Overview of Measures Taken Against Accidental Water Resource Pollutions in Japan

日本における水質汚染事故対策

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Overview of measures taken against accidental water resource pollutions in Japan

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1. Water supply systems and risk management

An ensured supply of safe drinking water is essential for the daily lives of citizens and economic activities in any local communities. Once accidental water resource pollution affects the water supply system, it threatens the health and lives of the residents, imposing a substantial influence on the socioeconomic activities of the community.

In risk management for drinking water, possible causes of accidents can be attributed to (1) human error (e.g., accidents at a factory), (2) natural disasters, and (3) terrorism. In Japan, the leading causes of accidents have been (1) human errors, and (2) natural disasters. The only case of (3) terrorism in the past is in 1978, where waste oil and poisonous substances were thrown into the Chiba Prefectural Waterworks Bureau's Hokuso Water Purification Plant. Later, however, alertness against terrorism was heightened among the water suppliers, especially after the Aum Shinrikyo religious cult's poison gas terrorist attack in the Tokyo subway in 1994. More recently, due to 9/11, or simultaneous multiple terrorist attacks, against the United States in 2001, people have raised their awareness about the importance of precautionary measures to protect water supply systems against terrorist attacks.

This report describes measures taken against accidental water resource pollutions in Japan. In this report, "accidental water resource pollutions" refers to an accident where a drinking water supply system is adversely affected by a change of water quality at the water source that is unpredictable in a usual situation. Unless noted otherwise, an "accident" or "accident at water source" in this report refers to "accidental water resource pollutions."

2. Japan's geographical profile and characteristics of waterworks in Japan

(1) Japan's geographical profile

The land of Japan consists of islands that lie in a rather narrow strip that runs from north to south with "backbone" mountains that run down the middle of the strip. Japan is a mountainous nation, 67% of which is covered with forests. Habitable areas are therefore limited. The majority of large cities, including Tokyo and Osaka, as well as the major industrial areas, are located in lowlands in downstream regions of the rivers. The geographical features allow rainwater to flow into the ocean in a relatively short period after falling on land.

(2) Characteristics of waterworks in Japan

The Water Works Law of Japan defines “public water supply” as a system that supplies drinking water to a population larger than 100 in response to public demand. The Law suggests that primary suppliers of drinking water be municipalities (governments of cities, towns and villages), while it does not prevent private sectors from becoming involved in the business. Currently, there are approximately 11,000 public water suppliers in Japan. Among them, the largest 74 suppliers, which have a customer size of 250,000 or larger, supply water to more than half of the nation’s entire population (Table 1).

Table 1 Scale, number, and total population served of public water supply*

Scale of water supply (population served)	Number of suppliers	Total population served (unit:1,000)
1,000,000 -	13	35,360
500,000-1,000,000	9	6,213
250,000-500,000	52	18,023
100,000-250,000	132	19,733
50,000-100,000	193	13,102
5,000-50,000	1,411	23,676
- 5,000	8,734	6,702
Total	10,544	122,809

* Excludes private water supply

The majority of drinking water (72% by volume) in Japan has surface water as its source, followed by ground water (25%) and other water sources (3%). The Rapid Sand Filtration system is the dominant purification system in Japan (76% by volume), while the Slow Sand Filtration system is used for a small portion (4%) of the water supplied. Twenty percent of drinking water in Japan is supplied after disinfection only without filtration (neither rapid nor slow sand filtration).

3. Legal systems concerning risk management of water supply systems

The Water Works Law in Japan describes regulations regarding risk management as shown in Table 2. Article 23 of the Law specifically stipulates that the water suppliers are obliged to suspend the water supply and to notify related authorities should the supplier learn that the water being supplied is harmful to public health. Enforcement regulations of the Law and other ordinances on technical standards stipulate regulations in other areas, such as measures taken for sanitary purposes and pollution prevention purposes (Table 3).

As regulated by the River Law, management of rivers in Japan is under the jurisdiction of either the Minister of Land, Infrastructure and Transport or the governor of a prefecture. The

Table 2 Water Works Law （Articles related to risk management）

Article 20 (Examination of Water Quality)
1. The water utility business operator shall be required to conduct the periodic & special examination of water quality as stipulated by the order of the Ministry of Health and Welfare.
Article 22 (Sanitary Measures)
The water utility business operator shall be required to take such sanitary and sterilizing measures as stipulated by the order of the Ministry of Health and Welfare, pertinent to the control and administration of the water facilities.
Article 23 (Emergency Suspension of Water Supply)
1. The water utility business operator shall upon learning that the water he supplies is suspected to be harmful to the health of people, suspend the supply immediately, and notify the party concerned of the danger. 2. Any person who learns the water supplied is suspicious of rendering danger to the people's health, he shall notify the water utility business operator of it.
Article 40 (Emergency Use of Water)
1. In case of natural calamity or other emergency, the prefectural governor shall have the power to order the water utility or water supply business operator, whenever he may deem it to necessary and proper to provide water for protection of the public interest, to supply water to other water utility or water supply business operator for a certain period of time and to a certain amount of water and by way of a certain method as shall be determined.
Article 43 (Request for Prevention of Pollution of Water Source)
The water utility or water supply business operator shall have the right to state his opinion and request the chief of the pertinent administration office of the chief of the pertinent local public body to take appropriate measures for prevention of pollution of water source, whenever he may deed it necessary to do so for the security of water quality of the source.

Table 3 The Ministerial Ordinance on Technical Standards for Water Supply Facilities （Articles related to risk management）

(General Provisions) Article 1 Water supply facilities must meet the following conditions.
4. They shall be arranged to minimize water failure and any other effects on feedwater in case of a disaster or any other emergencies, and also to be able to be restored promptly in such occasions.
7. According to the importance of facilities, they shall have the structure which is secure from the earthquake load. And they also shall be arranged out of regard for the effects of liquefaction, lateral flowage, etc. caused by earthquakes.
10. If required, underdrains shall be installed, or any other necessary measures including setting up of fences shall be taken, so that there is no risk of water contamination.

11. According to the size and attributes, any necessary equipment shall be installed to monitor and control the operational status including flow, hydraulic pressure, water level, water quality, etc.

12. In order to prevent expansion of damages in case of a disaster or any other emergencies, cutoff valves or any other necessary equipment shall be installed if required.

Minister of Land, Infrastructure and Transport manages the major water systems.

Environmental standards for the public waters and regulations on effluents from factories and business offices are overseen by the Ministry of the Environment, as well as by the environmental divisions of each prefectural office, based on the Basic Environment Law and Water Pollution Control Law. In accordance with the Water Pollution Control Law, the national effluent standards are established. They are made up of two categories; for protecting human health (27 items) and for protecting the living environment (15items).

The Water Pollution Control Law also regulates the measures to be taken in case of accidents in public waters and ground water. When the installation party of a specific factory accidentally discharges a hazardous substance or a type of oil into public waters or ground water, the party is obliged to take emergency measures and to notify the concerned authority, such as the prefectural government. Installation parties of oil storage facilities have the same obligation when oil is accidentally discharged into public waters or ground water.

The conservation of source water for public water supply systems is in the scope of the Law on Execution of Preservation Project of Water Resources Quality for Water Supply. This Law regulates the promotion of well-planned projects and the supporting measures needed to promote these projects. The projects are carried out in order to improve the quality of water resources for the water supply system in a specific area designated by the governor of the concerned prefecture. It is based on the source water conservation plan made by the governor in responding to a water supplier.

