprehensive River Development Project

Develop the relevant laws

1962

Japan Water Agency inaugurated

Basic Plan for Water Resources Development created

2. Background of Water Resources Development

(3) High Economic Growth and Drought in Urban Areas

1950-1970s Rapid increase in the demand for municipal water supply because of the rapid growth of population and economy

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Frequent water shortages

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- Water resource development (multipurpose dams etc.)
- Water saving
- Smooth adjustment of water allocation during drought
- Support for upstream reservoir areas from downstream users

2. Background of Water Resources Development

(4) Act on Advancement of Water Resources Development and Water Resources Development Public Corporation

1961 Act on Advancement of Water Resources Development

【 Purpose 】
- Comprehensive water resources development
- Rationalization of water use

【 Role 】
- Designation of priority river basins
- Determination of the Basic Plan for Water Resources Development
- Installation of the advisory committee
- Designation of responsible organizations to implement the basic plans

1962 The establishment of Water Resources Development Public Corporation (later renamed to the Japan Water Agency)

2. Background of Water Resources Development

(5) Bulk Water Supply

In Japan, the bulk water supply project provided the large-scale development of water resources for bulk treated water supply to large regional areas. The project contributed to securing water sources and reducing investment costs.

It was difficult for **small** water utilities to **secure water sources**.

- High cost
- Unstable sources
- Disparity of water sources among utilities

Consolidation of the whole utilities was **difficult**.

- Long process
- Conflict of interests
- Principle of municipal management

Prioritize the securement of water sources

→ The start of Bulk Water Supply Utilities

2. Background of Water Resources Development

The advantage of Bulk Water Supply Utilities

- Sharing of cost for securing water resources
- Reduction in maintenance costs
- Stabilization of water resources

The disadvantage of Bulk Water Supply Utilities

- Bulk water purchase contracts are for long-term fixed amounts which limits the ability to pass on any cost benefits for water saving to end users.
- Scaling-down of end user utilities
  → Decrease in technical capabilities and shortfall in human resources

2. Background of Water Resources Development

(6) “New” Water Sources

Water resources development in Japan

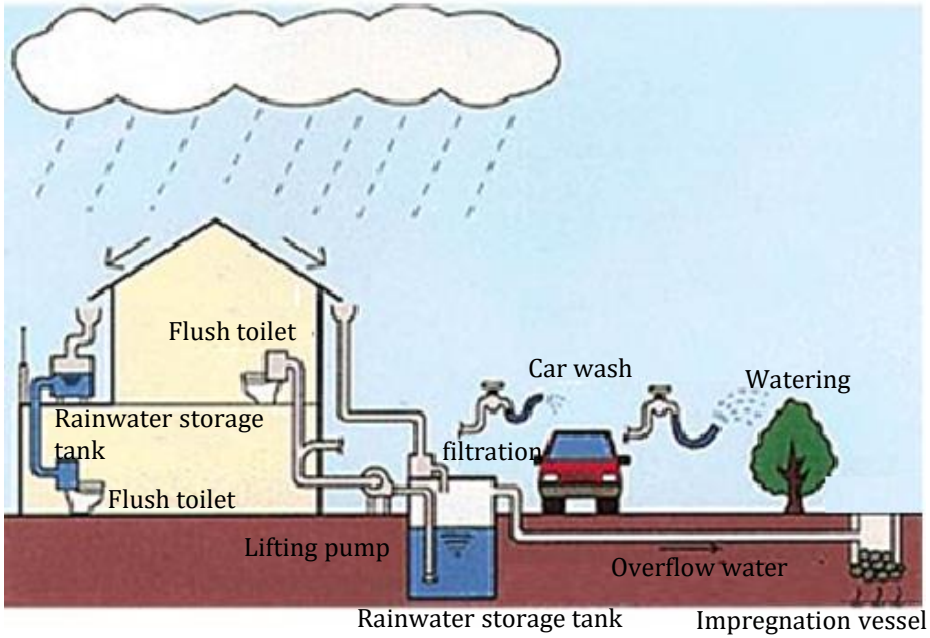
- Promotion of efficient use of water
- Improving efficiency of waterworks by reducing water leakage etc.
- Raising awareness for using water wise

Efforts in areas where drought occurs frequently:

