Current state of water management in Japan

Masao Shibuya, Francesc Hernández-Sancho and María Molinos-Senante

ABSTRACT

Financial sustainability of water utilities is essential to guarantee the provision of high quality services. The aims of this paper are to review the current state of water management in Japan and to identify the main difficulties which confront Japanese water utilities. As the facilities built when the country expanded water utilities rapidly are drawing near the renewal period concurrently, water operators must quickly accelerate facility renewal work. The statistical data from the Japan Water Works Association illustrate that one of the most significant challenges facing Japanese water utilities is to finance investments to renew facilities and to prepare them for earthquakes. Difficulties in reviewing the water rates and the decreasing water consumption per capita considerably affects cost recovery and, therefore, financial sustainability of water utilities. The Japanese vulnerability of technical base impacts mainly on small scale water utilities and it is linked to an insufficient number of qualified staff and limitations in emergency situations. With the water distribution rate already reaching about 100%, there are no factors that could lead to business expansion or revenue increase in the future.

Key words | cost recovery, small scale water service, small scale water utility, water consumption, water tariffs

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INTRODUCTION

Access to clean and affordable water is part of the 2015 water target under the Millennium Development Goals. While developing countries focus efforts on increasing access to safe drinking water, in developed countries other challenges such as improving the sustainability of water utilities should be faced (Molinos-Senante *et al.* 2012). The principle of water supply in partnership with sanitation emerged in the framework of the World Summit on Sustainable Development held in Johannesburg in 2002. The basic idea of such a principle is that both the provision of clean drinking water and adequate sanitation are necessary to protect human health and the environment (United Nations 2002). To improve the implementation and development of water supply and sanitation projects in developing countries, the United Nations Office for Project Services (UNOPS) set up the Water Supply and Sanitation Collaborative Council as a global partnership and membership organisation (UNOPS 2014).

Water utilities sustainability involves mainly institutional, environmental and financial issues. In spite of the efforts made to define institutional sustainability (e.g. Pfahl 2005; Hill 2008) and to measure it (e.g. Edwards 2005; Litten 2005), there is still no consensus on what institutional sustainability means, neither are there accepted indicators to facilitate its evaluation (Kayaga *et al.* 2013). In this sense, Kayaga *et al.* (2013) reported further information about the concepts of institutions, institutional sustainability, institutional capacity and institutional development and the methods to evaluate institutional development interventions in the urban water sector.

Regarding environmental sustainability, over the past 50 years, public attitude toward the environment has changed. Adapting itself to the demands of an evolving society, engineering has added environmental sustainability to its general objectives (Davidson *et al.* 2007). In recent years, many studies have assessed the environmental sustainability

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of water utilities using different approaches such as life cycle assessment (e.g. Rodriguez-García et al. 2011; Slagstad & Brattebø 2013); carbon footprint (e.g. Qi & Chang 2013; Flores-Alsina et al. 2014) or multicriteria assessment (e.g. Joerin et al. 2010; Mutikanga et al. 2011).

Financial sustainability of water utilities must guarantee long term revenues for covering the full cost of delivered water and sanitation services including the cost of operation and maintenance, renewal and rehabilitation, and extension and expansion (Organisation for Economic Co-operation and Development (OECD) 2008). Therefore, financial sustainability often has been linked to full cost recovery of urban water services (Martins et al. 2013). Nevertheless, financial sustainability also depends on other factors namely, technical expertise, balanced water consumption and production, low non-revenue water, effective metering, billing and collection practices, sound managements and quality of service (OECD 2005). Although provision of sustainable water utilities is essential to provide safe and reliable water services it is not an easy task. In this context, programmes to help ensure the long-term sustainability of water infrastructure have been promoted by several countries and international organisations. For example, a report of the World Bank discusses several issues related to long-term financial sustainability of water utilities and provides some suggestions to public utilities to improve their financial commitments (World Bank 2005). The Canadian Ministry of Environment (CME) published in 2007 a guideline to assist municipalities in preparing the required Financial Plans. It also provides broad principles and practical advice to help municipalities in moving toward long-term financial sustainability of water services (CME 2007). In 2010 the United States Environmental Protection Agency (USEPA) issued a Clean Water and Drinking Water Infrastructure Sustainability Policy. The policy is applicable to infrastructure funded through the clean and safe drinking water State Revolving Loan Fund programmes, traditional forms of community financing, or other appropriate financing mechanisms (USEPA 2012).