In general, many stakeholders are involved in river and watershed water management in Japan. In many watersheds, councils cooperate with various parties, including the river administrator, water consumers ((potable) water suppliers, industrial water suppliers, irrigation associations etc.), environmental divisions of prefectures and municipal governments, for the purpose of water pollution prevention. They are platforms to coordinate and to clarify roles in monitoring river water, and in general issues concerning water quality conservation. Many of them also organize emergency contact systems among the concerned parties at the time of an accident. The council, however, does not have legal backgrounds, except for those designated by the Law on Execution of Preservation Project of Water Resources Quality for Water Supply.

4. Examples of accidents at water sources and countermeasures taken in Japan

(1) Breakdown of accidents at water sources in Japan

According to data of the Ministry of Health, Labour and Welfare (MHLW), each year around 90 water suppliers, or 0.5% of the total suppliers, are affected by water quality accidents in Japan. As shown in Fig.1-1, oil spills account for 48% of the causes of water quality accidents in the past, followed by ammonium nitrogen (11%), turbidity (8%), odor

(6%) and others. The data shows that 79% of the accidents in the past were in surface water, while 8% were in river-bed water, and 13% were in groundwater. Factories are the most frequent source of pollution (17%), whereas civil engineering works (7%), vehicles (6%), and crop and livestock farming (4%) are listed as other sources. For 48% of the cases in the past, the source of the accident could not be identified. (Fig.1-2)

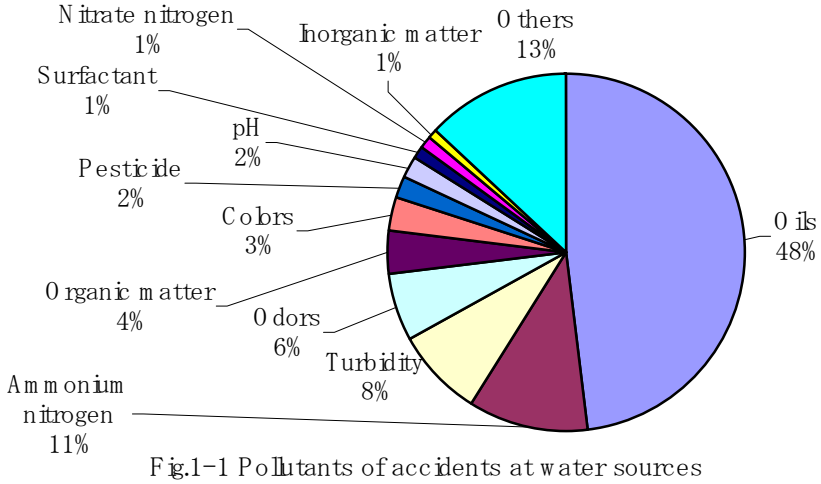

Fig.1-1 Pollutants of accidents at water sources

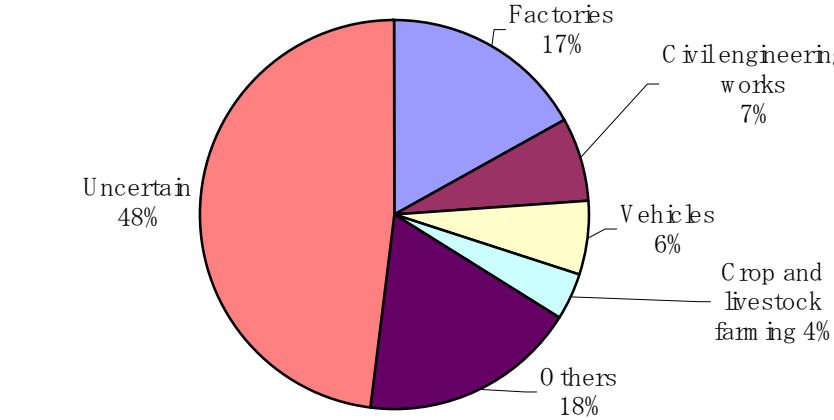

Fig.1-2 Source of pollution of accidents at water sources

(2) Measures taken by the Ministry of Health, Labour and Welfare

The MHLW itself does not operate water supply services and therefore does not directly carry out countermeasures against water quality accidents. The MHLW, however, is responsible for the general public health of the nation and general issues concerning water sanitation, and is in charge of approximately 500 major water suppliers. In addition, the MHLW operates several national research institutions that are involved in water quality research, the National Institute of Public Health, the National Institute of Health Sciences and the National Institute of Infectious Diseases, for example.

In 1997, the MHLW laid down the “Basic Guideline for Health Crisis and Consequence Management” with the aim of preventing the occurrence and spread of damage from accidents that are caused by pharmaceutical products, food poisoning, infectious diseases, or drinking water. Following the above Guideline, the MHLW also laid down the “Guideline for Health Crisis and Consequences Management for Drinking Water” in the same year. This guideline for drinking water provides countermeasures the MHLW should take in case of accidents that are caused by drinking water (specifically drinking water from water supply systems and wells, but excluding bottled water) and likely to threaten the lives and health of the citizens. It particularly prescribes the processes the MHLW should take regarding such issues as (1) information collection schemes, (2) decision-making in the actions to be taken, (3) investigation by study groups and councils, and (4) provision of information to concerned parties such as prefectural governments and water suppliers. On the occasion when the Guideline was prepared and published, the MHLW instructed each water supplier and prefectural government to notify the MHLW immediately in cases when a water quality accident occurred.

Each water supplier also has a crucial part to play in the case of an emergency. Prior to an actual occurrence of an accident, they should implement preventive measures. They must plan and prepare immediate actions to take in case of an emergency. To this end, the MHLW prepared the “Manuals for Establishing the Operations Plan on Water Contamination Emergencies” and distributed it to water suppliers and prefectural governments. This manual, which was published with the aim of supporting each water supplier in preparing its own crisis management guideline, covers various issues including examples of possible water quality pollution accidents, measures to allow them to acquire early detection, methods to accurately judge the situation and what immediate actions should be taken, collection and notification of information, organizational schemes, notification to the local residents and education, and training of employees. For example, as measures for early detection of possible accidents, the Manual recommends (1) enforcement of monitoring at upstream areas of the water source, (2) installation of automatic water quality monitoring systems and (3) enforcement of cooperation among concerned parties through the organization of a council. As examples of automatic water quality monitoring equipment, the Manual suggests equipment to monitor oil, turbidity, electrical conductivity, pH, ammonium ions, cyanide, and others. In order to promote the installation of monitoring facilities at the water source areas, the MHLW subsidizes the public water suppliers etc. for a quarter of their construction cost from national funds.

The MHLW also makes efforts to raise awareness preparation for accidents. For example, we introduce actual cases of accidents at the meetings of water suppliers or prefectural personnel who are in charge of supervising water supplies. In addition, related information is

provided through the Internet.

(3) Measures taken by water suppliers

The MHLW conducted a survey in 2003 on the public water suppliers' crises management performance by water suppliers in Japan. In the following sections, measures taken by water suppliers are explained based on the results of the survey.

