Japan's Experiences on Water Supply Development: Overview

Contents

1. Introduction

This module summarizes Japan's experience based on Goal 6 of the United Nations' Sustainable Development Goals (SDGs) and provides answer to questions about water supply that were frequently asked by the participants of water supply training courses from developing countries.

Q1. How has Japan achieved close to 100% water supply coverage?

Q2. How can Japanese waterworks provide around the clock supply of safe affordable drinking water?

This module presents an overview of the Japanese experience in archiving SDG 6 in "Goal 6 of SDGs and Japan's Experience." Each topic is explained in more detail in other chapters of this training manual aiming to provide answers to these questions:

3. Universal and Equitable Access (Q1)
4. Safe Drinking Water, 5. Sustainable Water Resources Management, 6. Ensuring Availability, 7. Efficient Water-Use, 8. Sustainable Management, 9. Affordable Drinking Water, and 10. Engaging Local Communities (Q2)

2. Goal 6 of SDGs and Japan's Experiences

Japan has practically achieved SDG Goal 6: “Ensure availability and sustainable management of water and sanitation for all.”

Goal 6 of the United Nations’ Sustainable Development Goals (SDGs) aims to "ensure availability and sustainable management of water and sanitation for all." Over the years, Japan has achieved an almost 100% water supply coverage. Japanese utilities secured water resources and constructed top-notch facilities to provide 24-hour service. They operate on a cost recovery basis with income from water tariffs, while demonstrating full accountability and transparency to the customers.

Target 6.1 aims to achieve “universal and equitable access to safe and affordable drinking water for all" (by 2030)." Japanese waterworks experienced followings concerning the target:

Universal and equitable access: Japan expanded water supply networks nationwide, including to rural areas, thus achieving 97.8% water supply coverage as of 2014. This was made possible by improving legal systems, securing financial resources, constructing facilities, and developing a skilled workforce.

Affordable drinking water: the Japanese water tariff system is structured with consideration for low-income groups, allowing reductions and exemptions from tariff payment.

Safe drinking water: In Japan, water is safe to drink from the tap anywhere in the country. Water quality and facility standards are stipulated in the Water Supply Act and are carefully followed by operators to ensure that public health will not be compromised.

Target 6.4 aims to "substantially increase **water-use efficiency** across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity (by 2030)." Utilities in Japan have focused on water-use efficiency, achieving one of the lowest water leakage rates in the world (4.69% in fiscal year 2013).

Target 6.5 aims to "implement **integrated water resources management** at all levels, including through transboundary cooperation as appropriate (by 2030)." Japan secures water resources in collaboration and coordination with stakeholders.

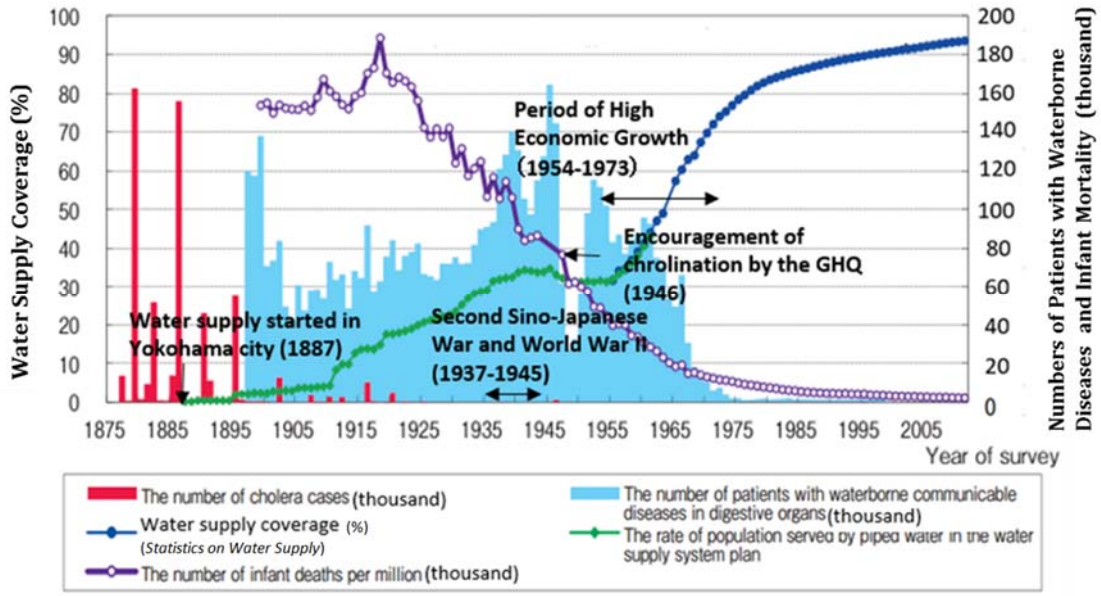
Target 6.b aims to "support and strengthen the **participation of local communities** in improving water and sanitation management.” Japan has a high collection rate for water tariffs

(more than 99%), which is the result of satisfying customer service. Utilities actively engage with customers and reflect their input in planning for the future of the service. The two sides have built a trusting relationship and work closely together solving problems such as water conservation to overcome the adversities during severe droughts.

These Japan’s experiences are very useful for others aiming to achieve the SDG on sustainable management of water supply.

3. Universal and Equitable Access

Japan achieved 97.8% water supply coverage in fiscal year (FY) 2014. Almost all residents of Japan enjoy safe drinking water. This is the result of years of effort to improve public health.



Source: Water Resources Department, Water and Disaster Management Bureau, Ministry of Land, Infrastructure, Transport and Tourism, "*Water in Japan*," http://www.mlit.go.jp/common/001044443.pdf

Figure 1. Water Supply Coverage Rate, the Numbers of Patients with Waterborne Diseases, and Infant Mortality Rate

(1) Reducing Incidence of Waterborne Diseases and Emergence of Modern Urban Water Supply System

The modern water supply system was introduced to combat the spread of waterborne diseases, such as cholera. The basic goal was to improve public health by providing every citizen with pressurized clean safe water around the clock.