Against this brief background, the aims of this paper are to review the current state of water management in Japan and to identify the main difficulties that confront Japanese water utilities from a financial sustainability point of view. Special attention has been paid to small scale water utilities (SSWU) and small scale water service (SSWS). In doing this, statistical data from the Japan Water Works Association (JWWA) were used. For a better understanding, Japanese data were compared with data from other countries. To address the main challenges of Japanese water utilities, some policy recommendations have been proposed.

OUTLINE OF WATERWORKS IN JAPAN

Most of the Japanese water utilities have been managed by the local governments under the control of the State government since the establishment of the first modern waterworks in 1887. Since then the waterworks has been extended until reaching the water coverage ratio of 97.5% (referred to 2010). The Japanese Administration System has three layers which also are reflected in water management, namely State, Prefectures and Municipalities (Urakami 2006). The authorities concerned with water supply and their responsibilities in Japan are as follows:

- Ministry of Health, Labour and Welfare: License of water supply, water quality, and regulation of the technical aspects.
- Ministry of Land, Infrastructure and Transport: Water resource development, rights to the use of water, and sewerage works.
- Ministry of Environment: Protection of water resources.
- Ministry of Economy, Trade and Industry: Management of industrial water.
- Ministry of International Affairs and Communication: Administration and management of water utilities at local level.

The statistics of water supply in Japan are presented in Table 1. Regarding water sources, it is shown that most of the drinking water (74.5%) is supplied from surface water while groundwater accounts for the 23.5% of the total. The remaining 2.0% is supplied from spring water (1.8%) and desalination (0.2%). Since total water abstraction is about 15,823 hm^3/year and annual water consumption is 14,993 hm^3/year, it can be estimated that leakages are 829 hm^3/year, i.e., the percentage of water leaks is 5.2% of the total water abstracted. In this sense, the European Environment Agency (2003) reported on leakages in 15

Table 1 | Statistics of water supply in Japan

Total country population	127,941,491	inhabitants
Population served by water supply	124,796,337	inhabitants
Service connections	52,037,026	connections
Mains length	614,820	kilometres
Total water abstraction	15,823,313,000	m^3/year
Surface water	11,789,668,000	m^3/year
Ground water	3,706,823,000	m^3/year
Spring water	292,424,000	m^3/year
Desalination	34,398,000	m^3/year
Annual water consumption	14,993,637,000	m^3/year
Households and small business (<10,000 m^3)	11,805,180,000	m^3/year
Industry and other billed water consumption (>10,000 m^3)	1,699,111,000	m^3/year
Unbilled water consumption	1,489,346,000	m^3/year

Source: Own elaboration based on Japan Water Works Association (2008, 2012).

European countries with Germany being the country with the lowest rate of water leaks (3%) and Bulgaria the one with the highest rate (50%). More recently, Hernández-Sancho *et al*. (2012) pointed out that water leaks in the Valencia Region (Spain) ranged from 10 to 38% depending on the company. Hence, comparatively, water losses in Japan are minor, indicating that currently the condition of water mains is good. Table 1 also illustrates that most of the water is consumed by households and small business (78.7%). Surprisingly, the percentage of unbilled water (9.9%) is almost the same as the percentage of water consumed by industry (11.3%).