The survey was conducted on public water suppliers with at least 5,000 customers. The results showed that 30% of suppliers have prepared a manual concerning water quality accidents, while 15% have issued a manual for terrorism. As shown in Fig.2, these numbers, especially the rate regarding manuals prepared for terrorism, are much lower than the percentage of suppliers that have issued a manual for earthquakes (approximately 47%) and heavy rain (approximately 39%). The majority of suppliers have already established an internal contact network for emergencies and crises, including water quality accidents. However, emergency contact and cooperation networks that include external parties have not been satisfactorily established, especially suppliers with 100,000 or fewer customers. This trend is even more noticeable for suppliers with 50,000 or fewer customers (Table 4).

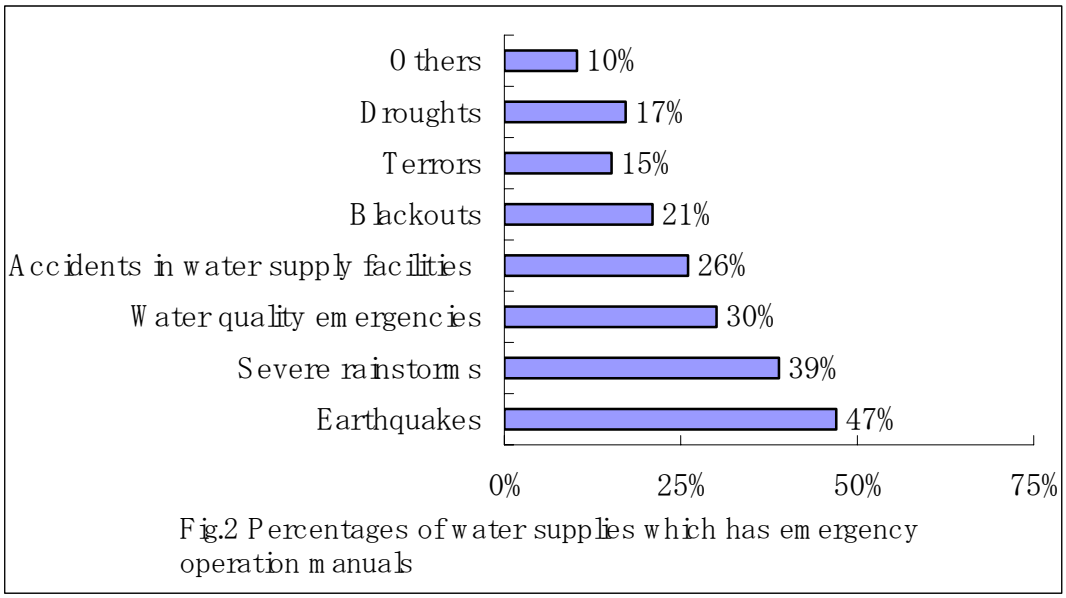

Fig.2 Percentages of water supplies which has emergency operation manuals

Table 4 Establishing emergency response system

Scale of water supply (population served)	Internal emergency response system		Emergency response system that includes external parties	
	Established or establishing(%)	Not-established or etc.(%)	Established or establishing(%)	Not-established or etc.(%)
1,000,000 -	100%	0%	100%	0%
500,000-1,000,000	90%	10%	90%	10%
250,000-500,000	100%	0%	94%	6%
100,000-250,000	100%	0%	95%	5%
50,000-100,000	99%	1%	79%	21%
5,000-50,000	90%	10%	72%	28%
- 5,000	92%	8%	73%	27%
Total	86%	14%	78%	22%

In Japan, continuous monitoring of source water is generally carried out at the site where the water is taken from the river for a water supply system. Larger water suppliers are more likely to conduct a continuous monitoring of source water quality. For example, 60 to 90 percent of public water suppliers that supply water to a population of 100,000 or larger, carry out continuous monitoring while the rate is merely 30 to 50% for the suppliers with a customer size of less than 100,000. The items for monitoring include turbidity, pH and alkalinity (Fig. 3-1,3-2). In addition to chemical analysis, approximately 30% of suppliers monitor for poisoning by keeping fish in tanks of the source water.

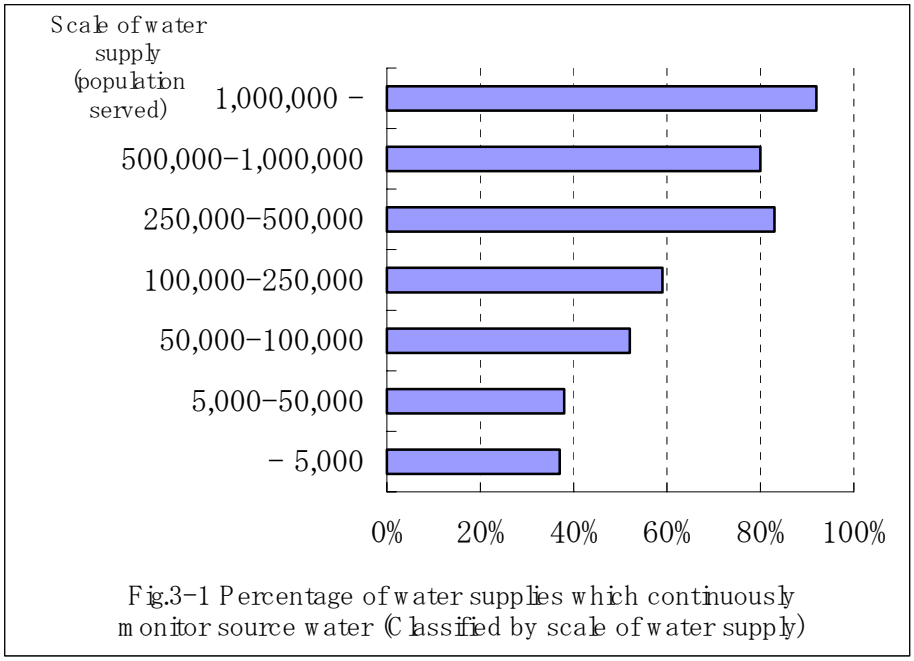

Fig.3-1 Percentage of water supplies which continuously monitor source water (Classified by scale of water supply)

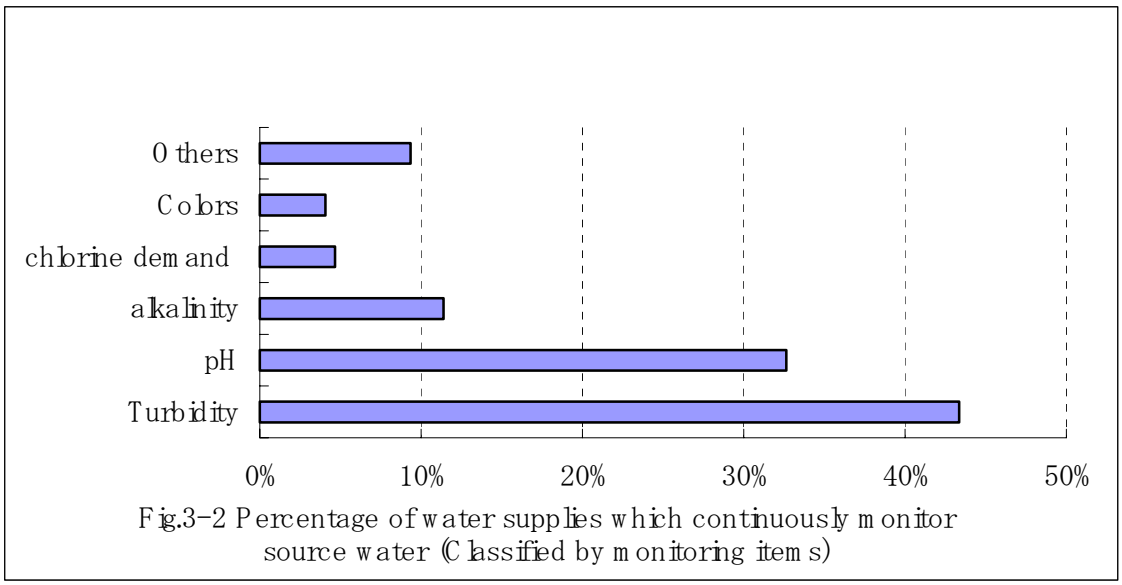

Fig.3-2 Percentage of water supplies which continuously monitor source water (Classified by monitoring items)