Japan began constructing waterworks to prevent the spread of waterborne diseases, such as cholera, at port cities. The trading with western countries in the latter half of the 19th century brought cholera epidemics to major port cities. An epidemiological survey conducted in Yokohama, one of major port cities, showed the relationship between outbreaks of cholera and locations of polluted gutters and wells. This result demonstrated that safe drinking water supply

was required to prevent cholera. Thus, the first modern water supply system was established in Yokohama in 1887.

The national government subsidised one-third of the construction costs of the project. Other water supply systems began to be built at port cities such as Kobe, and naval ports, such as Maizuru and Sasebo. These systems used slow sand filtration to remove *E. Coli* and imported cast iron pipes to convey treated water under pressure to avoid any contamination on the way to the customers.

The nationwide water supply system was established under the public management principle as stipulated in the Waterworks Ordinance enacted in 1889.

(2) Development of Nationwide Water Supply System

The following comprehensive measures were implemented: development of facilities and securing funds for construction, development of facility standards and human resources. These measures brought coverage from around 30% in 1950 to 80.8% in 1970.

The Constitution in Japan stipulates that “everybody shall have the right to maintain the minimum standards of wholesome and cultured living” and that “the State shall promote and improve public health.” The Water Supply Act was enacted in 1957 based on this principle of the Constitution. Under this law, the national government actively supported the funding of water utilities. This expanded the water supply coverage dramatically.

The main funding instrument for the development of water supply in urban areas was long-term municipal bonds issued by local governments. The national government allowed the issue of bonds, based on the utilities’ financial conditions, income projections, project feasibility and priority. The national government purchased 80-90% of the municipal bonds using public funds (from public financial institutions and pension funds).

A subsidy system for small-scale waterworks, established in 1952, contributed to the boost in water supply coverage in rural areas. This served to reduce waterborne diseases in rural villages and the physical burden on women who had to fetch water for their families.

Approval is required when starting a water supply system as stipulated by The Water Supply Act. The application for approval requires the submission of a master plan that describes the development of the system based on demand projections. The other information required for approval include: water demand projections, facility plan and financial plan (proposed water

tariff structure, subsidies and funding from enterprise bonds). The master plan is evaluated in terms of technical and financial feasibility.

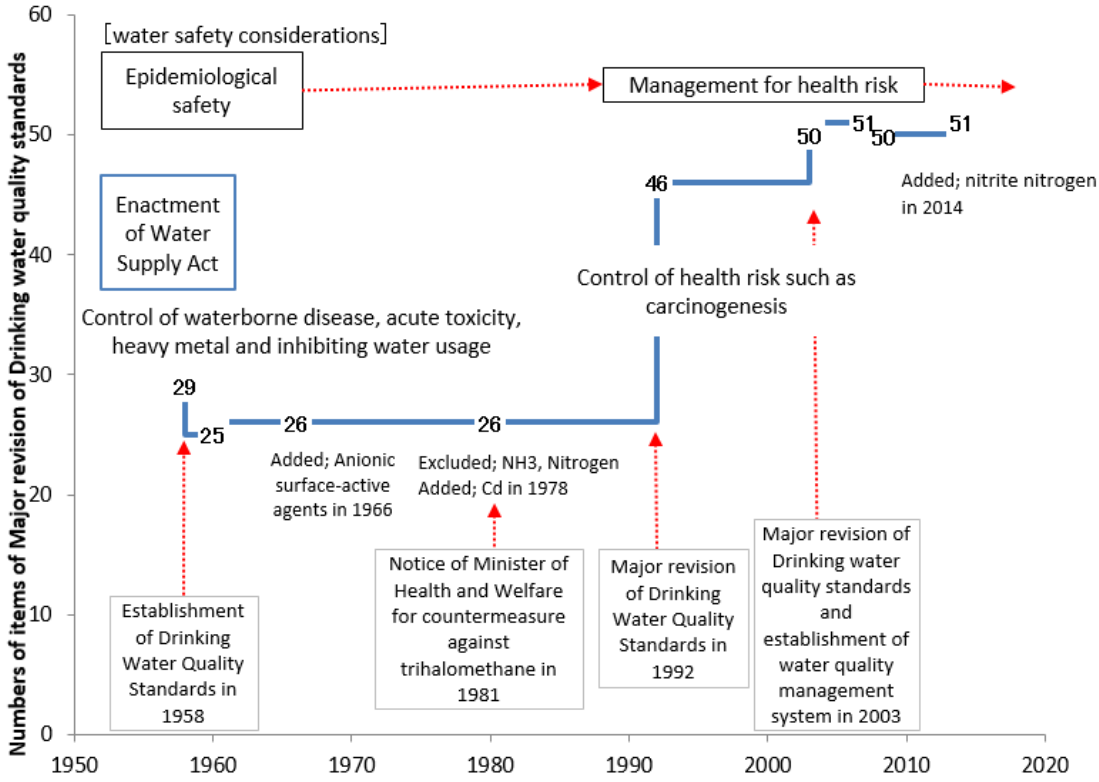
The National Institute of Public Health began to offer a public health engineering course in 1948 for local government employees to develop the much-needed human resources for the water supply sector. Utilities conduct on-the-job training, supplemented with training programs provided by the Japan Water Works Association (JWWA). JWWA published the *Water Supply Facilities Standards* in 1955 and the *Guidelines for Water Supply Facilities Standards* in 1958, leading to the standardisation of design and construction practices. The technical standards are especially helpful to small- and medium-sized utilities which have fewer engineers and skilled workers. These documents were revised and compiled into the *Guidelines for Water Supply Facilities Standards* in 1966.

The success in achieving nationwide coverage can be attributed to strong financial support from the national government, efforts in human resource development and the establishment of technical standards.

4. Safe Drinking Water

(1) Water Quality Standards and Facilities Standards under the Water Supply Act

Improving public health is the foremost reason for developing water supply systems and the safety of drinking water is a very important issue. The Water Supply Act stipulates water quality standards, facility standards and management methods to be followed by utilities.



