Risk Assessment and Management of Water Supply Business

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1. Introduction

The water supply coverage ratio in Japan is as high as 97 percent, which means that effectively all citizens have convenient access to hygienically problem-free running water, at any time, anywhere, and without restrictions on quantity. A steady supply of piped water is important not only in the daily lives of citizens, but it also has many other implications. It is significant for the maintenance and improvement of public hygiene and plays a fundamental role in sustaining the fabric of society. If the water supply were interrupted, the adverse effect on society would be drastic. Such an occurrence, therefore, must be prevented at all measures. In particular, water suppliers serving a population of 50,000 or more, making up about 80 percent of the annual water supply, would be severely affected because only few of citizens can access to alternative sources of water. In the case of large cities such as Tokyo, a disturbance in the water supply would also affect areas such as the supply of cooling water for large-capacity computing installations. It would lead to a disruption of financial services and public transport, as well as stoppages in industries and services due to lack of industrial water. Furthermore, living conditions would suffer and the supply of fresh foodstuff would be affected. In short, a severe disruption of ordinary life would result.

The Water Works Law proscribes that in the event the water supplier recognizes that water being supplied may be a risk to human health, the supply must be stopped immediately, and measures must be taken to fully inform all concerned parties of the fact that using the supplied water can be dangerous. The law defines water quality standards and requires the supplier to monitor the presence of chemical substances and possible health risks based on such standards, and to stop the supply according to these criteria. By implementing a thorough risk management system, the supplier must prevent the occurrence of stoppages in the water system. Measures must also be taken to deal with situations where water stoppages occur due to external factors that are beyond the control of the water supplier, such as natural disasters including earthquakes, wind and flood damage, drought, or wide-area power outages. In the event of such stoppages due to non-predictable factors, the focus will be on how quickly the water supply can be restored in order to maintain the requested level of the water services.

Water supplier risks include not only physical aspects such as water supply stoppage, but also aspects that pertain to the sustainability of water services. This includes situations where the principle of full-cost pricing can no longer be adhered to, making the goal of financial self-sufficiency unattainable and leading to a lack of funds for day-to-day operations as well as for facility upgrades and maintenance. Where water supply facilities are managed jointly with companies from the private sector, responsibilities for risk management are often not clearly defined, which can lead to a degradation of water services that in turn makes customers less willing to pay their water bills.

For the reasons outlined above, we will look at risk management under three aspects: human health related risks, disaster related risks and management related risks.

2. Risk Management of Water Quality Requirements

In August 1996, an outbreak of waterborne cryptosporidiosis occurred in Ogose Town, Saitama Prefecture. Out of a population of 13,000, about 9000 residents were infected, and the water supply was stopped. This was the largest mass incident of drinking water related gastrointestinal infection so far encountered in Japan. The fact that a sewage treatment plant with a discharge outlet had been constructed upstream of the intake point for the water supply was cited as a possible reason. A more direct cause can be seen in the fact that even after the discharge outlet of the sewage treatment plant became active, operation management of the water works purification plant, in particular procedures for coagulation, flocculation and filtration management were not adjusted to reduce the existing emergent risks.

In order to prevent a future occurrence of incidents such as the mass *cryptosporidium* infection at Ogose, in the same year the Ministry of Health, Labour and Welfare issued a provisional guideline for *cryptosporidium* control in drinking water. According to this guideline, if a sewage treatment facility, livestock breeding facility or other possible cryptosporidium source exists in the drinking water source area, and when coliform bacteria and anaerobic spore forming bacteria are detected in the source water, the risk of *cryptosporidium* contamination in the tap water is to be assumed and filtering or other proper measures must be immediately implemented to reduce the risk. In addition, the filtered water must be managed to keep turbidity less than 0.1 units. Accordingly, filter installations were improved or newly constructed at a rapid pace, and membrane filtration techniques were also put into place. No actual outbreak of cryptosporidium infection has occurred since, but *cryptosporidium* detection in drinking water has in fact led to water supply stoppage in a total of 17 cases.

Although the provisional guideline for *cryptosporidium* control as mentioned above was issued in 1996, the number of water suppliers that have implemented measures based on that guideline amounts to approximately 55 percent, as shown in Table 1. In other words, many water works still do not have appropriate systems in place. One of the reasons for this is to be found in financial limitations. The Ministry of Health, Labour and Welfare therefore has renewed the guideline in 2006 and has recognized the ultra-violet irradiation as a cryptosporidium control measure for water

Table-1 The enhancement of water purification plant for risk management of *Cryptosporidium*

	Public water supply	Small public water supply	Bulk water supply	Others	Total
Total No. of WPP	1679	3296	158	347	5480
No. of measured WPP	1147	1596	155	178	3076
No. of non-measured WPP	532	1700	3	169	2404
Population served[1)]	4011	944	-	49	5005

works with sources other than surface water. This was done in order to promote the implementation of anti-cryptosporidium measures. Whether by filtration or by ultra-violet irradiation, the required efficiency of *cryptosporidium* inactivation is assumed to be 3log.

The number of water suppliers that had to stop water intake due to oil spillage or other unpredictable events in the water source area, or that had to take measures to strengthen the water purification process such as powdered activated carbon application, or that had to temporarily stop the water supply amounts to about 80 - 100 per year, as shown in Figure 1. This represents some 0.5 percent of the total number of water supplier. Frequent causes are oil or organic matter contamination, as well as increased turbidity due to sediment discharge from civil engineering works. Because most rivers in Japan have a rapid water flow, there is often not enough time to stop the water supply before contaminants emerge from the intake area. The capacity of valves and other water discharge facilities designed to discharge contaminated water from the system after they have been transported downstream is often too low. Maintaining water quality in the drinking water source area is the most effective approach, not only with regard to accidents such as chemical spills but also for disinfection byproduct precursors, odor-inducing substances, agricultural fertilizers, etc. Close coordination with water environment administration authorities and water source area management authorities is therefore necessary.

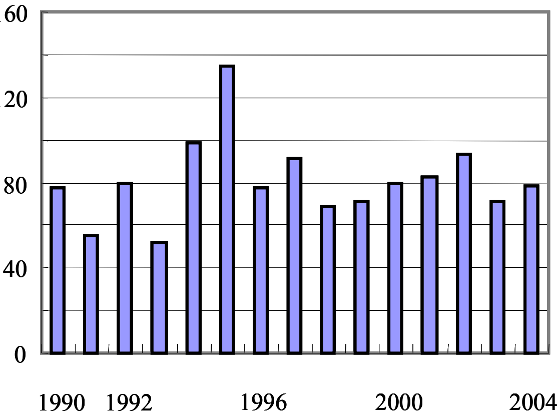

Figure -1 No. of accidental spills in the catchments area

Water stoppages are necessitated on occasion not only by contamination or accidents in the water source area but also by a failure of taking appropriate risk management measures within the water works system. In one example, painting inside a purification plant was done using solvents containing methylene chloride. The sublimated methylene chloride was dissolved again on the water surface of the sedimentation and filtration basins, which led to an unacceptable level of methylene chloride being detected in the drinking water, requiring a water stoppage. In other instances where sodium hypochlorite was used for disinfection purposes, bromate impurities in sodium hypochlorite created by on-site salt electrolyzation exceeded the permissible standard in water works with high chlorine injection rates, and water had to be stopped briefly until substitute sodium hypochlorite could be purchased.