Upstream monitoring by patrolling or water quality analysis, however, is usually conducted only on a regular basis and not continuously. To cope with this problem, suppliers have been working on building an enforced network throughout the region or watershed area. This way, important information regarding water quality accidents can be collected in an immediate manner from the river administrator, who often conducts automatic monitoring of water quality for management purposes, environmental divisions of prefectural governments, water consumers, and local residents.

More advanced measures against water quality pollution, such as drawing a map to indicate upstream pollution sources of the river or monitoring of the intake point by industrial televisions (ITVs), are taken by about 10% of the suppliers.

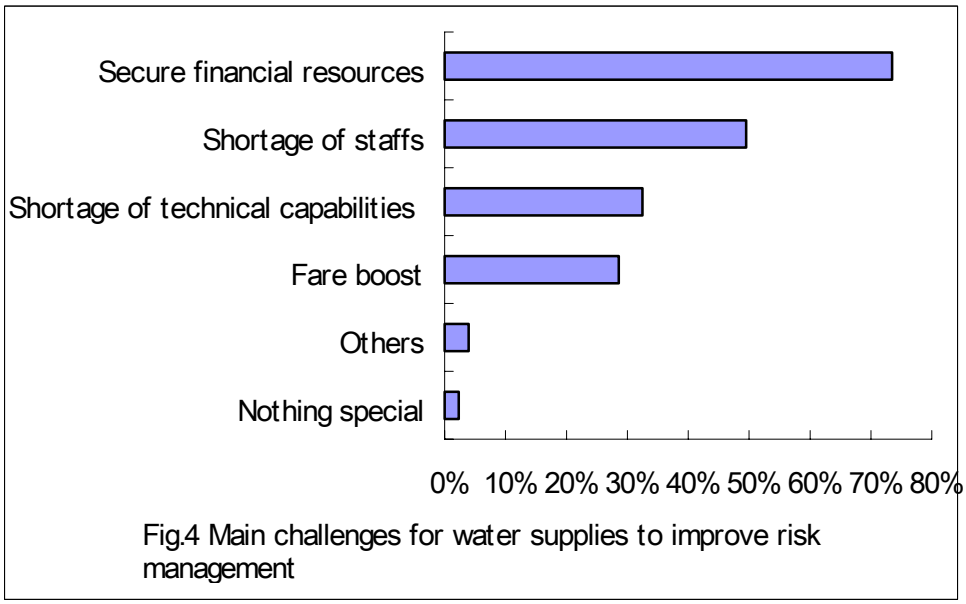

Fig.4 Main challenges for water supplies to improve risk management

Based on this data, we can conclude that about 87% of water suppliers in Japan need to improve their facilities and/or schemes for crisis management. The largest challenge to make such improvement should be how to find a way to allocate financial and human resources (Fig.4).

(4) Examples of measures taken for water quality protection

Case 1. Department of Waterworks of Osaka Prefecture

The Osaka Prefectural Government Department of Waterworks is a bulk water supplier, which supplies purified water to many municipalities other than the City of Osaka and another two towns in the prefecture. Its main source of water is the Yodo River, which flows from Japan's largest lake, Lake Biwa. The Lake Biwa-Yodo River System is the largest river system in the Kinki Metropolitan Area, the second largest metropolis following the Tokyo metropolis. The watershed includes two large cities, Osaka and Kyoto.

The Department of Waterworks carries out poisonous substance monitoring of source water with living organisms (fish-bioassay) and continuous source water VOC monitoring at water intake facilities of water purification plants in order to detect signs of a water accident.

In the poisonous substance monitoring with living organisms, or the "carp sensor," abnormal water quality is detected from the performance of carp fish that are kept in five series of water tanks (Fig.5). It is installed in the intake facility of Murano water purification plant. The Carps' behaviors are monitored by ITVs and the video data are transmitted to image processing equipment, and if there are abnormal behaviors, it will send an alert to the control center of the purification plant.

Continuous source water quality monitoring systems consist of an automatic water sampling system, gas chromatograph and other accessory equipments. They are installed in the intake facilities of Murano W.P.P and Mishima W.P.P. They monitor VOC items of drinking water quality standards and other VOC (Table 5) on an hourly basis.

As for wide-area water resource quality monitoring, the Osaka Prefectural Government Department of Waterworks and the nine other public water suppliers in Osaka prefecture, which intake source water from the Yodo River, organize "The Yodo River Water Quality Consultative Committee", and monitor source water effectively. The committee also performs other activities such as investigation, research, holding study meeting on water issues, demanding pollution control measures to competent authorities and establishing the emergency information network system etc. In addition, the Kinki Regional Development Bureau of the Ministry of Land, Infrastructure and Transport (the legal administrator of the Lake Biwa and Yodo River), the water suppliers, the environmental divisions of prefectures and municipal governments which concern the Lake Biwa and Yodo River Water System

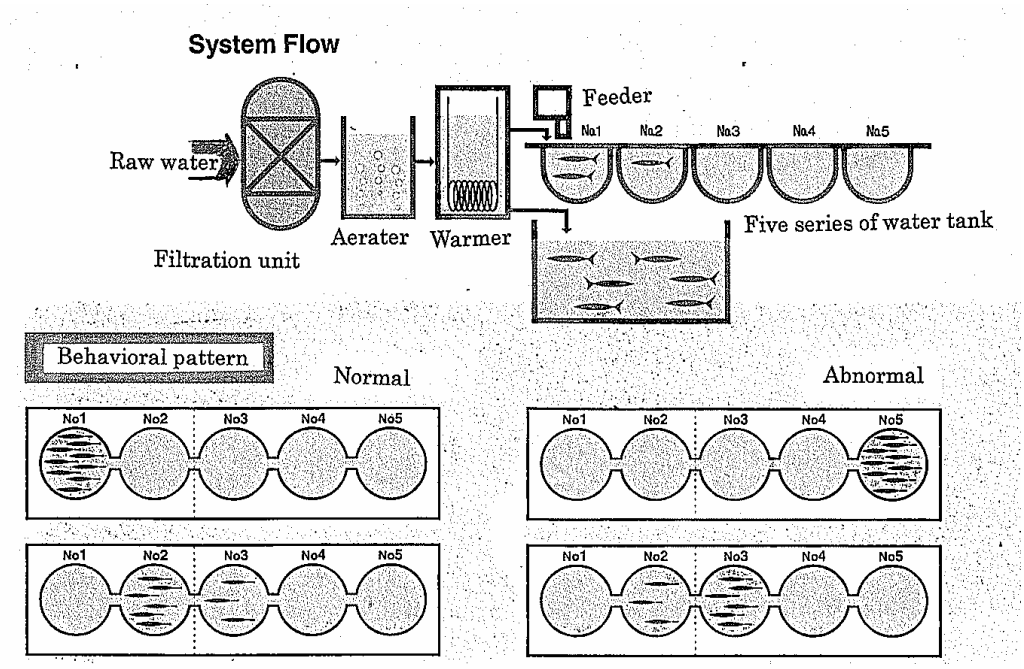

Fig.5 “Carp sensor”