Source: Material prepared by Koichi Ogasawara

Figure 2. Changes to Drinking Water Quality Standards in Japan 1950-2010

The Water Supply Act defines water quality standards in Article 4 and stipulates facility standards in Article 5. Supervision of facility construction by qualified engineers (Article 12), inspection of facilities and water quality testing before commencement of the treatment facility (Article 13), and use of appropriate service connections (Article 16 and others) are also stipulated.

Water quality standards are revised periodically as new knowledge emerges on toxic substances causing public concern. In addition, available analytical methods and environmental condition of the country are taken into consideration in revising water quality standards. The

Water Supply Act stipulates the appointment of a Technical Administrator (Article 19), regular and ad-hoc water quality testing (Article 20), mandatory medical screening of workers (Article 21), thorough sanitation of facilities by disinfection (Article 22), and provisions on the suspension of water supply in case of accidental contamination (Article 23).

Water utilities conduct water quality testing regularly, secure budgets for water quality management and develop water quality testing management systems for long-term maintenance. In addition the Ministry of Health, Labour and Welfare and the Health Centers conduct onsite inspections. The Health Centres also confirm utilities' water quality testing results and provide technical support to small- and medium-scale utilities (serving population of 50,000 or less) that lack skilled workers.

(2) Chlorination

The implementation of chlorination after World War II contributed considerably to the supply of safe drinking water.

It is ideal to have access to clean and abundant water sources. However, this is sometimes difficult in practice. Water utilities must conduct appropriate water treatment for different water sources to secure water quality. In Japan, chlorination implemented after WWII significantly contributed to making drinking water safe. Chlorine is inexpensive, but has a strong residual effect and can disinfect against pathogenic microorganisms. The concentration of residual chlorine at the tap is required to be ≥ 0.1 mg/l (0.1 ppm) under the Order for Enforcement of the Water Supply Act.

Chlorination has some undesirable side effects, such as the generation of disinfection by-products, corrosion of pipeline materials and equipment and disagreeable odor.

(3) Quality Management of Materials and Equipment

Japan has ensured the safety of drinking water by establishing standards, inspection, and certification processes for materials and equipment, such as pipelines and service connection facilities.

The Water Supply Act requires that tap water meet specific water quality standards. Water quality management is not limited to tasks carried out in the water treatment plant. Since treated water is distributed through pipelines, the quality of materials and equipment, such as distribution pipes, is a critical issue for maintaining water quality.

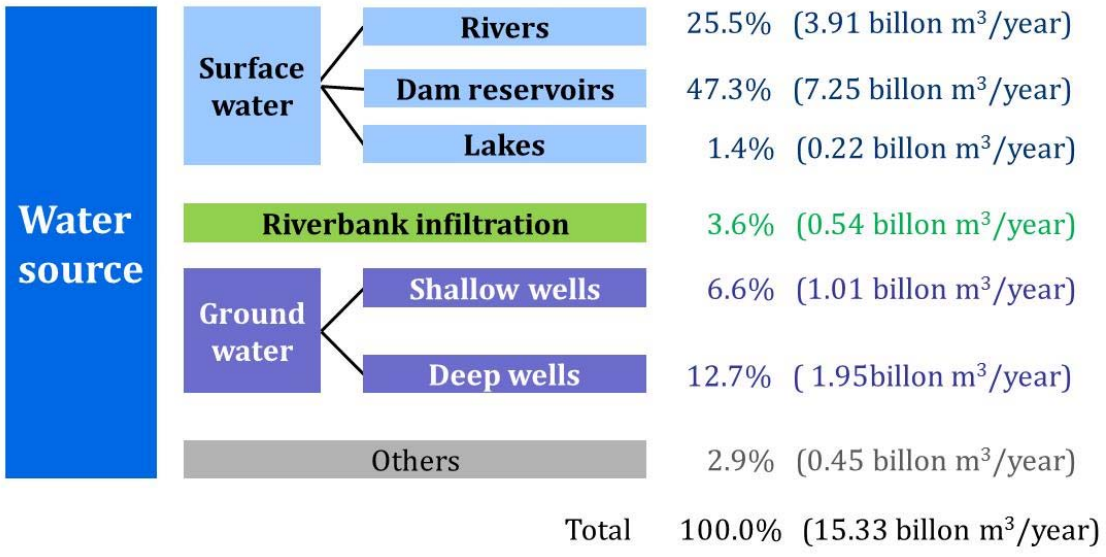
The Japanese Industrial Standards (JIS) and the Japan Water Works Association (JWWA) standards play a key role in ensuring the quality of materials and equipment for water supply. JWWA inspects and certifies the quality of materials and equipment at manufacturing facilities on behalf of the utilities. This approach is very efficient and cost effective for assuring quality of materials and equipment.

In addition, it is important to procure spare parts and repair-materials timely. Utilities used to procure and store them. Inventory control by utilities enabled to keep facilities in good condition. Nowadays, utilities no longer stock spare parts and repair-materials directly from the market, which is well matured and supported by well-developed transportation network.

5. Sustainable Water Resources Management

(1) Securing Water Resources

Utilities collaborate among themselves and with other users in water resources development and water quality conservation. Use of groundwater is strictly regulated to prevent land subsidence, and its use is now mostly replaced by surface water.



Source: JWWA, *Water Sources in Japan (2014)*, http://www.jwwa.or.jp/shiryou/water/water02.html

Figure 3. Water Sources in Japan

Abundant, good-quality water sources are very important to the water supply system. Spring water, groundwater, and water far from contaminated sources upstream of rivers are usually available to rural water supply systems.

In urban areas, the use of groundwater is restricted because excessive abstraction in the past had caused land subsidence that is not reversible. The use of surface water is promoted. Today, 70% of water sources in Japan is surface water and 30% is groundwater (see Figure 3). Many water utilities in urban areas receive water from downstream areas where a larger amount of water is available to meet increasing water demand. However, the water can be contaminated by discharge from households and industries. The national government regulates wastewater discharge and utilities started to install rapid sand filtration systems. Today, many utilities are forced to install expensive advanced treatment methods, such as ozonation and activated carbon treatment.