- Rainwater harvesting for non-potable water
- Water recycling for non-potable water
- Seawater desalination

2. Background of Water Resources Development

Rainwater Harvesting in Sumida City, Tokyo



1981 Start rainwater harvesting in "Ryogoku Kokugikan" the Sumo Stadium

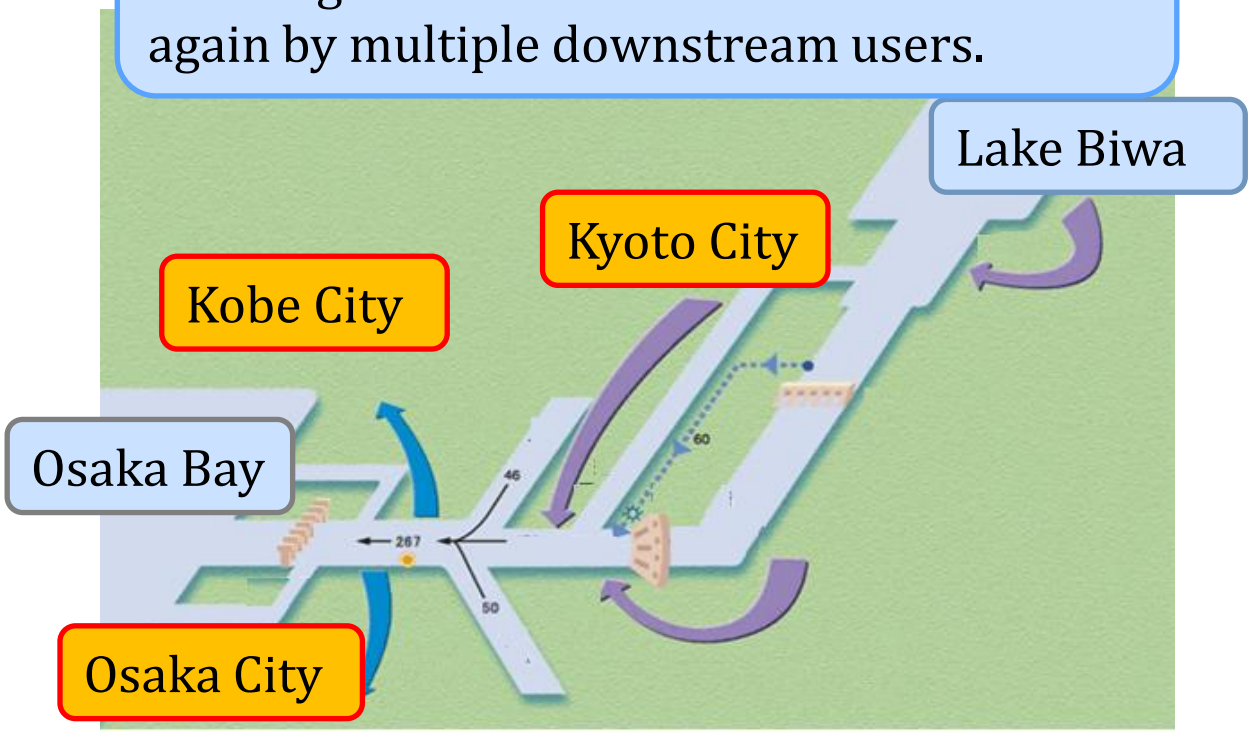
【 Purpose 】

- Effective use of rainwater
- Water supply in the event of a disaster
- Urban flood control measures

3. Case 1: Yodo River System Water Resources Development

(1) Background on Development of Yodo River System

The majority of water used upstream is discharged back to the Yodo River and used again by multiple downstream users.



Catchment area 8,240km^2
Population in the basin about 12 million

Kyoto city and many regional cities

High-density water use for various purposes

Pioneering role in comprehensive development for flood control and water use

Water use in the Yodo River Basin

Ministry of Land, Infrastructure and Transport Yodogawa River Office, "*Water use of the Yodo River*," http://www.yodogawa.kkr.mlit.go.jp/know/data/use/index.html