Table 5 List of items to be measured by continuous source water quality monitoring system of the Waterworks department of Osaka prefecture

	Component to be measured		
Drinking water quality standard items	Trichloroethylene	cis-1,2-Dichloroethylene	Bromodichlormethane
	Tetrachloroethylene	Dichloromethane	Dibromochlormethane
	Carbon tetrachloride	Benzene	Bromoform
	1,1-Dichloroethylene	Chloroform	
Other items	1,2-Dichloroethane	trans-1,2-Dichloroethylene	o-Xylene
	1,1,1-Trichloroethane	cis-1,3-Dichloropropene	m-Xylene
	1,1,2-Trichloroethane	trans-1,3-Dichloropropene	p-Xylene
	1,2-Dichloropropane	Toluene	p-Dichlorobenzene

organized Lake Biwa-Yodo River Water Pollution Control Liaison Council. It is a platform to coordinate the installation of automatic river water monitoring equipment, to exchange opinions on water pollution control and to organize emergency contact systems among the members.

Case 2. Waterworks Bureau of Sapporo City

Sapporo is the largest city in Hokkaido Island, which is the northernmost of the four main islands of Japan, and has a population of 1.8 million. Since 1998, the Waterworks Bureau of Sapporo City has established the “Real Time Water Quality Monitoring System”. It will allow the city to monitor the quality of the water throughout its course—from its source to the

faucet at home—24 hours a day. This program is aimed to further ensure the safety of drinking water.

The Real Time Water Quality Monitoring System in Sapporo monitors water quality from the upstream of the Toyohira River, the key water source of Sapporo City, to the faucet at the household for 24 hours a day (Fig.6). Four monitoring stations in the water source are located along the river, between points 14 km upstream of the water intake and a point 800 m away from the water intake. Monitoring items (ITV monitoring, conductivity, turbidity, and oil content etc.) in water source had been decided by the needs and profiles of each monitoring station. The actual monitoring items are listed in Table 6. As for tap water, automatic monitoring (residual chlorine and temperature etc.) at 19 points are executed. In addition to these, monitoring of the source water at intake of purification plant is also conducted.

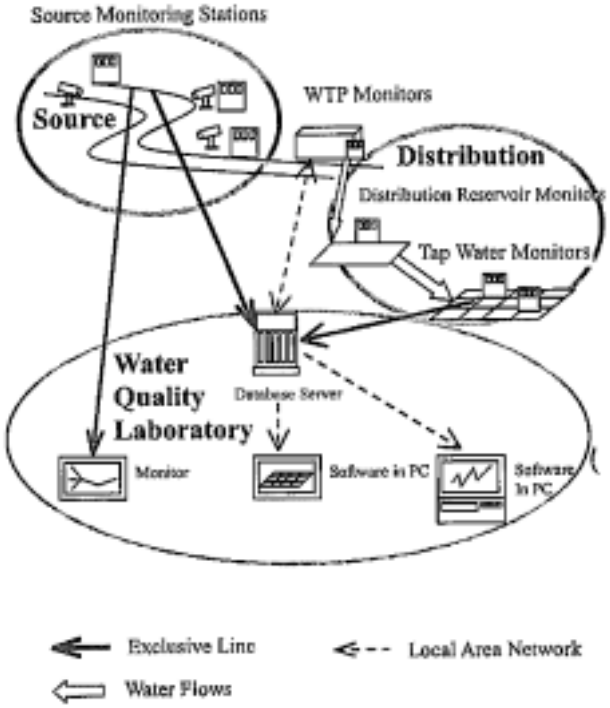

Fig.6 “Real Time Water Quality Monitoring System”[1)]

The water quality of the Toyohira River at the water intake point is substantially influenced by the amount of water discharged from the dams (two multi-purpose dams and two dams for power generation) that are located upstream of the intake. The city therefore receives data in a continuous manner from its administrator. The data includes the amount of water intake and discharge as well as the water level at the dams, precipitation at the catchment area, and water levels and flows of the river and dams. And it is used for efficient maintenance and management. It is reported that the system has enabled the plants to find accidents earlier, and to take proper actions promptly. And it has also decreased stress on the plant operators by giving the information taken from upstream, because it is useful for the plant operation even in the case of no accidents in water source.[1)]

Table 6 Monitoring sites and items in water sources of Sapporo city

Name of site	Distance from the intake	Items
1. Shirataki Bridge	14.0km	·Electric Conductivity ·Turbidity
2. Ichinosawa	10.4km	·Monitoring Camera
3. Toyama Dam	6.7km	·Electric Conductivity · Monitoring Camera ·Turbidity ·Fish-bioassay ·pH
4. Moiwa Dam	0.8km	·Electric Conductivity ·Chloride ion ·Turbidity ·Oil ·pH ·Monitoring Camera ·Ammonium nitrogen ·Fish-bioassay

5. Conclusion

In Japan, the role of the public water suppliers has become increasingly important as the service diffuses to larger areas. Meanwhile, the frequency of water quality accidents has not decreased, and the need for a higher-level security scheme has been increasing under recent social circumstances (e.g. alert for terrorisms). Against such a background, the importance of source water monitoring programs by suppliers and other concerned parties has been increasingly recognized. Except for the cases with large-scale suppliers, the necessary measures to protect the water quality against accidents and terrorism, nevertheless, have not been implemented at a satisfactory level, mainly due to financial reasons.

The majority of water supply systems in Japan have a river or surface water as their water source. These rivers are generally subject to concerns for many stakeholders, with different perspectives, who are located in a rather limited area. This fact makes it unfeasible for water suppliers to monitor the water quality at the water source on its own. The monitoring systems, instead, should be implemented in cooperation with various concerned parties or through the organized workings of a council that includes various members of the entire watershed. Some of the existing systems can be effectively used in this manner. For example, the river administrator has already been operating automotive monitoring programs for their management purposes, and data from such programs can be shared with other members at a

council. In addition, the residents who live in upstream areas of a water intake plant can provide helpful information and cooperation. This is especially true in Japan, where the upstream regions are often developed as residential areas.

Some leading water suppliers have already started to install automatic monitoring systems, or other measures, to protect the quality of their water. While some functional errors of equipment have been reported, as expected for the new and uncompleted programs, these automatic monitoring systems have reportedly reduced the level of stress on many workers in water purification, who otherwise are exposed to a substantial level of stress because they must be on continuous alert for possible accidents. In order to promote the diffusion of the systems in the future, efforts must be made to reduce the construction and maintenance costs and to facilitate the maintenance and management work of the systems.