The development of dams played an important role in securing stable water sources. Dam construction is expensive. In Japan, dams needed to be developed for multiple uses and with the collaboration of different users (e.g. irrigation and flood control, hydropower generation, industrial water) to enhance investment efficiency. The national government established an organization for dam construction to work with prefectures/municipalities, electric power companies and other stakeholders. Engagement of community near the reservoir is critical for securing support for the development and water quality conservation. Approximately half of today's raw water comes from dams. The development of Bulk Water Supply also works well in securing water sources for several utilities to gain the economies of scale. A wider area can be served with reduced investment costs. Bulk Water Supply businesses are publicly-owned in Japan, and can use public funds for the water source development.

6. Ensuring Availability

(1) Operation and Maintenance of Facilities

In Japan, the national government and water utilities work closely together to enhance the operation and maintenance of facilities to prevent drinking water contamination caused by cracked pipes and spreading of waterborne diseases. Preventive maintenance is most efficient for facility management. Its implementation requires scheduled testing, well organized records, and information sharing.

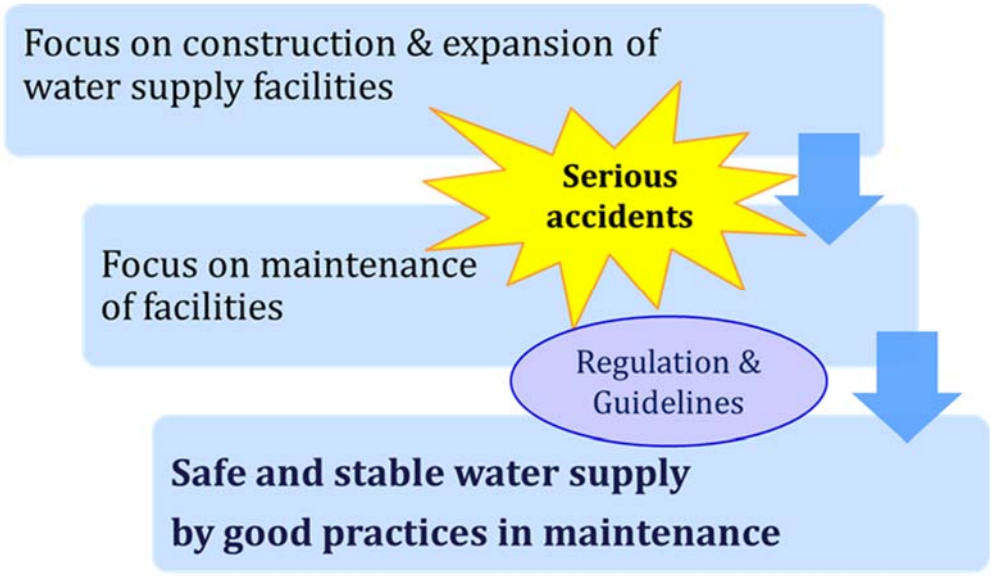


Figure 4. Steps toward Good Practices in Maintenance

Preventive maintenance includes Time Based Maintenance (TBM) that is periodical maintenance, and Condition Based Maintenance (CBM) that is maintenance in response to facilities' condition. Preventive maintenance is implemented by periodically checking the condition of the facilities, keeping good records and sharing information.

To provide a stable continuous water supply, utilities must be able to operate properly all the time. When the focus was mainly on construction of facilities, operation and maintenance tended to be neglected. Outbreaks of waterborne diseases (dysentery and typhoid) brought attention to maintenance issues such as insufficient disinfection, broken equipment, negative pressure in pipelines and accidents due to cracks in aging pipelines. The national and prefectural governments began to strengthen support for utilities by providing guidance and assisting with investigations. Utilities prepared manuals to share knowledge within the organization. They also

promoted preventative maintenance. They recorded operating situations and construction activities, gathered and organized data, shared information and prioritised maintenance activities. Senior engineers prepared pipeline inventories so that this information is available and accessible to anyone who needs it.

Using knowledge accumulated by major water utilities, JWWA developed two guidelines, the *Design Criteria for Water Supply Facilities* and the *Water Supply Facilities Maintenance Manual*. These guidelines standardised water supply technology and facilitated sharing of knowledge and training for workers in the sector.

Electric facilities with a certain capacity require an electrical chief engineer (licensed engineer). Water utilities have highly specialized mechanical equipment and electrical instruments, and their maintenance became to be out-sourced these days. Operation and maintenance for water supply facilities often involves private companies.

Many water supply facilities are facing the need to replace aging facilities. Adding to this challenge are social conditions such as declining population, water demand, water tariff revenue and shrinking workforce. Utilities are making efforts in asset management and preparing renewal plans to assure their long-term viability. Maintenance is a key element in these efforts.

(2) Water Supply Operation by Efficient Water Distribution Systems

The water supply network development and block distribution system made it possible to control water pressure, minimize downtime and maintain a stable water supply.

A simple tree (dendritic) system was used in the early water distribution networks. It enables water supply systems to be expanded with the least investment and additional facilities. It is easy to detect failure points in cases of accidental leakage.

When utilities fixed or installed pipelines in the past, they sometimes could not find documentations on layouts or connecting points. In some cases, it was difficult to evaluate the capacity of pipelines for expansion of service areas due to lack of information on existing pipelines. The problems on information management were often pointed out at the time of expansion or accident. Under the situations, a utility had to expand the networks by connecting new pipes to the existing dendritic system so as to form pipeline network. This favored less management because it equalized pipeline pressure and minimized downtime and disruption area using supply from other pipelines. This became a primitive form of block distribution

system for more stable supply to customers.

The water supply system has to be robust and efficient enough to sustain its service during disasters and droughts. Utilities introduced block distribution system to: (1) optimize water pressure in distribution pipelines; (2) understand distribution condition and optimize operations, and (3) identify and minimize accidental damage and provide backup water supply from another distribution pipeline routes.