3. Disaster Risk Management

Japan is a country where natural disasters such as typhoons and earthquakes occur with a high frequency. Consequently, there are regulations that require the structure of water works facilities to be able to withstand the influence of such disasters. However, it is usually not possible to fully preclude any disaster related damage. To reduce the risk of such damage, it is therefore necessary to have measures in place that are aimed at the quick restoration of services in the event of a disaster.

The damage status due to natural disasters is shown in Figure 2. As can be seen, damage occurs every year, and about 12 billion yen in government subsidies was needed in the period from 2000 to 2005. Vast sums are spent for restoring facilities, and water stoppages or restrictions are frequent. This of course affects not only the daily lives of citizens but also causes economic damage through the impact on socio-economic activities.

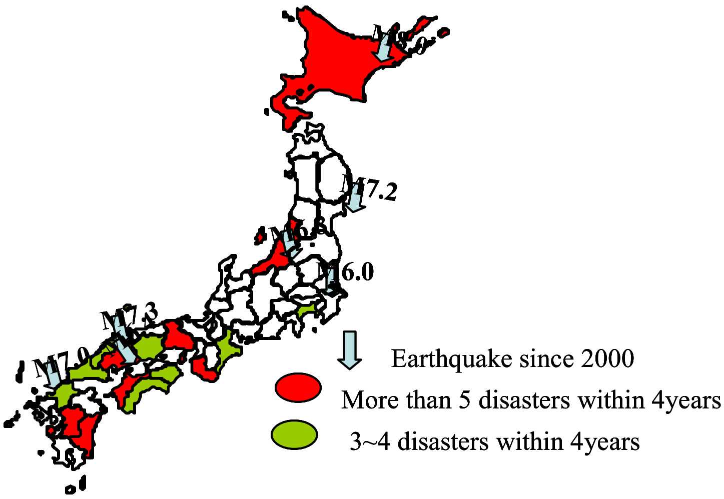

Figure 2 Earthquakes and disasters in recent years

Damage due to typhoons and localized torrential rains is listed in Table 2. Each year water facilities in about 10 areas are affected, with about 100,000 people nationwide experiencing water stoppages of 30 to 100 days duration. Road collapses causing pipeline rupture are a frequent cause, followed by lightning strikes and power outages that interrupt operations. Damage due to internal problems at water facilities such as operation stops because of an abnormal rise in intake water turbidity is relatively infrequent. However, collapses or cave-ins of roads and road shoulders often occur in locations where this can be predicted. Although these are counted under damage by natural disasters, it should be possible to reduce this kind of damage by fortifying such sections and taking other preventive measures.

In 1995, the Great Hanshin-Awaji Earthquake struck an area inhabited by 20 million people, causing 5,000 deaths and leading to water stoppages of up to nine weeks for 900,000 people. The costs for repairs to water facilities amounted to some 600 billion yen. This caused the Ministry of Health, Labour and Welfare to formulate a plan for the fortification of anti-earthquake measures by water suppliers, and the implementation of these measures is being systematically promoted. Using the prognosis of a large-scale earthquake in an area where about 30 percent of the Japanese

Table -2 Damage of water supply utilities by Typhoons and Heavy Storms

Year	2003	2004	2005	2006
No. of disaster	4	10	13	13
Population affected	59,079	168,057	137,368	7,1089
Total days of stoppage/year	—	99	72	35

Table-3 Damage of water supply utilities by earthquakes

	A	B	C	D
Date	2000,10,6	2001.3.24	2003.9.26	2004.10.23
Magnitude	M7.3	M6.4	M8	M6.8
Seismic intensity	More 6	Less 6	Less 6	7
Damage[1)]	M.P.260, S.P.612	MP213,Wreck of facilities	MP58,Wreck of facilities	MP 806, Wreck of many facilities
No. of house	150	40,269	15887	129,750
Length	5 days	4 days	8 days	25days
Cost for recover[2)]	20	21	26	650

	E	F	G
Date	2005.3.20	2006.7.23	2006.8.16
Magnitude	M7.0	M6.0	M7.2
Seismic intensity	Less 6	More 5	Less 6
Damage [1)]	MP31,SP101 800mm pipe in plant	MP2	MP37,Wreck of facilities
No. of house	None	430	40
Length	Few days/ 2months for plant	4 hours	3 days
Cost for recovery [2)]	18	-	7

MP: Transmission /Distribution pipe, SP: Service pipe
2)Million yen

population lives, the Japanese government is calling for the strengthening of earthquake-resistant design in important civil infrastructure sectors including water supply facilities.

An outline of earthquake related damage since 1995 is given in Table 3. Every year, somewhere in Japan there is damage from seismic activity. Increasingly, water facilities are being quake-proofed according to governmental policy. In the event of an earthquake measuring intensity 5 on the Japanese scale, severe damage can be expected for asbestos cement pipes, PVC pipes, and similar non-quake-resistant pipes. When the intensity exceeds 6, water supply trunk pipes will also suffer damage, as will water treatment plants, water supply reservoirs, and other structural facilities. The damage and the costs for restoration therefore can be expected to increase dramatically. Revisions of building standards in 1977 and 1988 have improved the earthquake proofing levels of reinforced concrete structures. Piping facilities also have come to be designed along similar principles, which is why structures and piping constructed in recent years are showing better resistance to earthquake related damage. However, it is desirable that earthquake proofing and updating of older facilities should also be carried out.