3. Case 1: Yodo River System Water Resources Development

(2) Securing Water Resources for Downstream Water Utilities

1942

Yodo Basin Flood Control Basic Plan

Yodo Basin Water Resource Development Basic Plan

- Flood control and water use were considered separately

1952

Yodo Basin Consolidated Master Plan 1st stage （1943～1952）

- Reallocate flood control capacity to water resources

Rapid demand growth

1962

Yodo Basin Water Resource Development Basic Plan (full plan) （1962）

- Using amount required for maintaining normal river function
- Construction of dams

Still demand exceeds resource

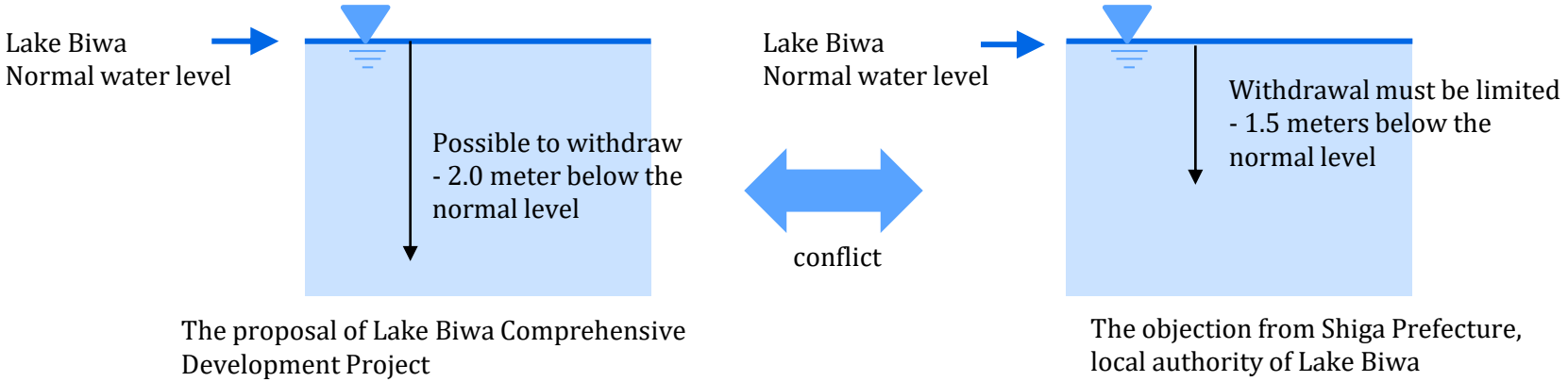
1972

Lake Biwa Comprehensive Development Plan (1972)

- Not only water use and flood control but also water quality management and conservation of aquatic environment

3. Case 1: Yodo River System Water Resources Development

To secure water sources to meet water demands and control floods, Act on Special Measures concerning Development of Lake Biwa was enacted in 1972. Under the law stakeholders made a compromise deal.



The proposal of Lake Biwa Comprehensive Development Project

The objection from Shiga Prefecture, local authority of Lake Biwa

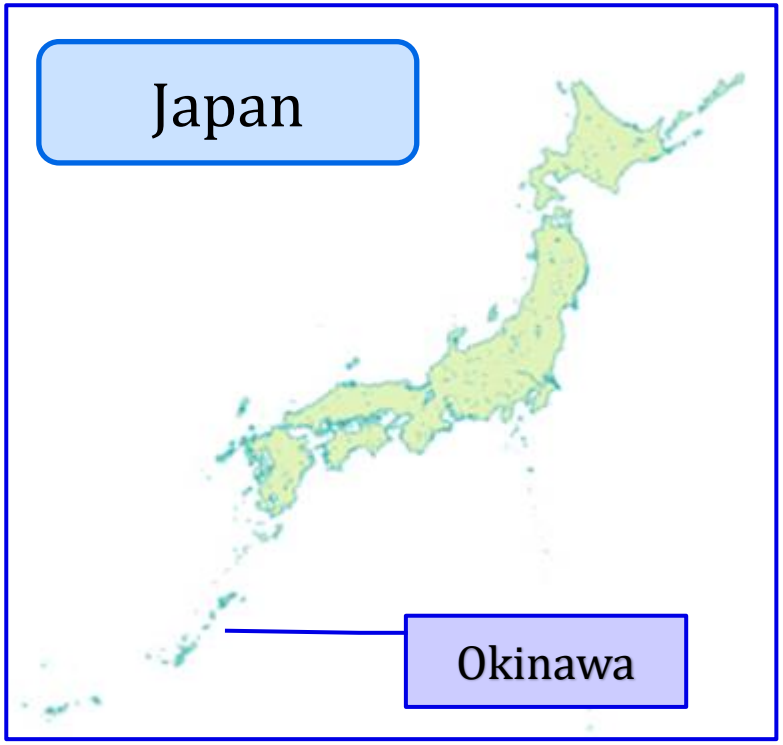
- - 2.0 m below normal level: Estimated water level for water control and utilization
- Water intake below - 1.5 m : Requires the approval of the Ministry of Construction