7. Efficient Water-Use

(1) Water Leakage Prevention

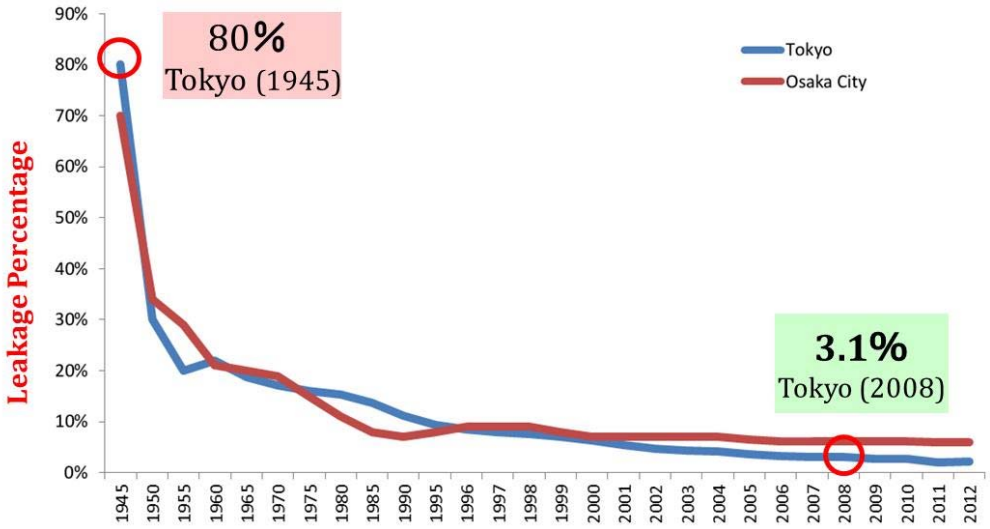
The national average leakage rate is 4.69% (as of FY 2013), much reduced from 70 - 80% in large cities after WW II. This drastic improvement is the result of taking intensive corrective and preventive measures. Utilities have a keen awareness of the importance of leakage control, because of the country's experience with severe droughts and accidents involving the suspension of water supply.

Utilities in large cities in Japan (such as Tokyo and Osaka) had 70-80% leakage rates after WW II. The leakage rate has been brought down to 3% in Tokyo. That is a result of intensive efforts on leakage prevention. Utilities recognized the importance of leakage control through experiences with war destruction, severe droughts and accidental service interruptions. Cities with scarce water resources also took leakage prevention very seriously.

Concretely, utilities continuously improved pipe joints and installation methods, and detected and repaired leakage. They replaced aged pipelines with more durable products and improved pipeline location, earth cover depth, and backfill materials. The block distribution system made it easy to control leakage and reduce disruption caused by construction and repair activities. Manufacturers have also played important roles in reducing leakage through the development of better joints and pipe materials. Preventing leakage reduces contamination in distribution pipelines.

In Japan, the non-revenue water rate is low because (1) metered billing and accuracy of flow meters are well-established, since early stage (2) illegal connection is rare and (3) there is a sustained effort to reduce leakage. The reduction of leakage can ease the pressure on water resources development and improve the financial situation of the utilities. Customers pay for the cost for treated water that reaches their homes and not water that is wasted through leakage.

While the national average leakage rate is 4.69% as of FY2013, it can be more than 20% for some utilities. Those utilities' water supply unit cost is low because they have abundant water sources and favorable land features such as elevation of source and distribution area. High leakage rates are also found in utilities with aging pipelines and undurable pipe materials.



Source: Materials from Osaka Municipal Waterworks Bureau and Bureau of Waterworks, Tokyo Metropolitan Government

Figure 5. Reduction of Water Leakage Rate in Tokyo and Osaka City

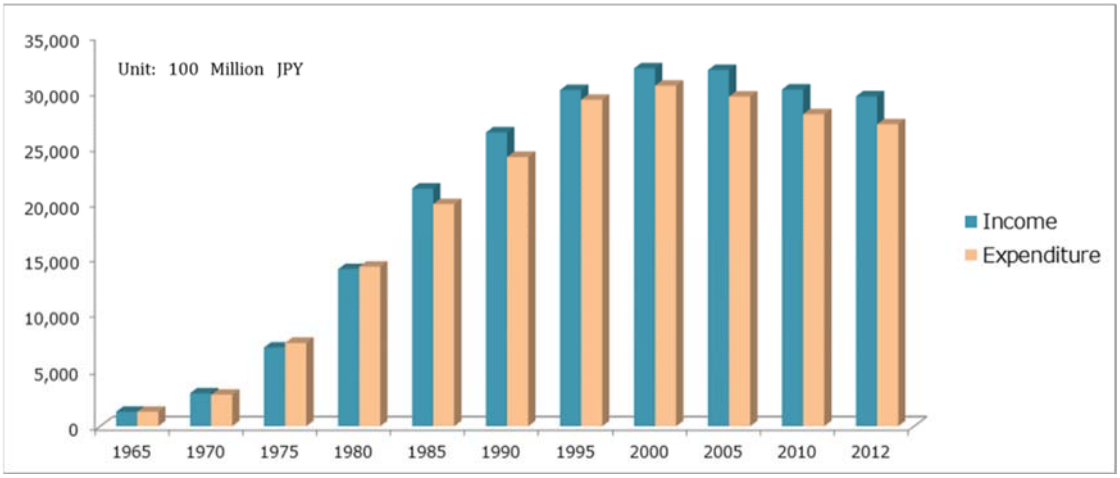
The main causes of non-revenue water are leaks (real loss), measurement error and unauthorized consumption/illegal connections (apparent loss). Utilities in Japan could reduce non-revenue water by preventing leakage. Quality of construction and pipe materials is vital to prevent leakage in distribution pipes and service connections.

To optimize meter accuracy, the equipment should be replaced every eight years as required under the Measurement Act. Utilities are responsible for the management of water meters as stipulated in the Water Supply Act, and this contributes to minimize the apparent loss caused by measurement error.