The MHLW will continue to support public water suppliers and concerned parties for the installation of water quality monitoring systems, to enforce their management measures against crises, including terrorism. In addition, the Ministry will continue to support research activities for the improvement and development of technologies that are needed for crisis management in water supply systems.

Reference

1) SASAKI Takanori, MOTOI Naoyoshi, SADO Akira and TAGUCHI Hideyo (2003) Real Time Water Quality Monitoring System in Sapporo, Technical Report, 13th IWA-ASPAC Regional Conference, 422-428

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Risk management in water supply

- Water is essential for the daily lives of citizens and economic activities.
- Once accidental water resource pollution affects the water supply system, it threatens the health and lives of the residents, imposing a substantial influence on the socioeconomic activities of the community.

Possible causes of accidental water resource pollution

- Human error (e.g., accidents at a factory)
- Natural disasters
- Terrorism

The only case of terrorism in Japan

- In June 1978, waste oils and pesticides were thrown into Hokuso Water Purification Plant (Chiba Pref. Waterworks Bureau).
- It was estimated that 120L waste oils and 12kg pesticides (diazinon, MPP) had been thrown.
- It was suspected a left-wing extremists' activity against opening of Narita Int'l Airport.
- It took about 16 hours to find the emergency, and took about 198 hours for full recovery.
- There was no serious damage because of system redundancy and distribution from the other plant.

"Accident" in this presentation

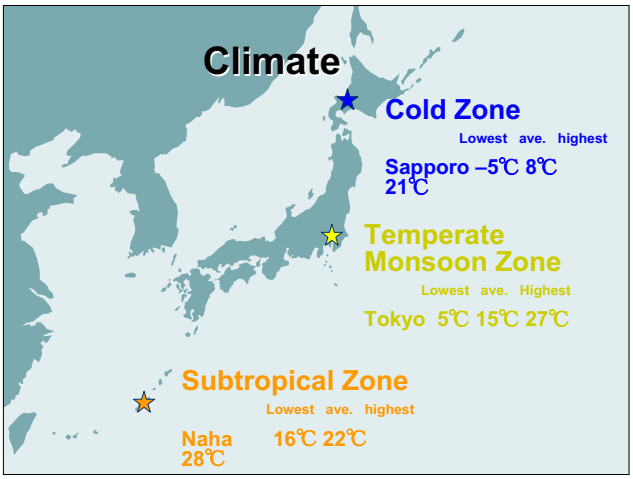
- An accident where a drinking water supply system is adversely affected by a change of water quality at the water source that is unpredictable in a usual situation

Characteristics of national land and climate of Japan (1)

- Strip-shaped island country
- "Backbone" mountains runs from north to south in the middle of the strip.
- It is located in Asia-monsoon area, there is an apparent seasonal change of precipitation

Precipitation

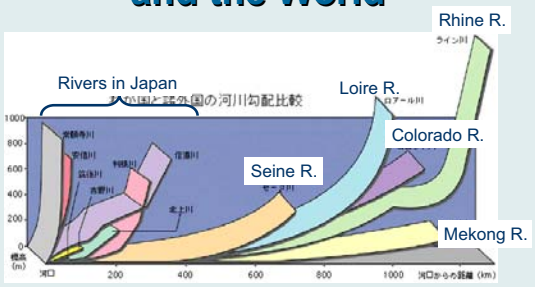
- National Average 1718 mm/year
  cf. World Average 970mm/year
- Sapporo 1158mm/year
- Tokyo 1460mm/year
- Naha 2128mm/year



Characteristics of national land and climate in Japan (2)

- Forests cover 67% of national land.
- Habitable areas are therefore limited.
- Megalopolises and major industrial areas are located in lowlands in downstream regions of the rivers.
- Rainwater flows into an ocean in a relatively short period after falling on land.

River gradients of Japan and the World



Characteristics of water source (river) in Japan

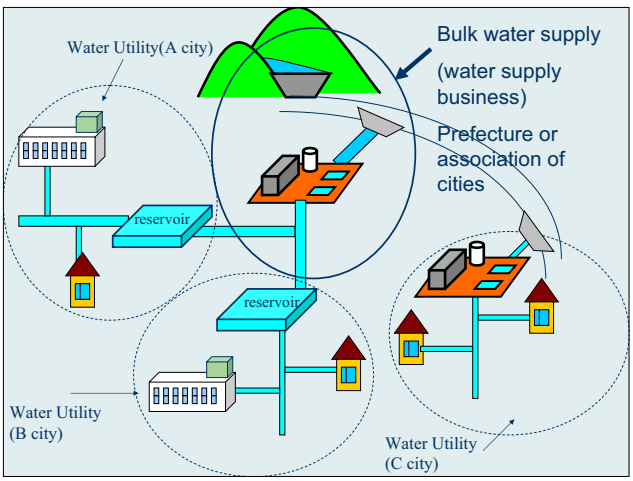
- Pollutions spread to downstream quickly
- Abrupt changes of river water quality (turbidity etc.) and river flow in heavy rainfall time

Overview of water supply in Japan

The type of water supply system

Public water supply systems	Municipal water supply (1,956 systems)	・Supply of water for general needs ・Licenses authorized by the MHLW or Pref. Governor	Supply for population: 5,001 and over
	Small scale public water Supply (8,790 systems)		Supply for population: 101-5,000
Bulk water supply systems (111 systems)		・Wholesale of purified water to city water suppliers ・License authorized by the MHLW or Prefecture Governor	
Private water supply Systems (3,723 systems)		・Supply of water for private use for over 101 residents or 20m³/d ・Confirmation of design by the pref. governor is required	

Note: Number of systems at the end of 2001



Scale, number, and totalpopulation served of public water supply*

Scale of water supply (population served)	Number of supplies	Total population served (unit:1,000)
1,000,000 -	13	35,360
500,000- 1,000,000	9	6,213
250,000- 500,000	52	18,023
100,000- 250,000	132	19,733
50,000- 100,000	193	13,102
5,000- 50,000	1,411	23,676
- 5,000	8,734	6,702
Total	10,544	122,809

* Excludes private water supply

Water Sources of Public Water Supplies and Bulk Water Supplies(as of March,2002)

- Surface water (Dams, rivers) ・・・ 72%
- Groundwater ・・・25%
- Others ・・・ 3%

(By volume)

Water Purification systems in Japan

- Rapid Sand Filtration system ・76%
- Slow Sand Filtration system ・ 4%
- Disinfection only ・・20%

(By volume)

Legal system concerning risk management of water supply system

Waterworks Law (Articles related to risk management)

Article 20 Examination of Water Quality

Article 22 Sanitary Measures

Article 23 Emergency Suspension of Water Supply

Article 40 Emergency Use of Water

Article 43 Request for Prevention of Pollution of Water Source

Article 23

(Emergency Suspension of Water Supply)

- The water utility business operator shall upon learning that the water he supplies is suspected to be harmful to the health of people, suspend the supply immediately, and notify the party concerned of the danger.
- Any person who learns the water supplied is suspicious of rendering danger to the people's health, he shall notify the water utility business operator of it.