Out of the 506 water suppliers serving communities with over 50,000 inhabitants, about 80 percent have implemented earthquake proofing measures in accordance with the government policy. However, among water suppliers serving communities with over 10,000 inhabitants, this figure drops to only 25 percent. On a national average, the implementation of earthquake proofing stands at 20 percent for

Table – 4 Performance Index relating the anti-seismic measures

	A	B	C	D	E	F	G	H	I	J	K	L	M
Earthquake-resistant treatment facility (%)	-	0	18.6	0	-	60.9	0	0	35.8	0	0	21.9	-
Earthquake-resistant pumping station (%)	72.3	59.3	26.7	30.5	-	53.1	17.6	0	15.7	0.3	0	-	0.7
Earthquake-resistant service reservoir (%)	20.9	12.7	30.2	24.2	34.8	87.3	16.0	0.3	19.6	34.4	67.6	-	9.6
Earthquake-resistant pipeline (%)	16.8	7.1	11.0	9.1	23.0	21.5	3.9	0.1	1.7	1.3	11.6	17.4	7.5
Chemicals stock (day)	24.1	32.0	51.9	27.7	19.8	-	32.4	19.1	35.4	23.9	60.6	30.2	29.7
Fuel stock (day)	1.1	2.7	0.7	0.15	0.6	0.8	1.6	0	0.38	0.7	0	0	0
Non-utility generation facility (%)	54.3	32.9	91.3	100	72.4	100	88.0	61.5	66.7	42.9	-	78.4	55.1

water purification plants, 30 percent for water supply reservoirs, and 14 percent for piping facilities.

The Water Supply Business Guideline issued by the Japan Water Works Association specifies various performance indicators. The rating of 10 major water suppliers regarding earthquake proofing indicators is given in Table 4. Regarding in-house power generating capability and stockpiling of chemicals, which are indicators related with earthquake safety and disaster risk management, there is a considerable difference among water suppliers. In particular, the level of earthquake proofing of water purification plants and pumping stations is very uneven, and there are many water suppliers whose installations do not meet modern quake resistance reinforcement standards. For piping facilities, earthquake proofing by using ductile cast iron pipes with quake resistant joints, steel pipes with welded joints, ductile cast iron pipes with mechanical joints, polyethylene pipes with fused joints, or similar pipes is recommended. However, the upgrading of older cast iron pipes or asbestos cement pipes without quake resistance is not progressing at a great pace. For example, since 1990 there has been a government subsidy plan for upgrading asbestos cement pipes. Consequently, this has progressed as shown in Figure 3, but in 2004, there were still about 16,000 km of such pipes in existence. The cost for upgrading these is estimated at 450 billion yen, which is why progress in this area is slow especially in the case of water suppliers whose financial condition is poor.

Because the overall earthquake proofing progress is slow, point measures are being taken to secure the water supply to critical facilities such as hospitals that will act as medical bases in case of disasters. Pipes are being replaced by quake-proof types, and some businesses also have taken other measures such as locating emergency underground water supply tanks in

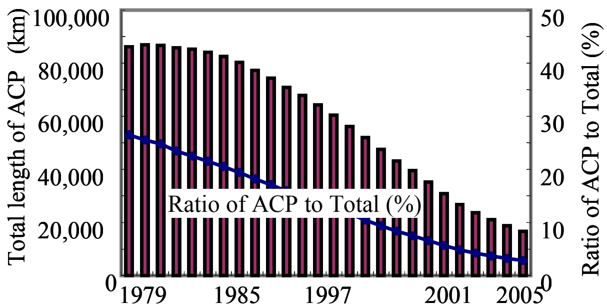

Figure 4 Replacement of ACP

nearby parks, etc.. The biggest risk facing Japanese water suppliers is earthquakes. While consumers are aware of this fact, the crisis awareness of the general populace has not reached a level where an increase in water rates in order to cover the costs for adequate risk management could be easily tolerated.

4. Business Operation Risks Management

Japanese water works are local public enterprises run in effect by local governments, under the management of water works administrators. These represent the local government and operate largely independently, except for making budget adjustments, submitting measures to local councils, having their books examined by audit commissioners, obtaining council approval, and imposing fines. In this sense, the water works are public enterprises whose business accountability is effectively self-supporting.

Normally, water rates are determined according to the multiple costing principle. As seen on a national basis, income from water rates in the year 2004 accounted for about 90 percent of the gross income of water works, which means that self-sustenance is largely achieved. However, 358 water suppliers were posting a net loss, and 383 businesses had carryover losses. The highest items on the outgoing side were costs for construction and renovation of 1.128 billion yen, and debt repayments of 720.3 billion yen. Funds were obtained from corporate bonds, other account funds, government and other subsidies as well as accumulated reserves. The effective shortage in financial sourcing amounted to 1.32 billion yen. On the national level and in the short term, business operations of water works therefore can be seen as largely functional, but in the long term, lack of financial resources is likely to affect the upgrading of facilities. This in turn leads to social problems such as the possibility of a degradation of water services due to aging facilities, and the need for steep rises in water rates. The total debt load of national and local government is on the order of 800 trillion yen, which necessarily makes it increasingly difficult for water works to obtain funding and subsidies from other accounts. Implementing risk management principles in the business operations of water works therefore is becoming ever more important.

Under this viewpoint, the Ministry of Health, Labour and Welfare publicized its "Water Works Vision" in 2004, and analyzed the current situation as follows: (1) Many water works have a weak business operation basis. (2) Management of operations is therefore also not fully developed. (3) Technical response to citizens' demands with regard to water services has run out of options. (4) Necessary investments are being put off.

For example, as shown in Figure 5, the drop in the amount of supplied water and the corresponding drop in income from water rates is especially pronounced in the case of small and medium size water works serving areas where the demographics are changing due to aging and depopulation. Lower birth rates and aging are expected to lead to lower population numbers in general, with a figure of 100 million instead of today's 125 million being predicted for 2050. The employment situation at water works is also expected to change, as shown in Figure 6, with about 35 percent of the personnel retiring over the next 15 years. Daily operations may well be affected by the much lower number of employees that is to be expected.

With regard to facilities, piping accounts for some 70 percent of water works assets. Figure 7 shows that from year to year, there is a steady increase in piping facilities that exceed their statutory useful life of 40 - 60 years. As the revenue from water bills falls, fewer funds are available for the upgrading of equipment and facilities, and as the necessary minimum is not being met, the result is obsolete and aging equipment. Eventually, failures will occur that will impact the stability of water services.

Many social infrastructure services including water suppliers operate according to a management principle that can be called “incrementalism”. This is based on the assumption that both the income from water bills as well as the number of personnel will increase every year, and operations can be conducted simply by allocating these increased resources. Proper stock verification is not carried out, while attempting to maximize water services under the assumption that past allocations of increased resources have been appropriate. However, now that decreasing revenue because of a drop in population numbers and in the amount of supplied water have become an unavoidable trend, the efficiency of past allocations must be carefully examined and new structures for allocating funds and manpower must be established. In other words, a change towards "decrementalism" is necessary. Services should still be maximized, but this must be done while revising the old allocation structure and keeping budget restraints as well as shrinking revenue in mind.