Since the scale of water utilities is a key factor in their assessment (Guerrini *et al*. 2011; Molinos-Senante *et al*. 2014), the figures below show the number of utilities and annual supply volume by population served. For the purpose of the present study, the scales of water utilities are defined as follows:

- *Large scale water utilities (LSWU):* They supply water to populations equal or higher than 250,000 inhabitants. This level of population corresponds to the seats of each prefectural office, of which there are 47 in Japan.
- *Medium scale water utilities (MSWU):* They supply water to populations ranging from 50,000 to 250,000 inhabitants. This level of population is usually classified as a city in Japan.
- *Small scale water utilities:* They involve the water utilities that supply water to populations ranging from 5,000 to 50,000 inhabitants. This level of population corresponds to Japanese towns or villages.
- *Small scale water service:* They supply water to populations smaller than 5,000 inhabitants. In most of the cases, these water operators serve rural mountain areas or fishing villages using independent water resources. They are exempt from some regulations. For example, they can choose whether to manage the operation by special account or not. Although there are about 6,700 small-scale water services in Japan, since they do not belong compulsorily to the JWWA, statistical data are only available for 100 operators. Accordingly, Figure 2 does not include annual water supply volume for these water utilities.

The number of water utilities and the annual volume of water supplied breakdown by scale are presented in Figures 1 and 2, respectively. It is shown that SSWU and SSWS constitute a vast majority of Japanese water utilities. Moreover and based on the annual water consumption (Table 1), although there are not statistical data available, it can be estimated that most of the water is supplied by water utilities categorised as SSWS. In this sense, it is noticed that as a general rule these water utilities are managed by local governments. Hence, special attention should be paid to improve their management and to identify their main challenges to be addressed in the forthcoming years.

METHODOLOGY

The methodology followed to identify the main challenges facing Japanese water utilities consists of assessing the trend of some operational and managerial variables of such facilities. It should be highlighted that in most cases, the information has been split by population supplied, allowing identification of which scale of water utilities are more affected by a specific problem or difficulty.

For information on available financial resources, Japanese population and water consumption per capita trends

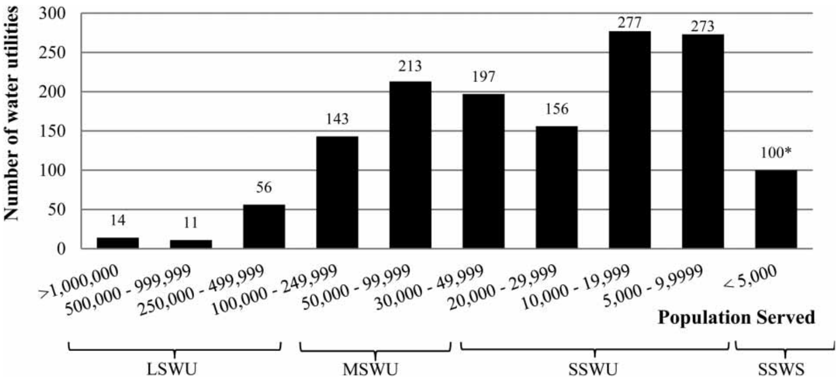

Figure 1 | Number of water utilities breakdown by scale of population supplied. *Source:* Own elaboration from Japan Water Works Association (2012). *The total number of water utilities is 6687. However, the available data are for 100.

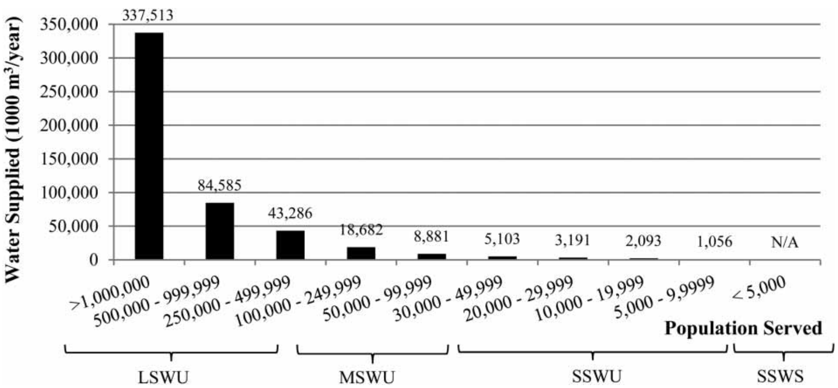

Figure 2 | Annual water supplied breakdown by scale of population supplied. *Source:* Own elaboration from Japan Water Works Association (2012).