National Government

10 Ministries and 2 Agencies

- Water supply: Ministry of Health, Labour and Welfare
- Water Environment: Ministry of Environment
- River Control, Water Resource: Ministry of Land, Infrastructure and Transport
- Industrial water: Ministry of Economy, Trade and Industry
- Agricultural water: Ministry of Agriculture, Forestry and Fishery
- Sewerage system: Ministry of Land, Infrastructure and Transport

Related regulation in Water pollution control law

- National effluent standards
  - For protecting human health 27items
  - For protecting living env. 15items
- Measure to be taken in case of accident in public waters or ground water

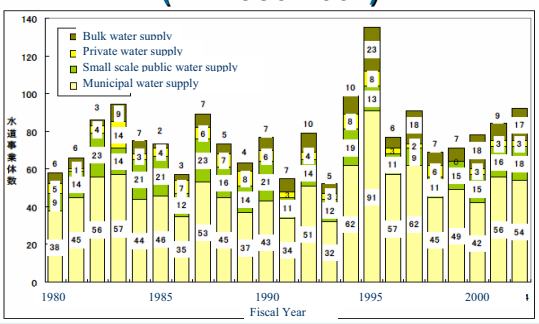
  When Specific factory etc. accidentally discharges a hazardous substance or a type of oil into public waters or ground water, the party is obliged to take emergency measures and to notify the concerned authority

Liaison council for the purpose of water pollution prevention

- (Potable) Water suppliers
- Industrial water suppliers
- Irrigation associations
- River administrator
- Environmental division of local government etc.

Examples of accidents at water sources and countermeasures taken in Japan

Number of water suppliers which is affected by water quality accidents (FY 1980-2002)



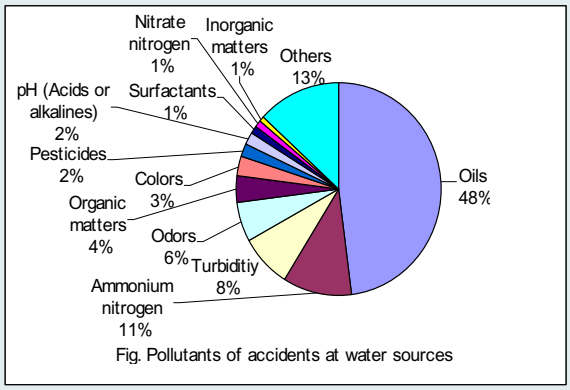


Fig. Pollutants of accidents at water sources

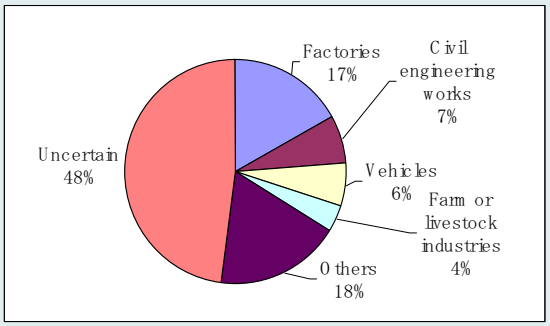


Fig. Source of pollution in accidents at water sources

Measures taken by the Ministry of Health, Labour and Welfare

- The "Basic Guideline for Health Crisis and Consequence Management"
  - Pharmaceutical products
  - Food poisoning
  - Infectious diseases
  - Drinking water

The "Guideline for Health Crisis and Consequences Management for Drinking Water"

- Information collection schemes
- Decision-making in the actions to be taken
- Investigation by study groups and councils
- Provision of information to concerned parties such as prefectural governments and water suppliers

The "Manuals for Establishing the Operations Plan on Water Contamination Emergencies"

- Examples of possible water quality pollution accidents
- Measures for early detection
- Methods to accurately judge the situation and what immediate actions should be taken
- Collection and notification of information
- Organizational schemes
- Notification to the local residents
- Education, and training of employees

Measures for early detection of possible accidents

- Enforcement of monitoring at upstream areas of the water source
- Installation of automatic water quality monitoring systems (e.g. oil, turbidity, electrical conductivity, pH, ammonium ions, cyanide monitoring)
- Enforcement of cooperation among concerned parties through the organization of a council

Other measures by MHLW

- MHLW subsidizes for the public water suppliers' installation of monitoring facilities at the water source areas.
- MHLW makes efforts to raise awareness preparation for accidents.

  (e.g. introducing actual cases of accidents through the Internet etc.)

Measures taken by water suppliers

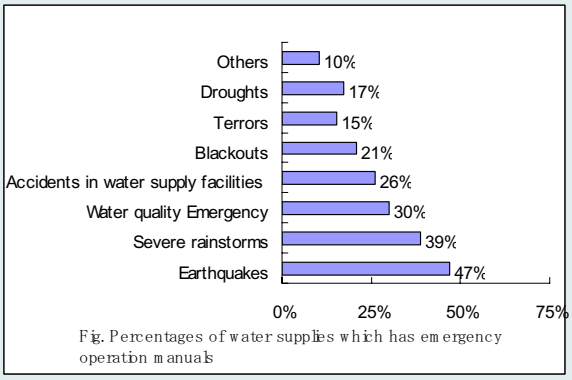


Fig. Percentages of water supplies which has emergency operation manuals

Establishing emergency response system

Scale of water supply (population served)	Emergency response system in water supplies		Emergency response system with other administrative bodies etc.	
	Established or establishing(%	Not-established or etc.(%	Established or establishing(%	Not-established or etc.(%
1,000,000 -	100%	0%	100%	0%
500,000-1,000,000	90%	10%	90%	10%
250,000-500,000	100%	0%	94%	6%
100,000-250,000	100%	0%	95%	5%
50,000-100,000	99%	1%	79%	21%
5,000-50,000	90%	10%	72%	28%
- 5,000	92%	8%	73%	27%
Total	86%	14%	78%	22%

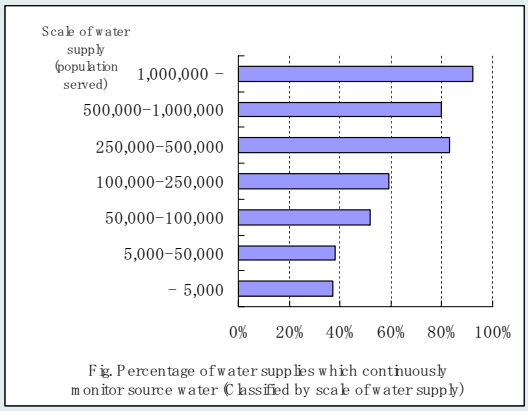


Fig. Percentage of water supplies which continuously monitor source water (Classified by scale of water supply)

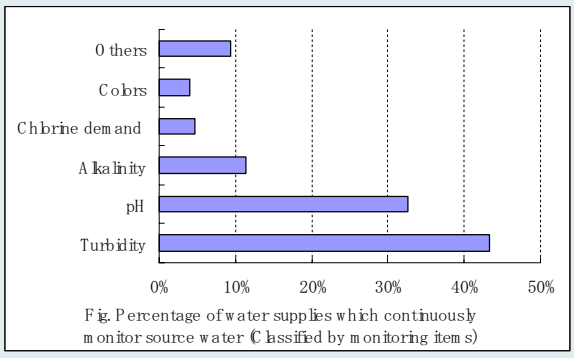


Fig. Percentage of water supplies which continuously monitor source water (Classified by monitoring items)