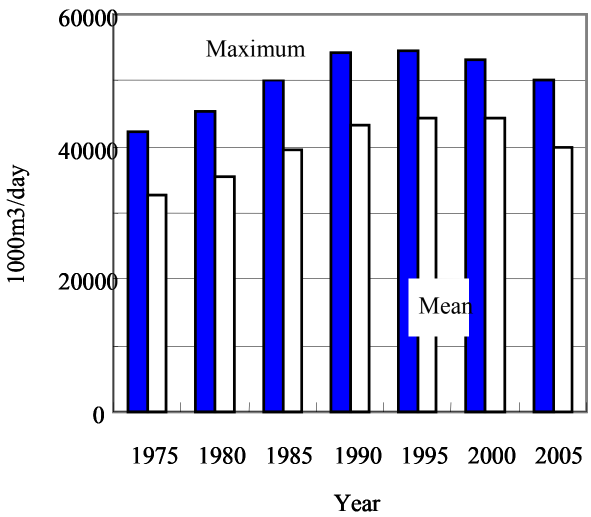

Figure 5 Trends of water supply demands

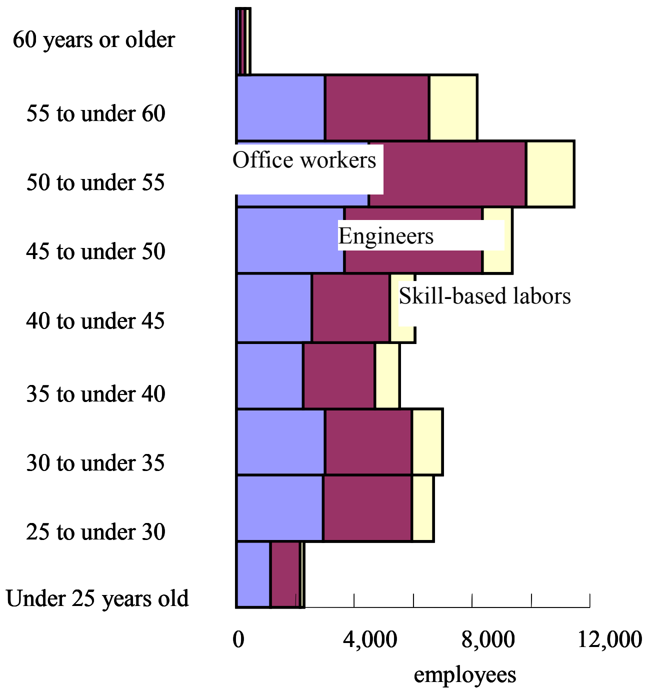

Figure 6 Age distribution of employee

Of course, this means that efficiency must be a priority, but it is even more important to uncover and eliminate hidden inefficiencies. This in turn can be done most successfully by adopting private-sector management policies, i.e. by managing water works according to the mechanisms of the market. Advantages to be expected from this approach are as follows: (1) Provide efficient water services to the public. (2) Promote cost awareness and the desire to devise and implement improvements. (3) Overcome the high cost concept. (4) Consolidate and integrate operations, implement downsizing of facilities, and realize the sustainability of the water supply business.

Because water works are public enterprises run by the local administration, required funds for upgrading facilities and other activities can come from raising water rates and pursuing the merits of scale by water works integration. Small-scale improvements aimed at allowing existing facilities to be used on a long-term basis can help to control the need for large-scale investments and reduce outgoings by cutting down on the interest burden and depreciation costs. However, it is doubtful whether water works that for a long time have been accustomed to the decision making patterns of local and central government will be able to successfully make the switch to private sector type management based on market mechanisms. In this respect, cooperation between public water works and private-sectors seems a more promising approach that should allow the deliberate adoption of private-sector methods.

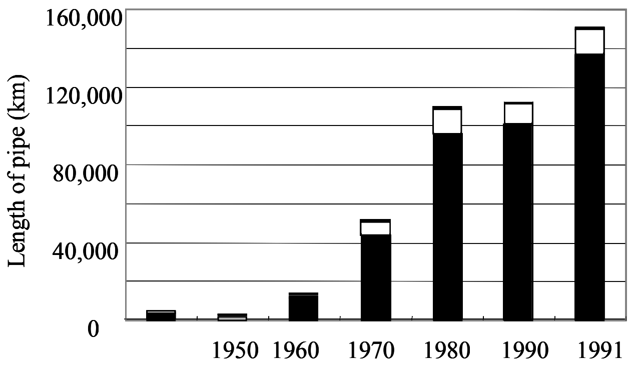

Figure 7 Distribution of aged pipes

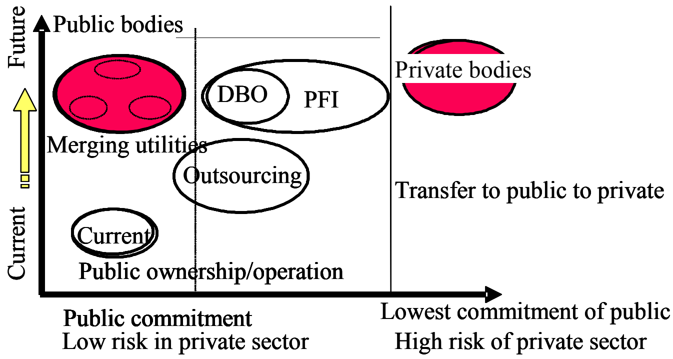

Figure 8 Type of Public and Private Partnership

Reflecting such environments, revisions of the Water Works Law and the promulgation of the PFI Law have made possible outsourcing to third-party suppliers. At the same time, local governance regulations have been revised to introduce a system of designated administrators for public facilities, and a law allowing the creation of independent administrative corporations has been enacted. These and a number of other regulatory changes have enabled a much more varied interaction between water works and public-sector companies. As shown in Figure 8, such interaction can take various forms, each with different characteristics. How to select an optimum pattern is an important question that must be approached from various angles, taking the service needs and expectations of customers into consideration. Since water works are providers of a public utility, proper risk management allocation between the public and the private sector is mandatory. In this regard, it must be acknowledged that in addition to the traditional stakeholders of a public venture, the investors that effectively enable operation of private-sector companies by providing funds will have to be included in the equation.

If a private-sector company is to partially or wholly provide a public-interest service, a highly developed management structure capable of managing any involved risks is necessary. A principle often adopted in joint undertakings between the public and private sector is that risks should not be borne by a party that is not able to take responsibility. In other words, a party that is capable of taking the responsibility for risks must be found and defined. Rather than information about current cost structures and management principles, a private-sector enterprise looking to enter into a

Table-5 Component of manual of audit to water supplier

	Safety	Stability	Sustainability	Management	Environment
Satisfaction of customer	●	●	○	●	○
Capability of facilities	○	●	●	●	○
Competence of Employee	●	○	●	●	○
Appraisal of asset	○	○	●	●	●
B/S assessment	●	○	●	●	○

public-private relationship will need information about the size of possible risks during the intended contract period. This includes data about facility performance and aging status, available manpower resources, type and reliability of compiled management data, accident and failure history, amount and causes of payment arrears, history of warnings or infringements against legal regulations, limitations at the end of operations, and involvement and support by the local administration. In particular, if facilities are to be upgraded with funds raised on the open market, investors will require exact information about the size of possible risks.