Such efforts successfully secured water resources to meet the demand in the large cities located downstream such as Osaka and Kobe. In the 1990s, the water demand reached a peak, and since then, water demand in those cities has been stable.

4. Case 2: Securing Water Resource in Okinawa Prefecture

(1) History of Okinawa Prefecture and its Water Shortage

Per capita water resources potential is only 60% of the national average.



Steep short rivers

Small watersheds

Scarce water resources

Frequent water service suspension until 1994

Various activities

There has been no water service suspension related to water resource shortage since March 1994.

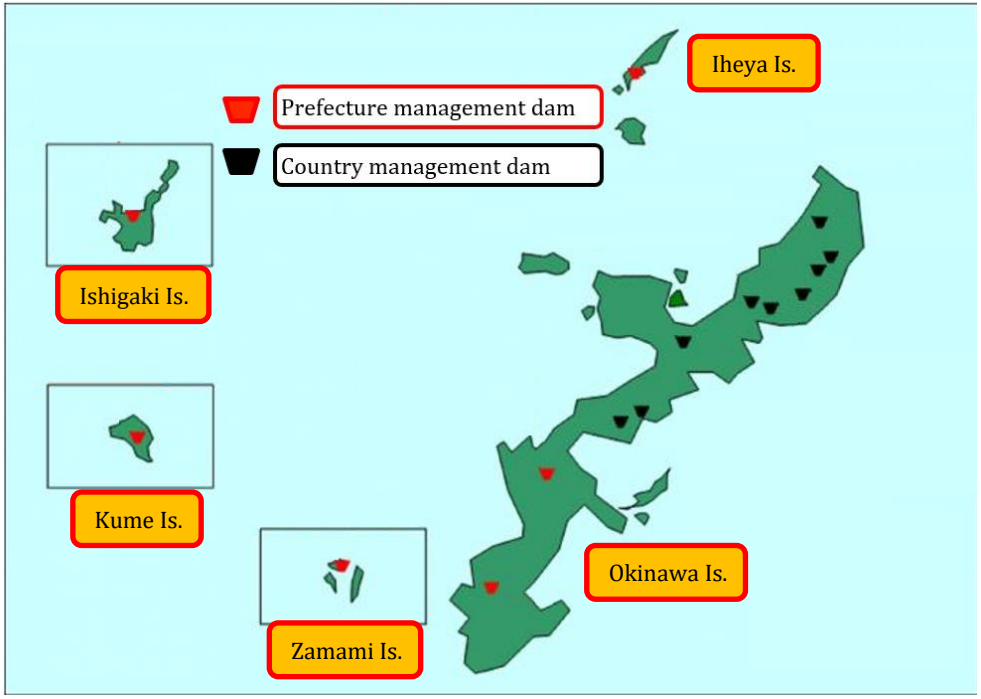
4. Case 2: Securing Water Resource in Okinawa Prefecture

(2) Dam Development

The River Act, enacted in 1964, stipulated that the rivers in Okinawa should be governed by the prefecture.

In 1971, Act on Special Measures for the Promotion and Development of Okinawa was enforced and it included a special provision of the River Act to allow the state government to construct dams, in order to promote water resources development in Okinawa.

1974 Completion of Fukuchi Dam; Construction of another nine dams in the north



Dams in Okinawa Prefecture

Okinawa Prefectural government, http://www.pref.okinawa.jp/site/doboku/damu/kanri/ken-damu.html

4. Case 2: Securing Water Resource in Okinawa Prefecture

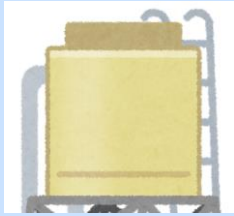
(3) Rainwater Utilization

Rooftop tank in Okinawa Prefecture

Countermeasure against frequent droughts

- Residents installed rainwater reservoirs on the rooftop
- Rooftop tanks were used to store tap water and rainwater until stable water resources were developed.