have been assessed. Regarding the cost recovery issue, three variables have been evaluated: namely, situation of tariff revision, unit price of water supplied and unit cost of water supplied.

The breakdown of water supply costs into eight categories (personnel, bulk water, power, chemical, depreciation, repair, interest and other costs) for each business scale allows a better understanding of cost differences according to the scale of population supplied and to the future needs of SSWS, since the water utilities with the highest capacity are in general the oldest ones.

The transition of capital income and capital expenditure, the percentage of redemption of bonds in revenue on water supplied and the inter-annual variability of cost breakdown have provided useful information to assess financial issues of Japanese water utilities.

To conclude the study, some remarks about the vulnerability of the technical base, based on the number of staff per utility and the annual volume of water supplied per number of staff, have been pointed out.

RESULTS AND DISCUSSION

Statistical data from JWWA (1998, 2002, 2005, 2007, 2008, 2012) have been used to identify the main issues of Japanese water utilities. It has been illustrated that water utilities in Japan are confronted by enormous difficulties and their effects have become more serious for the SSWU and SSWS. The main challenges identified and the information used to support our statements is presented as follows:

Vulnerability of financial resources

As most of the facilities were built when the country expanded water utilities rapidly, they are now near the renewal period and water operators must quickly accelerate facility renewal work. Although Japan is an earthquake-prone country, only about 30% of the water pipes are quake-proof (JWWA 1998). To prepare for increasingly frequent earthquakes in recent years, water operators need to implement quakeproof technologies as soon as possible (JWWA 2007). Another challenge regarding water infrastructure is the need to establish readiness for emergent chemicals to mix into source water and install new facilities quickly. However, there are not enough funds to invest in facilities for these purposes due to the following reasons.

The decrease in the total revenue from water tariff

Total revenue of water tariff is decreasing due to two motivations: namely, population decline and water consumption per capita decrease. With the water distribution rate already reaching about 100%, there are no factors that could lead to business expansion or revenue increase in the future. Large-scale water utilities are required to downsize their facilities. As shown in Figure 3, Japan's population, which began to decline in 2008, is expected to decrease rapidly going forward. A similar trend was reported by the United Nations (2004) for the more developed regions.

As water-saving supply equipment and polyethylene terephthalate bottled water gain popularity, water consumption volume per capita is steadily decreasing (Figure 4). Under these circumstances, water supply revenue is on a downward trend. If the population continues to decrease in the future, water revenue is likely to see a steep drop. Detailed information about the evolution of the water consumed per capita and per day in many worldwide cities can be consulted in the leaflets on International Statistics for Water Services developed by the International Water Association Specialist Group on Statistics and Economics. An overview of the leaflets published from 2004 to 2012 illustrates that the decrease in water consumption is not a general trend. On the one hand, there are some cities such as Brisbane (Australia), Barcelona (Spain) and Budapest (Hungary), among others, that have significantly decreased their water consumption per capita from 2002 to 2010. On the other hand, for the same time period, other cities, for example, Milan (Italy), Buenos Aires (Argentina) and Vantaa (Finland), have increased the volume of water consumed per capita. More information about the leaflets can be consulted at: http://www.iwahq.org/1w1/communities/specialist-groups/list-of-groups/statistics-and-economics/se-resources.html.