In order to assure sustainability, the water works business model will need to be revised from the ground up, including the aspect of joint operations between the public and the private sector. It is necessary to fully examine what management style can be adopted in order to properly manage the water supply business based on the situation in each area from both the managerial and technical perspectives. In order to involve the private sector, it is necessary to evaluate objectively whether business operations carried out by the private sector can achieve its goals, and obtain the agreement of customers.

Therefore, it is also necessary to develop a third party audit system that includes an evaluation of the recommendation for better performance, including the sustainability, of water services. Although the water supply service level is characterized by a sociological, cultural, economical, natural and environmental background, the minimum service level should be able to fulfill the human dignity right in the 25th article of the Japanese government constituent, that is regulated by the Water Works Law. Therefore, the audit system should be composed from the basic point such as protecting public health to the sophisticated point such as aesthetic satisfaction of the water services. And the implementation of the audit to each water service business should be done by a type of de facto standard so as to publish the evaluation and the recommendation as an effective tool to develop consumers' agreements of the stakeholders with its water service business. The audit of the water supplier will be implemented from the view points of safety, stability, management and environment in order to evaluate the satisfaction of customers, capability of facilities, competence of employees, and appraisal of asset and balance sheet assessment, as shown in Table-5. The ISO/TC224, that will be ISO/WD24512, and the Water Supply Business Guidelines issued by the Japan Water Works Association in 2005 will be referred in the manual, because they have been standardized in the performance index.

5.Conclusions

In recent years when most people have access to tap water, their main concern is whether the water supplied is safe to drink and easily available. However, according to the results of on-site inspections of water suppliers nationwide conducted by the Ministry of Health, Labor and Welfare, there are many cases where management of water supply system is inadequate. In addition, safe water is not yet available to all because of the deterioration in water quality at the source, loss of water quality at connecting points between the public water supply system and private water supply facilities such as the customer's water storage tanks and so on. Significant differences among areas are also present in terms of the availability of drinkable water; specifically, poor taste and odor, the presence of chlorine, color, and turbidity. In order to solve these problems, it is necessary not only to exercise strict control over water quality based on the Waterworks Law but also to implement the risk management from a wider point of view. In order to implement an appropriate risk management it is necessary to identify the goal of environmental management considering the social, natural and economical conditions.

Because of the huge demands of fund for the renovation of exiting facilities that will be terminated the service life, it is necessary to promote public private partnerships for sustainable service of water. In order to evaluate a risk of water utility management it is necessary to develop a de facto standard to audit the water supplier.

Various globalization movements have been visible recently in the water supply service, including progress in international standardization for water supply and sewage treatment systems in connection with ISO/TC224. Under these circumstances, we can advance international cooperation in water supply services and strengthen our competitiveness by promoting bilateral and multilateral exchanges and adopting an aggressive stance on globalization that will benefit to citizens

References

1. Ministry of health, labor and welfares. The Water Works Vision. June 2005
2. Japan Water Works Association. Water works management guideline. Oct 2005

Guidelines
for the management and assessment of a drinking water supply service

Japan-US Governmental conference
Bankoku Sinryoukan Okinawa ,2007

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Public Water Supply

- Continuous supply is the most important task for water supplier
  - None alternative water source
  - Civil and social activities dependent on water supplied by public water supply
- Risk
  - Water quality
  - Disaster
  - Management

Water Utility Management

- Onsite Inspection report :MHLW
- Inadequate management
- Water Quality Management at On-site of customer
- Risk communication with customer

Crypto. Risk management

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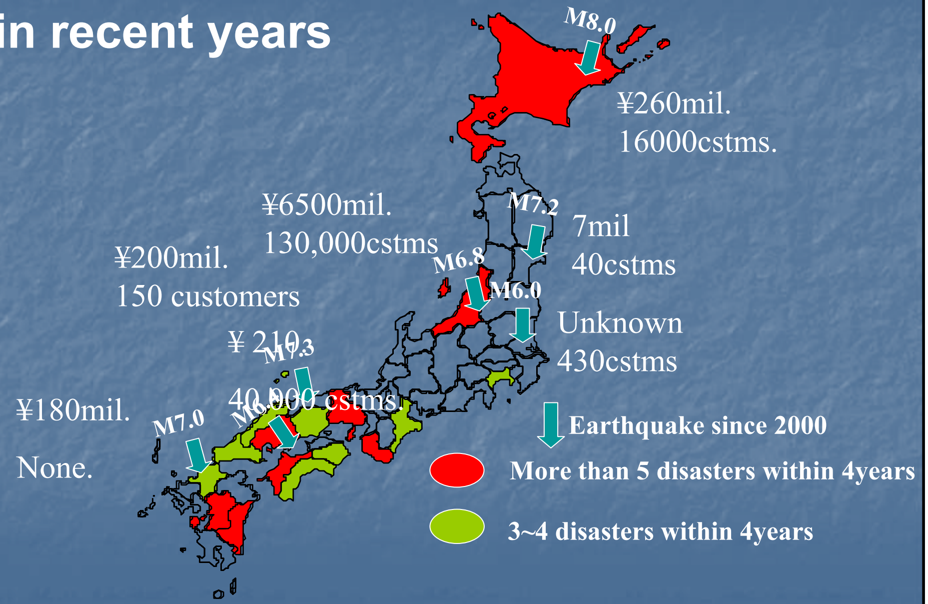
Earthquakes and disasters in recent years



Damage of water supply utilities by Typhoons and Heavy Storms

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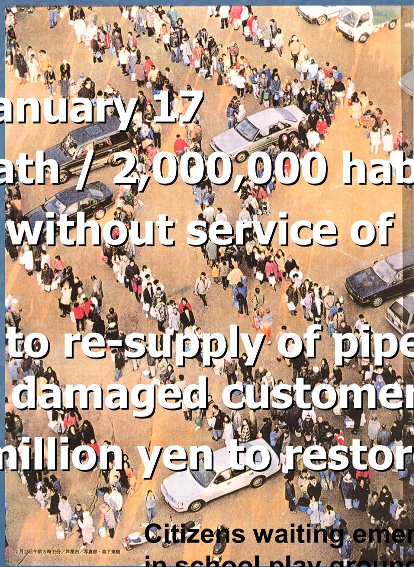
No. of disaster	4	10	13	13
Population affected	59,079	168,057	137,368	7,1089
Total days of stoppage/year	—	99	72	35

Great Hansin Earthquake

- **1995, January 17**
- **5000 death / 2,000,000 habitants**
- **891,000 without service of piped water**
- **9 weeks to re-supply of piped water to damaged customers**
- **60,000 million yen to restore the facilities**