The custom of installing a storage tank still remains even now.



4. Case 2: Securing Water Resource in Okinawa Prefecture

(4) Seawater Desalination

The development of a seawater desalination system, which was planned in the time when Okinawa suffered from repeated drought, was completed in 1996.

1980 – 1990s　Repeated drought

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Seawater desalination plant
Completed in 1996

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Today, dam construction has been completed and demand has stabilized. The desalination plant does not run at its full capacity. But this system ensures stable water supply even in an emergency situation such as serious drought.

40,000m^3/day

Seawater Desalination Facility in Chatan Water Treatment Plant

4. Case 2: Securing Water Resource in Okinawa Prefecture

(5) Promoting Water Conservation in Times of Drought

Repeated drought → High awareness of the people to prepare for interruptions in water service

【 Methods of calling for water conservation in times of drought 】

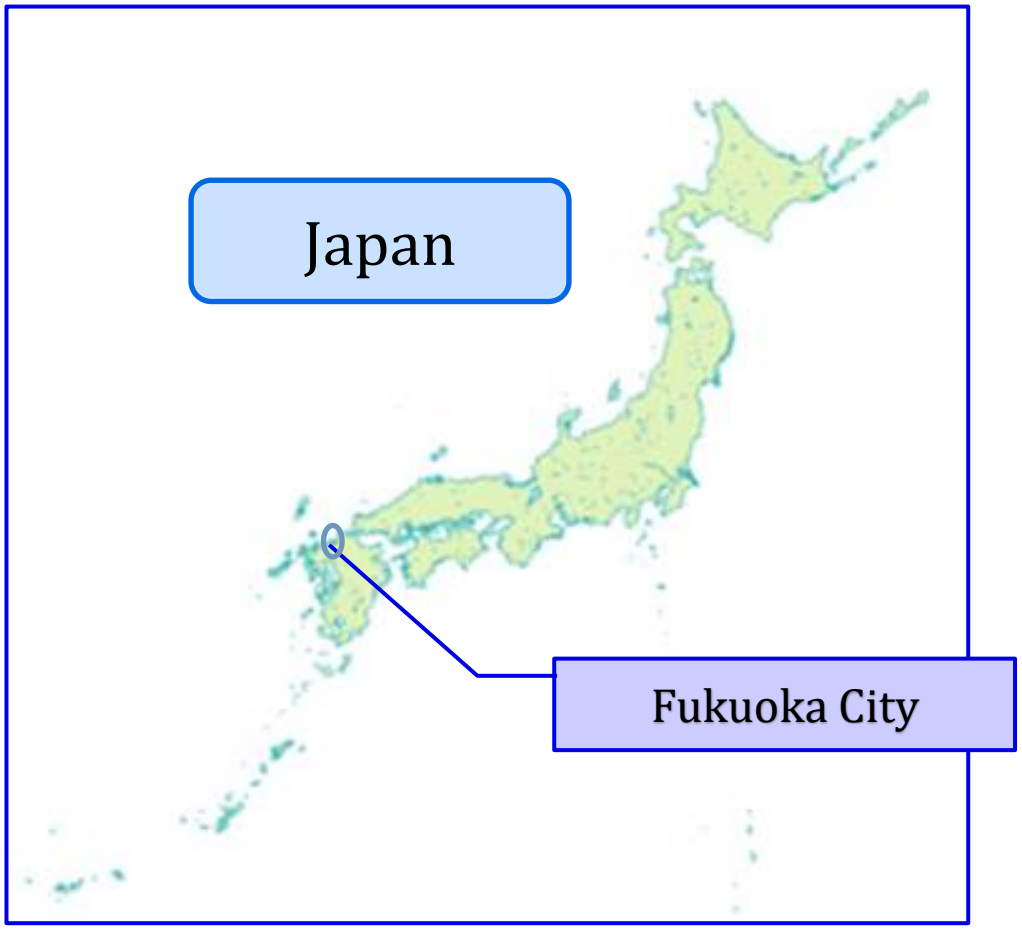
- The message of water saving on sign boards along the roads
- Daily announcement of water levels of dams in the newspaper
- Call for water saving by radio and television

5. Case 3: Water Resources Development and Water Conservation-Conscious City; Fukuoka

(1) History of Various Water Resources Development

Fukuoka City was chronically suffering from shortage of water source. Water restriction continued 287 days under severe drought in 1978.