Setting appropriate water tariffs

While water utilities use the idea of full cost recovery in setting tariffs, few of them have been able to set tariffs at sufficiently high levels. Figure 5 shows the tariff revision rates for 285 water utilities that revised tariffs from 2010 to 2012. Among these operators, 109 water utilities (38.2%) lowered water rates. The average change rate was +4.1% with the maximum increase being about 34.3%

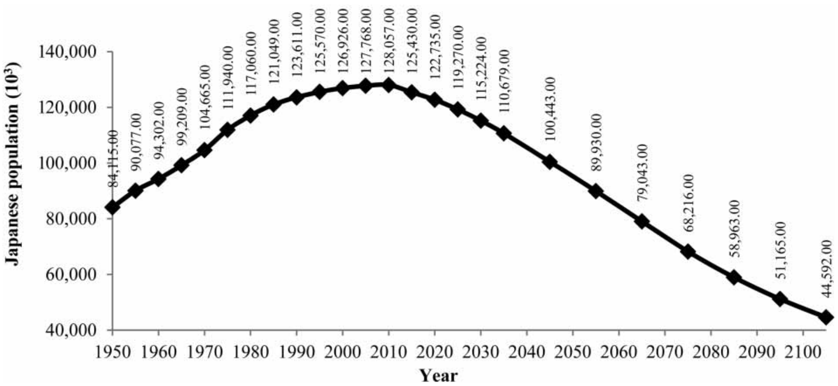

Figure 3 | Transition and estimation of population in Japan. *Source:* Own elaboration from Japan Water Works Association (2005).

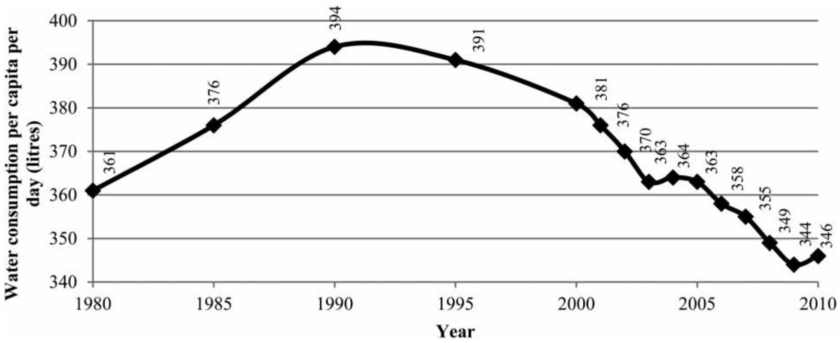

Figure 4 | Evolution of the water consumption per capita per day in Japan. *Source:* Own elaboration from Japan Water Works Association (2012).

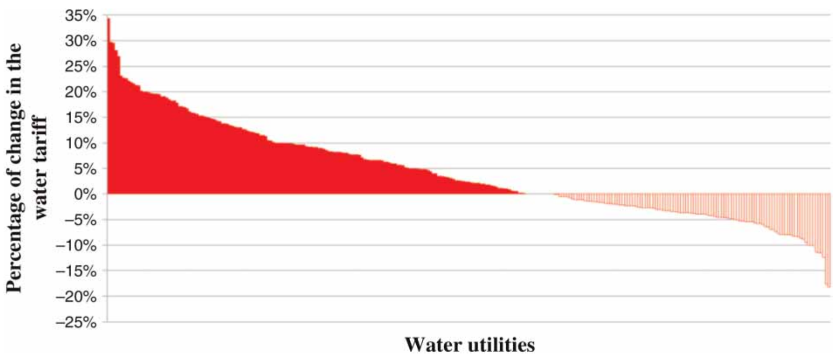

Figure 5 | Situation of water tariff revision from 2010 to 2012. *Source:* Japan Water Works Association (2012).

while the highest decrease was −18.2% (JWWA 2012). In Japan, water tariffs are subject to the decision of the council of local governments that run water utilities. Several water utilities have had to lower tariffs for lack of approval from council or according to mayor's intention. Moreover, tariff revisions are infrequent. The average period between the last two tariff revisions was 8 years and 3 months (JWWA 2012). For 132 water utilities (46.3%), it took longer than this average. This indicates the difficulty in obtaining approval for tariff revisions from local government council. As tariff revisions are infrequent, it is difficult to reflect price fluctuations and economic impacts on water rates (JWWA 2002).