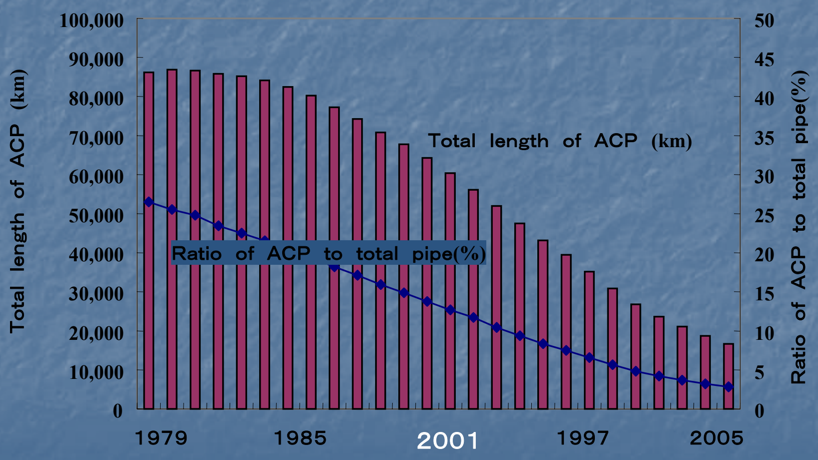


Citizens waiting emergent water supply in school play ground

The manual of anti-earthquake measures for water services (1996)

- Design standard of water supply facilities
  - Bench mark for physical strength of each unit facilities
- Guidelines for developing the anti-earthquake plan
- Guidelines for anti-earthquake construction practice

Replacement of ACP



Anti-earthquake

Main facilities:23%

Main pipelines:14%

Emergency Water Supply Plan :34%

Repairing work of distribution main pipe

Water supply business management

- local public enterprises run in effect by local governments
- water rates are determined according to the multiple costing principle
- The highest items on the outgoing side were costs for construction and renovation of 1128billion yen, and debt repayments of 720.3 billion yen .
- The effective shortage in financial sourcing amounted to 1.3 billion yen
- business operations of water works therefore can be seen as largely functional, but in the long term, lack of financial resources is likely to affect the upgrading of facilities.

"Water Works Vision"

(1) Many water works have a weak business operation basis.

(2) Management of operations is therefore also not fully developed.

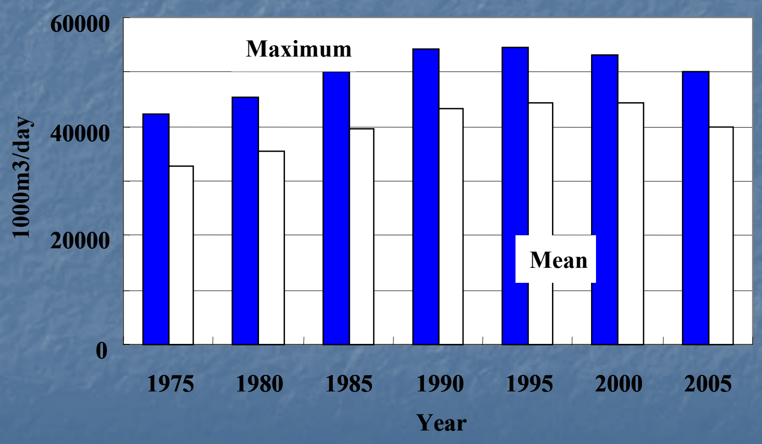
(3) Technical response to citizens' demands with regard to water services has run out of options.

(4) Necessary investments are being put off.

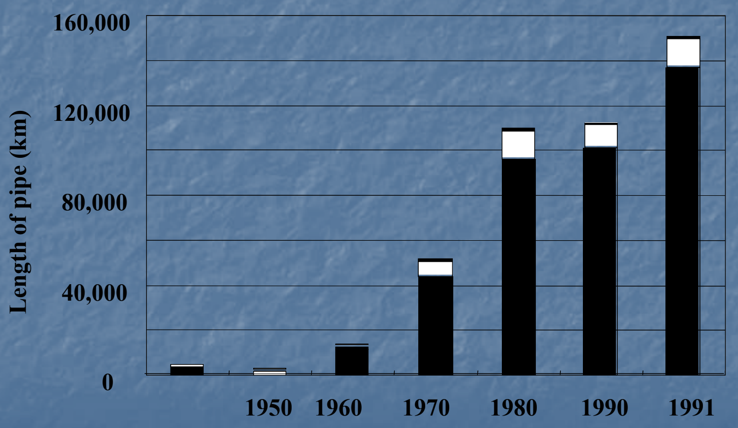
Corrections

- Page 7, 18lines 11.2 billion
  → 1.120billion
- Page 7. 21 lines 1.327 billion
  → 1.3 billion