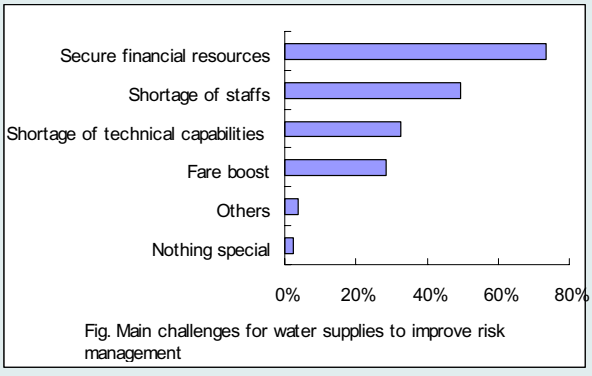


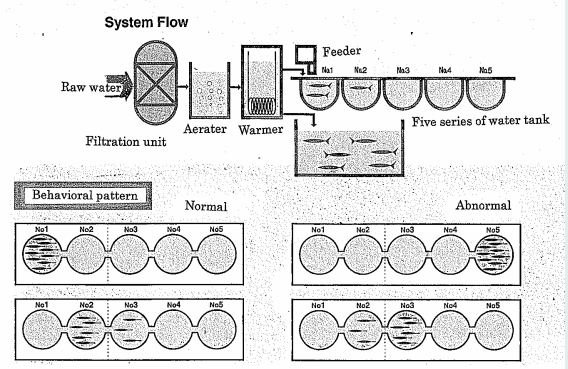
Fig. Main challenges for water supplies to improve risk management

Example of Department of Waterworks of Osaka Prefecture

- Osaka Pref. is heart of Kinki Metropolitan Area, the second largest metropolis following the Tokyo metropolis.

- The Osaka Pref. Gov. Dep. of Waterworks is a bulk water supplier, which supplies purified water to many municipalities other than the City of Osaka.
- The Department of Waterworks carries out
  1. Fish-bioassay named “Carp sensor ”
  2. Continuous raw water VOC monitoring at water intake facilities
- The Department of Waterworks monitors raw water (Yodogawa River) Effectively, by collaborating other water suppliers in the prefecture

“Carp sensor”



“Continuous source water quality monitoring systems”

- They consist of an automatic water sampling system, gas chromatograph and other accessory equipments.

Table List of items to be measured by continuous raw water quality monitoring system of the Waterworks department of Osaka prefecture

	Component to be measured		
Drinking water quality standard items	Trichloroethylene	cis-1,2-Dichloroethylene	Bromodichlormethane
	Tetrachloroethylene	Dichloromethane	Dibromochlormethane
	Carbon tetrachloride	Benzene	Bromoform
	1,1-Dichloroethylene	Chloroform	
Other items	1,2-Dichloroethane	trans-1,2-Dichloroethylene	o-Xylene
	1,1,1-Trichloroethane	cis-1,3-Dichloropropene	m-Xylene
	1,1,2-Trichloroethane	trans-1,3-Dichloropropene	p-Xylene
	1,2-Dichloropropane	Toluene	p-Dichlorobenzene

Initial and O&M costs of the systems

- Carp sensor
  - Initial cost 60million JPY
  - O&M cost 600,000 JPY/year
- Continuous raw water quality monitoring systems
  - Initial cost 43million JPY
  - O&M cost 700,000 JPY/year

Wide-area water resource quality monitoring in Yodo River

- Osaka Pref. Gov. Dep. of Waterworks and the nine other public water suppliers in Osaka prefecture, which intake source water from the Yodogawa River, organize “The Yodo River Water Quality Consultative Committee”, and monitor source water effectively.

“The Yodo River Water Quality Consultative Committee”

- Monitoring raw water effectively
- Other activities
  - ・ Investigation & Research
  - ・ Holding study meeting on water issues
  - ・ Demanding pollution control measures to competent authorities
  - ・ Establishing the emergency information network system etc.

Example of Waterworks Bureau of Sapporo City

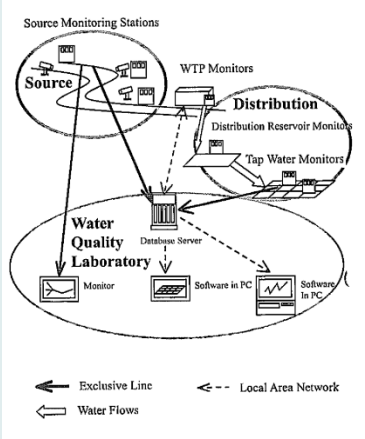
The Waterworks Bureau of Sapporo City has established the “Real Time Water Quality Monitoring System”

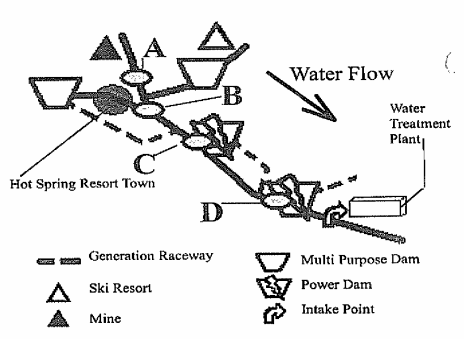
"Real Time Water Quality Monitoring System"

- The system monitors the quality of the water throughout its course—from its source to the faucet at home—24 hours a day.
- Four monitoring stations in the water source are located along the Toyohira River
- Automatic tap water monitoring (residual chlorine and temperature etc.) at 19 points

"Real Time Water Quality Monitoring System"

(Sasaki,Motoi,Sado,Taguchi)





Monitoring points in water source area

(Sasaki,Motoi,Sado,Taguchi)

Table Monitoring sites and items in water sources of Sapporo city

Name of site	Distance from the intake	Items	
1 Shirataki Bridge	14.0km	·Electric Conductivity	·Turbidity
2 Ichinosawa	10.4km	·Monitoring Camera	
3 Toyama Dam	6.7km	·Electric Conductivity	·Monitoring Camera
		·Turbidity	·Fish- bioassay
		·pH	
4 Moiwa Dam	0.8km	·Electric Conductivity	·Chloride ion
		·Turbidity	·Oil
		·pH	·Monitoring Camera
		·Ammonium nitrogen	·Fish- bioassay

Initial and O&M costs of the system

- Initial cost one billion JPY
- O&M cost 44 million JPY/year
  (It equivalents to about 0.1% of gross expenditure of the Waterworks Bureau)

WB of Sapporo's other effort to collect data of upstream of the intake

- The water quality of the Toyohira River at the water intake point is substantially influenced by the amount of water discharged from the four dams
- Therefore WB of Sapporo receives data in a continuous manner from its administrator.
- It is used for efficient maintenance and management

Effects of "Real Time Water Quality Monitoring System"

- The system has enabled the plants to find accidents earlier, and to take proper actions promptly.
- It has also decreased stress on the plant operators by giving the information taken from upstream
- It is useful for the plant operation even in the case of no accidents in water source

Conclusion

- Building the monitoring systems, in cooperation with various concerned parties, is important.
- Automatic monitoring systems have reportedly reduced the level of stress on many workers in water purification plants.
- Promoting the small and middle scale suppliers' efforts is important.
- The MHLW will continue to support public water suppliers etc. for the installation of water quality monitoring systems, research activities for the improvement and development of technologies.