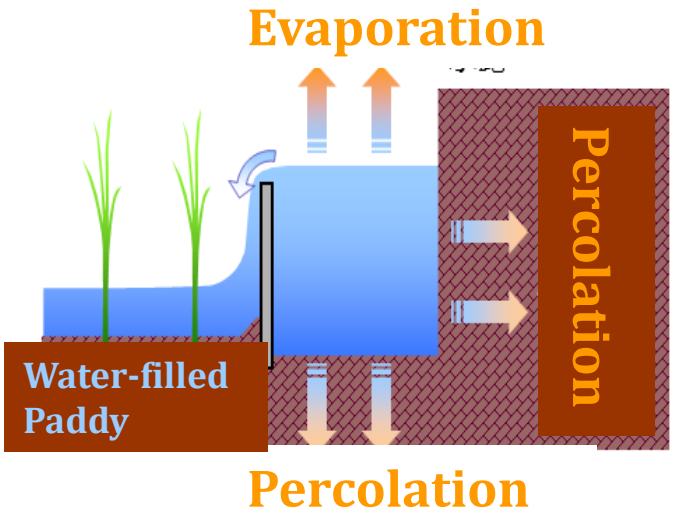
- Only small rivers in the area
- Population growth and increased water demand



5. Case 3: Water Resources Development and Water Conservation-Conscious City; Fukuoka

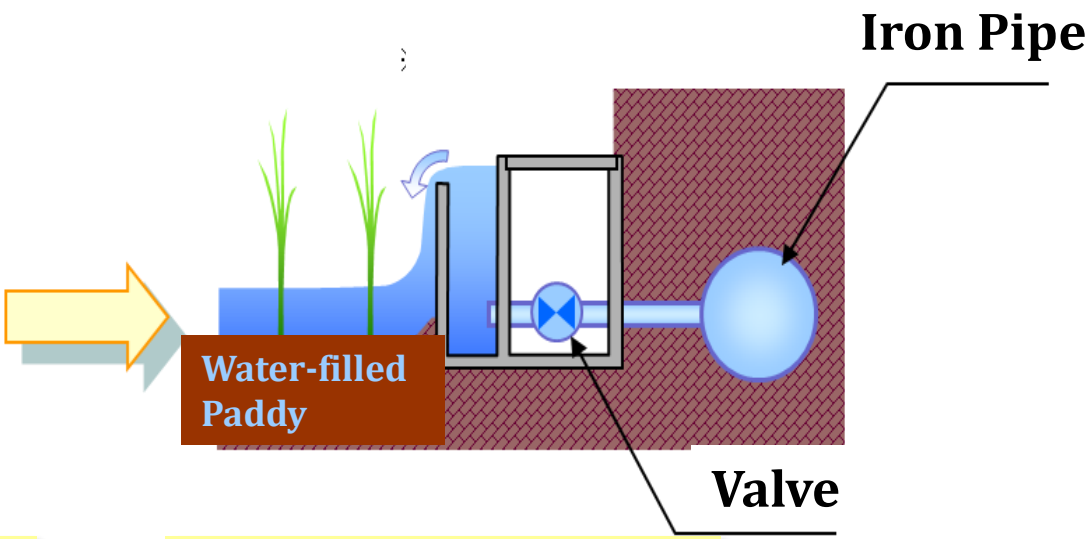
(1) History of Various Water Resources Development

Open-channel Type
(cross section)



Much Water Loss

Iron Pipeline Type
(cross section)