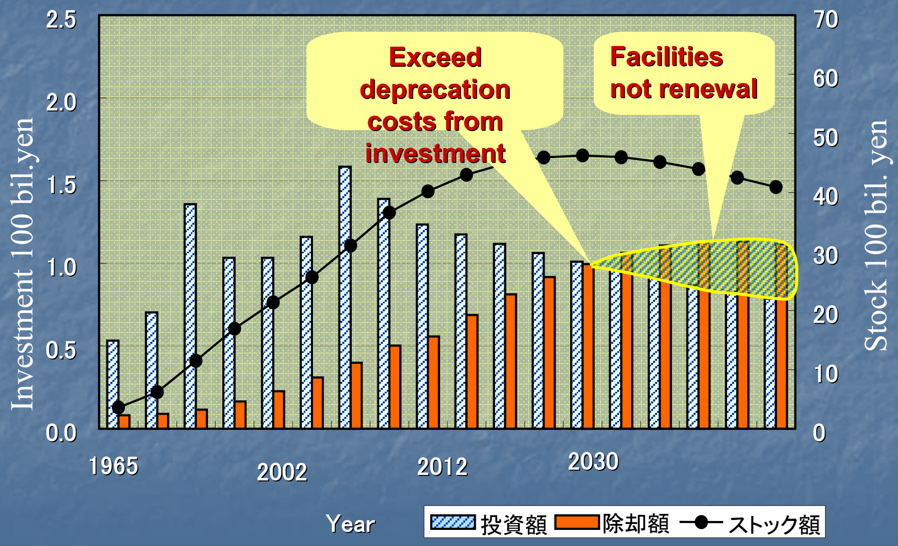
Trends of water supply demands

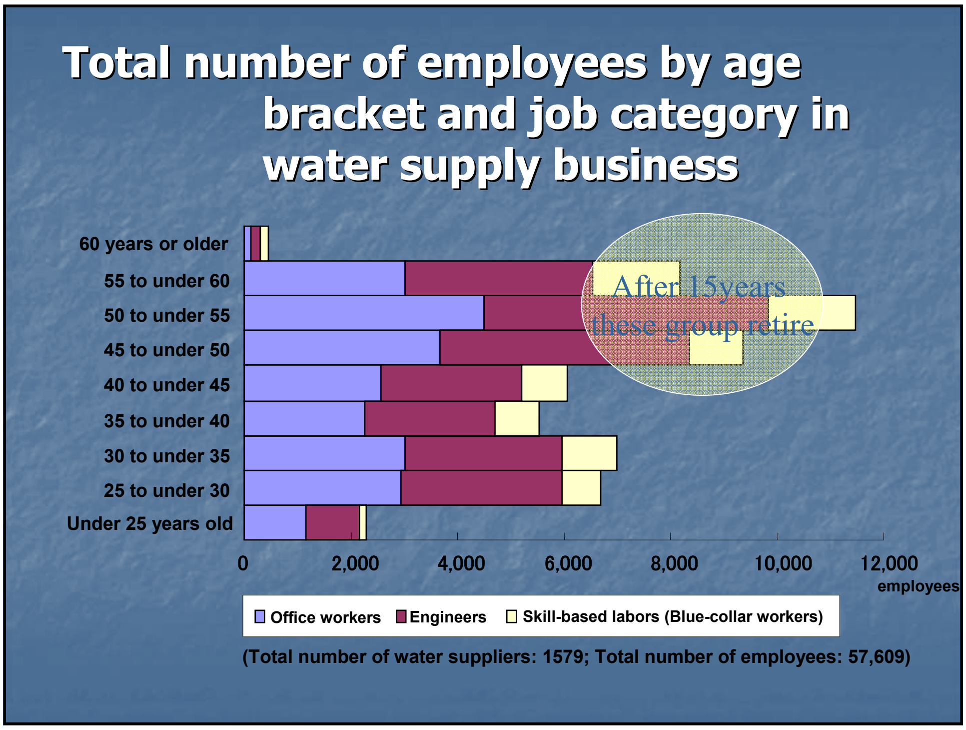


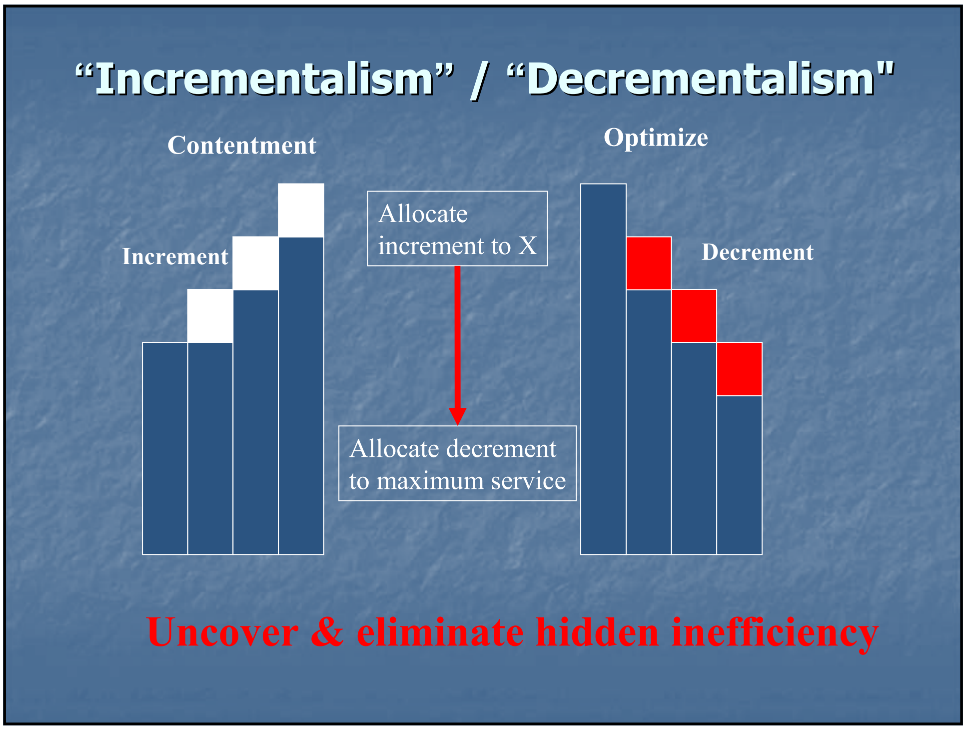
Distribution of aged pipes



Stock and Depreciation of water facilities




Total number of employees by age bracket and job category in water supply business
60 years or older
55 to under 60
50 to under 55
45 to under 50
40 to under 45
35 to under 40
30 to under 35
25 to under 30
Under 25 years old
0
2,000
4,000
6,000
8,000
10,000
12,000
employees
After 15years these group retire
Office workers
Engineers
Skill-based labors (Blue-collar workers)
(Total number of water suppliers: 1579; Total number of employees: 57,609)


"Incrementalism" / "Decrementalism"
Contentment
Optimize
Increment
Allocate increment to X
Decrement
Allocate decrement to maximum service
Uncover & eliminate hidden inefficiency

uncover and eliminate hidden inefficiencies

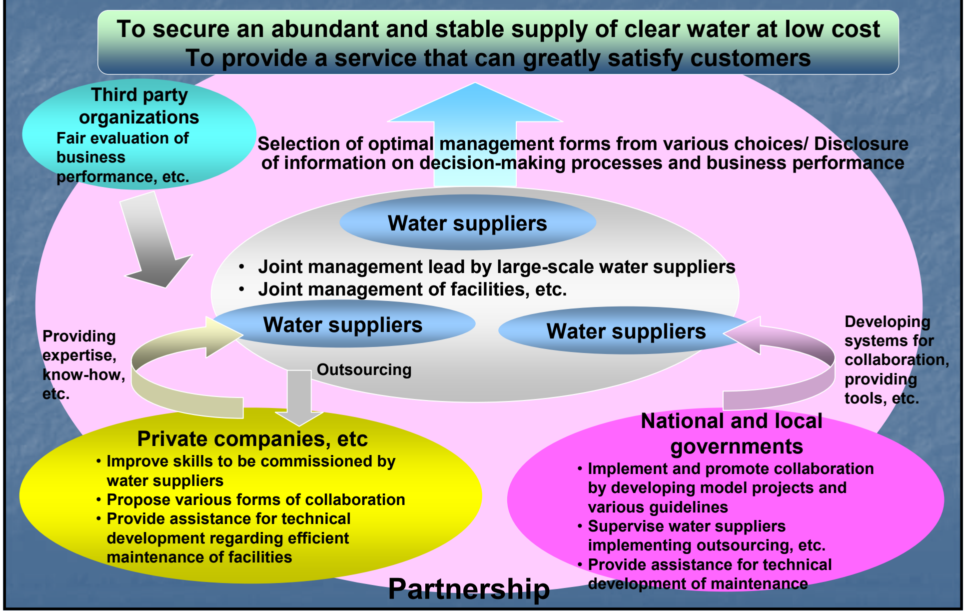
(1) Provide efficient water services to the public.