Appropriate water rate design is a problem which affects not only Japanese water utilities but worldwide facilities, since most water utilities operate under some level of political or regulatory price control aimed at minimising tariffs (Zetland & Gasson 2013). Based on the assessment of water tariffs in 308 cities (102 countries), Zetland & Gasson (2013) concluded that water prices are relatively low and correlated with greater risk of shortages.

Although water tariffs design should be performed based on several criteria such as full cost recovery, economic efficiency, equity and simplicity (Barberán & Arbués 2009), it also involves a social dimension based on the universal access to water services for basic needs. In this sense, Martins *et al*. (2013) reported that essential minimum quantities of water are enclosed in the first block of consumption. Hence, in order to improve the affordability and to guarantee water access, water supply is subsidised at basic level.

Regarding cost recovery, Figure 6 presents the unit price and unit cost per cubic metre of water supplied for each business scale. In average terms, costs are slightly higher than water tariff revenues. Therefore, there is some economic deficit for most Japanese water utilities. In other words, sufficient costs are not recovered through water tariffs. Taking into account future facility renewal, it is

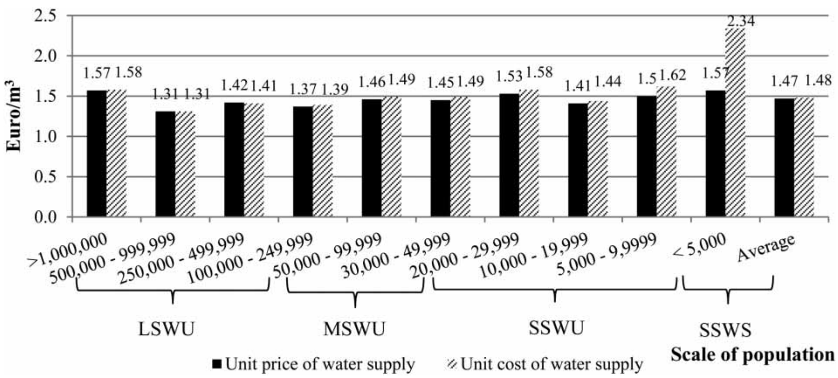

Figure 6 | Unit price and unit cost of water supply by scale of population. *Source:* Own elaboration from Japan Water Works Association (2012).

advisable to set tariff levels so that reasonable profit can be secured. However, most water utilities are unable to do so, while the deficits are covered by other revenues and state and local government subsidies and they are sometimes covered by reserved funds generated by depreciation. Many water utilities cannot afford the funds for the facility renewal in the future. The problem of cost recovery is even more acute in SSWU and SSWS since the smaller scale leads to inefficiency of facilities and personnel. Although these facilities increase depreciation costs, the water operators remain unable to reflect the increased cost in water tariffs.

The cost recovery issue has been widely discussed (Unnerstall & Messner 2007; François *et al*. 2010; Molinos-Senante *et al*. 2013) especially after the implementation of the European Union Water Framework Directive (Directive 2000/60/EC), since one of the key innovations of such a Directive is its call for water services to be charged at a price which fully reflects the services provided (Water Information System for Europe (WISE) 2008).