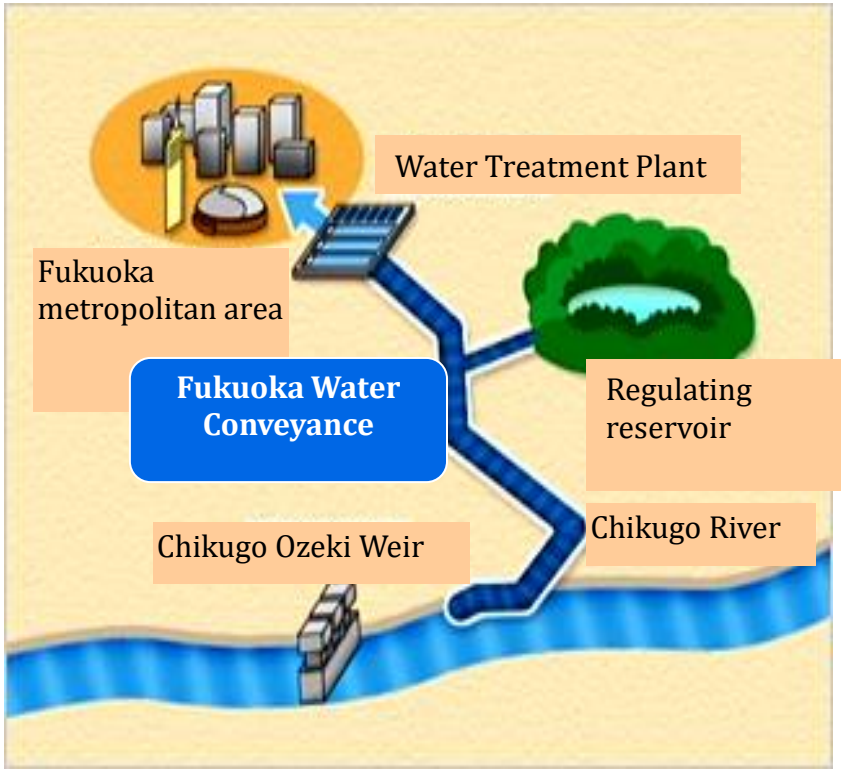
Less Water Loss

Efficient Use of Agricultural Water

5. Case 3: Water Resources Development and Water Conservation-Conscious City; Fukuoka

(1) History of Various Water Resources Development

Conveyance from Chikugo River, which flows outside of Fukuoka City, to mitigate the shortage of water resources was realized by understanding and corporation with residents and related entities in watershed.



Conveyance from outside of the watershed

Fukuoka District Waterworks Agency, http://www.f-suiki.or.jp/facility/ushikubi-placement/placement-shikumi/

5. Case 3: Water Resources Development and Water Conservation-Conscious City; Fukuoka

(1) History of Various Water Resources Development

Uminonakamichi Nata Sea Water Desalination Center

- 2005 in service
- Capacity of facility is 50,000 m^3/day.
- Fukuoka City receives 16,400 m^3/ day.

Uminonakamichi Nata Sea Water Desalination Center

5. Case 3: Water Resources Development and Water Conservation-Conscious City; Fukuoka

(2) Water Conservation-Conscious City

Water-Wise City

- Non-revenue water rate: 3.9% in 2015
- Water Consumption: 194 L/person/day (the lowest among large cities in Japan)

Promotion of Water Reuse

Introduce of Water Distribution Control System

Proactive Promotion of Leakage Reduction

Improvement of Water Distribution System

Public Relation Activities, etc.

Diffusion of Water Saving Device

6. Lessons Learned (1)

- **(Comprehensive River Development)** While securing water resources is a top priority for utilities, the use of river water must be well planned and controlled in a fair and equitable manner. The Japanese system takes great efforts in this regard, by allocating water rights and implementing comprehensive river development. The Water Resources Development Public Corporation (now Japan Water Agency) balances the needs for flood control and water utilization.
- **(Multipurpose Dam)** Dam development is expensive and must be carried out with a multi-purpose concept to be cost effective. This requires cost sharing and coordination among government organizations and dam reservoir users.
- **(Bulk Water Supply)** Water utilities can cooperate to utilize Bulk Water Supply as their water source. They also benefit from integrated management by joining efforts from resource development to water distribution to end users.

6. Lessons Learned (2)

- **(Other Means to Secure Water Resource)** Dam construction takes a long time to complete; therefore, other means to secure water resource must be implemented at the same time. The combined efforts in rainwater utilization, leakage reduction, reuse and water saving campaign have all helped to make lower water consumption in Fukuoka City to than the national average. Seawater desalination is much more expensive than the use of surface water, so it is still only a supplemental method to obtain additional water resources.