8. Sustainable Management

(1) Self-Supporting Accounting System and Cost Recovery

Utilities in Japan operate under the self-supporting accounting system. Subsidies were provided based on the policy goals to enhance water supply coverage and the development of water sources, etc. Furthermore, it helped to develop water supply systems especially in rural areas.



Source: Created from JWWA, "*Outline of Water Supply*," 1st ed. 1987 and 6th ed.2015.

Figure 6. Changes in Total Revenue and Expenditures of Waterworks in Japan

Revenue from water tariffs should cover all the expense if the utility is to operate sustainably. The Local Finance Act and the Local Public Enterprise Act stipulate that utilities should be managed under a self-supporting accounting system, using the fully distributed cost method.

Tariffs are determined based on the fiscal balance of the utility and carefully considered by the local assembly. Those Acts require: (1) fully distributed cost method and self-supporting account system, (2) fair cost sharing and clarity in the pricing of water tariffs, and (3) the demonstration of efficient management. The *Water Tariff Setting Manual* plays a key role in providing guidance in the tariff setting process.

When the water supply service was under expansion, many utilities had to raise tariffs frequently to secure the much needed financing. Utilities prepared financial plans, looked for cost saving measures and thoroughly examined their future financial situation before raising tariffs.

Water utilities continue efforts to streamline their operations (cost reduction via proper staffing and the promotion of outsourcing, collection of arrears, effective use of assets and efforts to lower the non-revenue water rate) while disclosing information and focusing on public relations and customer services to be understood by customers.

Tariff collection ratio is close to 100%. The success is attributed to changing collection intervals and payment methods that are more convenient for the customer. Collection notices are sent to delinquent accounts with clear warning of punitive measures for late payment, following to standard procedures. Training and incentive programs for meter readers and bill collectors are effective in improving performance.

Subsidies made for water sources development and water facility expansion were instrumental in expanding and improving the water supply coverage. Subsidies were especially necessary for less-populated regions, as they were not able to generate enough tariff income to finance facilities construction. Small-scale utilities continue to experience tight financial conditions after construction, due to the small revenue base. They are aiming to gain economies of scale by integrating their operations through various means, including consolidation and joint operation/management.

(2) Customer Relations

Customers pay water tariffs for water supply services. Tariffs are the revenue source and the basis of the water supply business. Utilities put high priority on customer relations and improve their operations and management by enhancing their customer services.

The Water Supply Act stipulates the obligations of utilities to their customers and the rights of customers. Utilities pay a lot of attention to customer relations based on the stipulation. The relationship between the customer and the utility is clearly defined in the water service contract. The customer pays the water tariffs in exchange for water supply services. Good customer service leads to the enhancement of the operation of the utility. The high service level and technological strength and superb organization of Japanese utilities all originate from their customer-oriented attitude and sense of responsibility to supply safe drinking water.

(3) Master Plan, Business Plan and PDCA (Plan-Do-Check-Act) Cycle

A master plan and/or business plan is needed when building or expanding facilities and when water tariffs are being revised. These plans set the foundation for the sustainable operation of the business. The PDCA cycle is a very effective tool for the development of business plans.

A master plan is required in applying for Approval (License) to operate a utility, and a business plan is required to applying for subsidy, and raising water tariffs. It explains the water supply operations and commits the utility to set clear goals to meet business objectives.

With the focus on operation and maintenance, utilities are encouraged to prepare the long-term business plan (Local Water Supply Vision), which include the following: (1) analysis and evaluation of the current business situation, (2) future direction, (3) objectives, (4) means to achieve the outcomes, and (5) evaluation procedures and periodic reviews.

Those plans are guideposts for sound day to day management, while visualizing the path toward future directions. The preparation of the plan is a process that engages all employees and an opportunity for team building and improving performance. In the past, master plans were prepared to deal with increasing population and the long time line to develop water resources. Later, population growth has stopped and there are some cases of overcapacity at some utilities. Therefore, planning with a sufficiently long-term outlook to foresee and address new challenges is paramount. Asset management and the PDCA cycle have led to the enhancement of operating systems and the realization of sustainable business operations.

(4) Public-Private Partnership

Outsourcing is gradually increasing. Private sector participation has improved operational efficiency. Now public-private partnerships are promoted, and regulatory frameworks have been developed to clearly define the allocation of risks among the partners.

Utilities used to rely on their own expertise for carrying out all their activities including design and building facilities. These and other tasks such as meter reading are gradually outsourced. With the aging society and declining population, the concern about the long term sustainability of public enterprises is growing. The involvement of private companies in the water supply sector now includes public-private partnerships in facility development and

operation and maintenance. In promoting public-private partnerships, regulatory frameworks are being strengthened to protect public good, including ensuring water quality, safety and affordability, and the clear understanding on allocation of risks between the partners.