(2) Promote cost awareness and the desire to devise and implement improvements.

(3) Overcome the high cost concept.

(4) Consolidate and integrate operations, implement down-sizing of facilities

Optimal Management Using Various Forms of Collaboration



Guidelines for the management and assessment of a drinking water supply service (JWWA Q 100)

Safety	22
Stability	33
Sustainability	49
Environment	7
Management	24
Globalization	2

Safety of tap Water

PI	Definition	2001 (%)	2002 (%)	2003 (%)	2004 (%)
Compliance to DWQS	(No. of Exceeding / No. Test)x100	0	0	0	0
Compliance to Must odor	(2-MIB,Geosmin) /(DWQS)x100	67.5	67.5	62.5	100
Replacement of Pb pipes	(No. Pb Plumbing/No. connection)x100	13.0	10.3	7.7	5.8

Stability of Services

		2001 (%)	2002 (%)	2003 (%)	2004 (%)
Rehabilitation of aged pipe	Length of rehabilitated pipe/Total length	1.4	1.3	1.5	1.3
The accident of water source	No. of accident	18	26	7	6

Sustainability of water services

		2001	2002	2003	2004
Income per employees (yen)	(Income/employees/1000)	63723	65587	68841	71444
Ratio of owned capitals(%)	(Capitals+surplus)/Debt	59.7	61.4	62.8	64.8
Effectiveness of capitals(m3/10000yen)	Amount of supplied /Capitals	9.1	8.7	8.5	8.4
No. Claims	Claims/ customer	0.2 (‰)	4.6 (‰)	3.9 (‰)	1.0 (‰)

Environmental Governance

		2001	2002	2003	2004
Reuse of sludge	Reused sludge/Total sludge	50.4	53.8	66.0	68.4

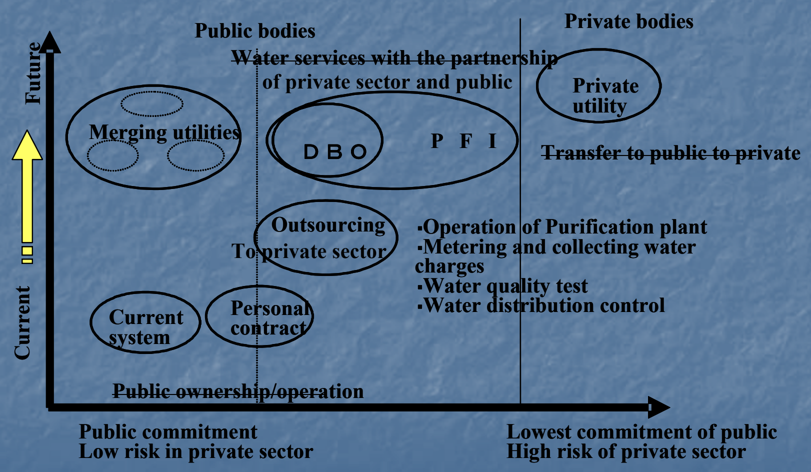
Performance Index relating the anti-seismic measures

	A	B	C	D	E	F	G	H	I	J	K	L	M
Earthquake-resistant treatment facility (%)	-	0	18.6	0	-	60.9	0	0	35.8	0	0	21.9	-
Earthquake-resistant pumping station (%)	72.3	59.3	26.7	30.5	-	53.1	17.6	0	15.7	0.3	0	-	0.7
Earthquake-resistant service reservoir (%)	20.9	12.7	30.2	24.2	34.8	87.3	16.0	0.3	19.6	34.4	67.6	-	9.6
Earthquake-resistant pipeline (%)	16.8	7.1	11.0	9.1	23.0	21.5	3.9	0.1	1.7	1.3	11.6	17.4	7.5
Chemicals stock (day)	24.1	32.0	51.9	27.7	19.8	-	32.4	19.1	35.4	23.9	60.6	30.2	29.7
Fuel stock (day)	1.1	2.7	0.7	0.15	0.6	0.8	1.6	0	0.38	0.7	0	0	0
Non-utility generation facility (%)	54.3	32.9	91.3	100	72.4	100	88.0	61.5	66.7	42.9	-	78.4	55.1

Maintenance/ Operation

		2001 (%)	2002 (%)	2003 (%)	2004 (%)
Anti-earthquake pipe ratio	(Ductile+Steel)/Total length	95.1	95.8	96.2	96.9
Leakage	Leakage/Total supplied water	7.1	6.4	5.4	4.7

Model of private public partnership

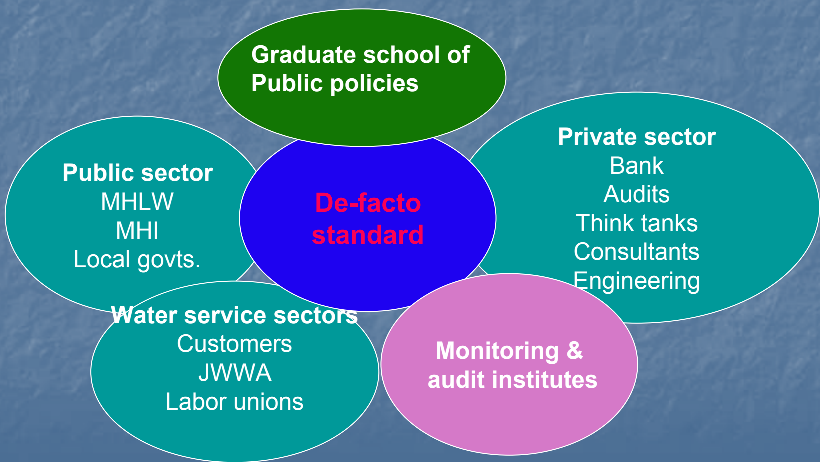


Component of manual of audit to water supplier

	Safety	Stability	Sustainability	Management	Environment
Satisfaction of customer	●	●	○	●	○
Capability of facilities	○	●	●	●	○
Competence of Employee	●	○	●	●	○
Appraisal of asset	○	○	●	●	●
B/S assessment	●	○	●	●	○

● :High priority ○ :Secondary priority

De-facto standard to monitoring and audit of water service



Conclusions

- Full cost pricing
- Monopoly system
- Water is essential not only in healthy daily life but also economical/social activities
- Sustainability
- Customers satisfaction
  - Governance/Transparency of business
  - Financial soundness
  - Human resource