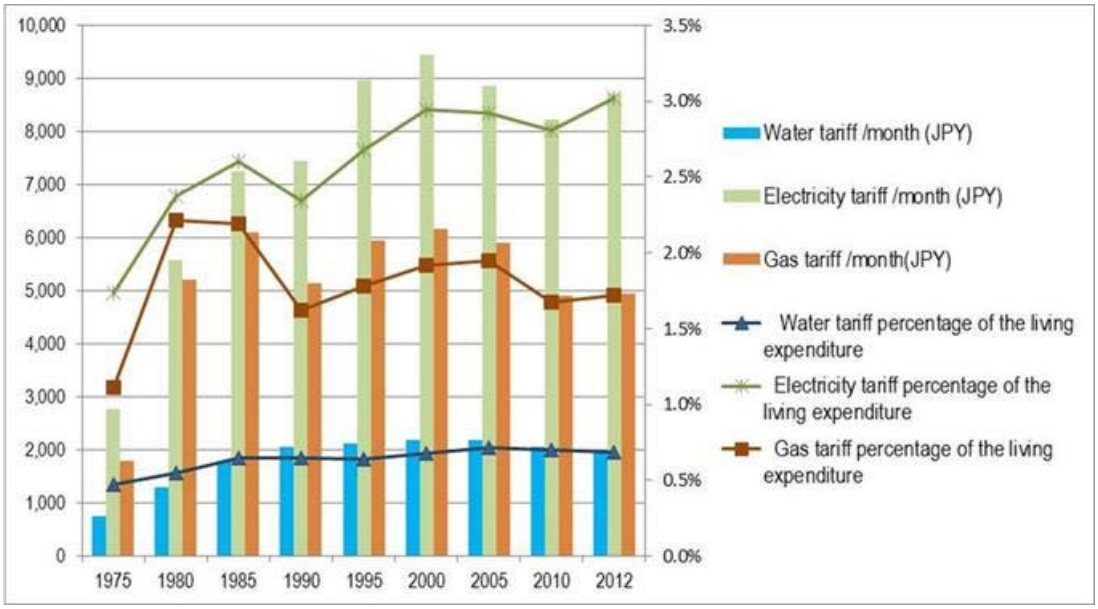
9. Affordable Drinking Water

(1) Consideration for the Low-Income Group

The water tariff structure always considers affordability. Tariff reduction and exemption are utilized for the low-income groups, which are clearly defined.

Water tariffs in Japan consist of minimum and volumetric rates. Many utilities set a minimum volume in the minimum rate that is affordable for most households. The minimum rate does not cover the cost to supply the minimum volume of non-charged water that comes with it. This low rate is off-set by higher rates charged to large-volume users as a cross subsidy to avail inexpensive rating of minimum required volume of water for living. Some utilities clearly define the low-income groups and provide tariff reduction and exemption for them on social welfare programs of the local government. Based on the definition they are applied to the customers who are in case of illness or unemployment.

In the past, some utilities used installment plans and encouraged citizens to set aside money in a systematic manner to pay for connection charges.



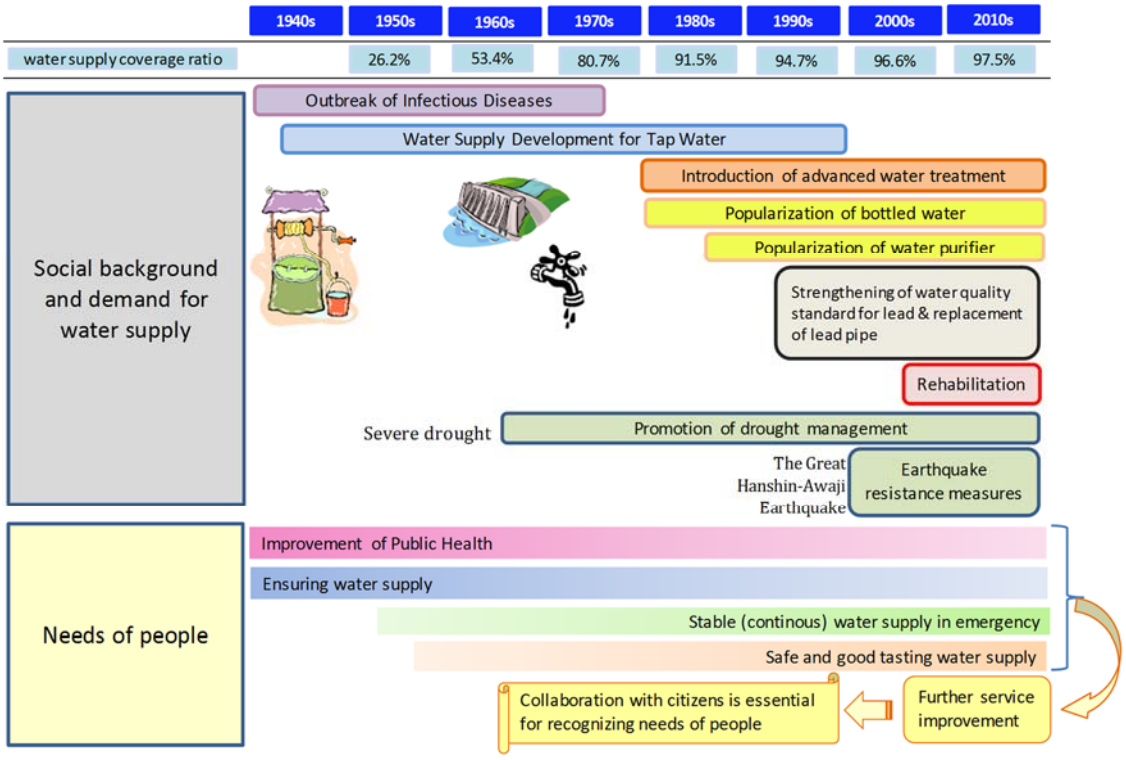
Source: Created from JWWA, "*Outline of Water Supply*," 6th ed. 2015.

Figure 7. Water Tariff Affordability Compared with Electricity and Gas

10. Engaging Local Communities

(1) Participation of Residents

Residents in rural areas contributed funds and labor to speed up the development of water supply systems to improve their living conditions. Increasingly in recent years, utilities seek input from residents in preparing business plans, tariff revisions, and on day to day issues related to water supply services. This kind of engagement ensures that the needs of the customers are met. It also requires that utilities demonstrate accountability and transparency and conduct public relations (PR) activities. Support from the residents can be directly linked to the improvement of sustainable management of the utilities.



Source: Ministry of Health, Labour and Welfare

Figure 8. Changes in the Roles of Waterworks and Needs of Customers

To improve poor sanitation and nutritional conditions in rural areas after World War II, the Ministry of Agriculture and Forestry expanded the Livelihood Improvement Movement nationwide while the Ministry of Health and Welfare[1] established a subsidy system to promote

[1] The Ministry of Health and Welfare was merged with the Ministry of Labour to form the Ministry of Health, Labour and Welfare in 2001.

water supply development. Residents in rural communities worked voluntarily on facilities construction. They sold timber from their common forests and farm produce to add to the subsidies to accelerate water supply development. These contributions from local communities made the nationwide coverage possible.

The operation of waterworks in Japan relies on revenues from water tariffs that are set based on the water service contract between water utilities and customers. Utilities promote citizens' understanding of the water supply business by practicing fair billing based on the management of meter accuracy and persistently conducting public relations activities to build trusting relationships. Public relations activities have been always on-going. They help customers understand how tariffs are set (transparency in tariff calculations) and why increases are necessary for good water service. The engagement of the residents is very helpful in gaining their broad and strong acceptance in and contribution to water conservation and use of water-saving devices.

Public consultations, customer satisfaction surveys, and supporter groups are some examples of outreach efforts. Utilities organize many activities in the national campaign during “Water Week.” School children and citizens participate in facility tours. Through these efforts, it is widely recognized that water tariffs are necessary for good water services. In addition to supplying safe water without water outage, transparency of tariff calculation and promotion of positive public relations are also recognized as important services. Public relations are recognized as an important service component. Dialogue with residents can build good relationships. These activities lead to the improved water supply services and the sustainable operation. Some large-scale utilities have customer service centers to serve customers at any time. The combination of these activities has led to the improved water supply services and the sustainable operation of waterworks.

11. Lessons Learned

Japan has achieved nationwide water coverage and high quality of potable water. The following Japanese experience could be useful for other countries.

(Laws and regulations for nationwide coverage of water supply service) >>> [Details are explained in Theme 1. Sector Governance and Regulation for Nationwide Full Coverage of Water Supply Service]

- The national government established the legal frameworks to support utilities in securing funds and in standardizing technical requirements in developing water supply system. Utilities could issue public enterprise bonds for long-term financing. Small utilities in rural areas could not recover the cost with their operation and utilized national subsidies for facility construction.

(Sustainable Water Resources Management) >>> [Details are explained in Theme 2. Water Supply System: from Water Resources to Distribution]

- Sustainable water resources management is crucial for stable water supply. In Japan, new water sources were developed to meet increasing demand and allocations have been adjusted to accommodate the competing needs of various users. The national government established an organization responsible for multi-purpose dam constructions and coordination of dam users. By sharing both the costs and benefits of dam construction, the financial burden for each water utility was reduced. In cities located downstream, where water quality is poor, raw water has to be treated with rapid sand filters, and with advanced treatment systems in the worst cases. Measures and new laws to improve and protect raw water quality, have helped to restore water quality.

(Safe water supply) >>> [Details are explained in Theme 3. Water Quality Management]

- To operate a stable supply of good quality water for 24 hours a day, the national government established water quality standards and evaluates each utility’s master plan through the Approval (License) process as stipulated in the Water Supply Act. Water utilities are responsible for implementing water quality analysis, and made efforts to secure quality pipe materials and equipment. The JIS and other standards, and JWWA inspection played key roles to guarantee the quality of pipe materials and equipment.

(Sustainable operation) >>> [Details are explained in Theme 4. Operation and Maintenance of Facilities]

- Preventive maintenance is very important for a stable water supply. Accidents can be prevented by analyzing data and information of daily inspections, operation, and repairs. Sharing know-how among workers was also promoted to set the priority for maintenance. Knowledge, experience and technical know-how were passed on from the senior to junior staff, by manuals and OJT. Regulations and guidance by the national government also played an important role for the prevention of accidents and problems.

(Leakage reduction for efficient water use) >>> [Details are explained in Theme 5. Reducing Non-Revenue Water]

- The average leakage rate in Japan's water supply is 4.7%. The dramatic drop from 70-80% after the war was the result of corrective and preventive measures implemented after experiencing severe droughts and water scarcity. These include detection and repair of leaking pipes, replacement of aging pipes and installation of new pipes with better materials and improvement of construction methods such as standardizing pipe placement, earth cover depth and backfill materials. Pipe networks organized in distribution blocks facilitates the leakage reduction activities. Manufacturers also improved the quality and reliability of joints and materials. Leakage reduction saves limited water resources, contributes to reduce investment cost on water source development, makes water usage more efficient, and prevents groundwater intrusion which causes water quality deterioration.

(Finance and tariff for sustainable management) >>> [Details are explained in Theme 6. Financial Management: Finance and Tariffs]

- The Local Public Enterprise Act in Japan requires utilities to use the self-supporting accounting system. National subsidies were provided for water supply expansion, water resources development, installation of advanced treatment facilities and Small Scale Public Water Supply in rural areas. The national government supported a bond financing scheme for utilities to secure funding for the construction and expansion of water supply systems. During the period of rapid economic growth, water utilities often fell short of the necessary funds for expansion of water supply systems, which occasionally forced them to raise the water tariff. Utilities are required to prepare a financial plan, clearly describe future conditions demonstrate efforts for cost reduction, to convince the local assembly on the need for tariff increases.

- The water tariff system in Japan consists of a minimum rate and a volumetric rate. The minimum rate including minimum water is set relatively low making it affordable for low-income households. The progressive rates allocate more financial liabilities to

high-volume users. Low-income group can apply for tariff reductions or exemptions which are established by a local government as a part of the welfare policy, if they are in difficult financial or social situations such as illness and/or unemployment.

(Human resource development for sustainable management) >>> [Details are explained in Theme 7. Institutional Management: Governance, Human Resources Development, Consolidation of water utilities, Public-Private Partnerships]

- The National Institute of Public Health developed the human resources required to establish the nationwide water supply system. Utility workers were trained through OJT and attended training programs conducted internally. JWWA organizes seminars and committees for knowledge sharing and professional development.

(Communication with customers for safe, equitable and affordable water service) >>> [Details are explained in Theme 7. Institutional Management: Governance, Human Resources Development, Consolidation of water utilities, Public-Private Partnerships]

- Utilities make continuous effort to provide residents with a better understanding of the water supply business and importance of water supply. They conduct PR activities and facility tours for school children and interested citizens. Public relations activities and mechanisms for public participation are important to building mutually supportive relationship between the utility and its customers Staff of each utility understand that customers' willingness to pay is directly related to their level of satisfaction with the quality of service (i.e. safe, reliable, stable water supply). Customers also appreciate transparency on tariff calculations, easy to understand tariff structures and the utilities' outreach efforts. Some large-scale utilities have customer service centers. Maintaining trusting relationships with customers is a very important component of the water supply service.