The percentage of cost recovery for water services is variable depending on the country and within the country depending on water utilities. Therefore, it is difficult to establish general conclusions regarding cost recovery. Nevertheless some studies have been developed addressing this issue. For example, the International Commission for the Protection of the Danube River Basin (ICPDR) (2009) reported the following rates of cost recovery: full cost is recovered in the German Danube River Basin; in Croatia, the rate was 77% for drinking water supply and 45% for wastewater services; in Slovenia the cost recovery was variable depending on the companies but none of the evaluated companies achieved the value of 100%; and in Slovakia cost recovery in 2006 was 98.8% for drinking water supply and 89.7% for wastewater collection and treatment. The United States Agency for International Development (USAID) and OECD (2005) reported that only 5% of Indonesia's 300 utilities were operating at full cost recovery levels and that 40% of utilities were unable to recover their operational costs. Globally, the International Benchmarking Network for Water and Sanitation Utilities (IBNET) water supply and sanitation performance blue book (IBNET 2011) pointed out that the median operation cost coverage ratio declined from 1.11 in 2000 to 1.05 in 2008, with the most significant decrease after 2003. Moreover, the proportion of utilities unable to cover their basic operation and maintenance costs increased from 35% in 2000 to 43% in 2008 with the effect being especially noticeable in low-income countries.

Summarising, full cost recovery is a challenge to be addressed globally since it is linked with the overall performance of water utilities, their financial health and other social issues such as affordability, access to drinking water and good quality services.

Coming back to Japanese water utilities, the breakdown of water supply costs for each business scale (Figure 7 and Table 2) confirms the difficulties that SSWU and SSWS will have in covering rising repair costs when their facilities become dilapidated in the future. Repair costs are a considerably greater percentage of the total cost for the bigger water utilities than for the rest of the utilities, suggesting that the larger facilities, with longer histories, are increasingly inefficient.

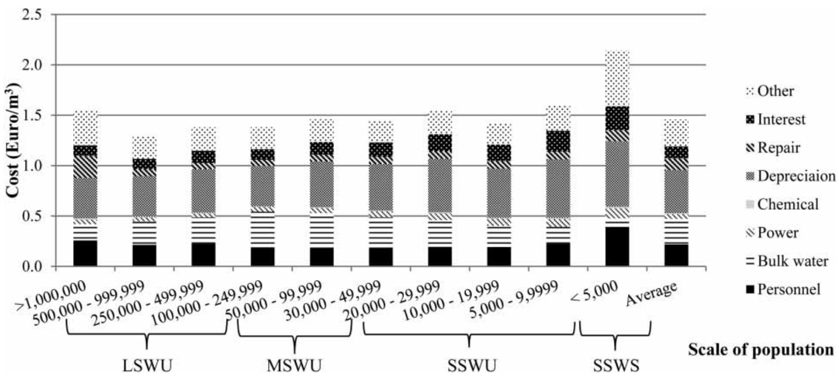

Figure 7 | Cost breakdown of water supply by scale of population. *Source:* Own elaboration from Japan Water Works Association (2012).

Table 2 | Cost breakdown of water supply by scale of population expressed in %

Scale of population		Personnel	Bulk water	Power	Chemical	Depr.	Repair	Interest	Other
LSWU	> 1,000,000	16.6	10.4	2.8	1.0	25.8	14.1	6.6	22.6
	500,000–999,999	16.6	18.1	2.7	0.7	31.1	5.5	7.7	17.5
	250,000–499,999	16.3	19.0	2.7	0.7	31.3	4.5	8.7	16.9
MSWU	100,000–249,999	13.7	25.6	3.3	0.5	29.0	4.5	7.5	15.9
	50,000–99,999	12.3	24.0	3.4	0.6	31.0	4.7	8.5	15.4
SSWU	30,000–49,999	12.3	21.4	4.1	0.6	31.8	5.0	9.7	15.1
	20,000–29,999	12.6	17.3	4.2	0.8	34.4	4.8	10.9	14.9
	10,000–19,999	13.6	14.8	4.9	0.7	34.3	5.4	11.4	14.9
	5,000–9,999	14.1	10.6	4.8	0.8	36.4	4.9	12.9	15.5
SSWS	< 5,000	17.7	4.5	4.7	0.8	30.2	5.2	11.0	25.8
	Average	15.0	17.4	3.2	0.8	29.3	8.0	8.0	18.3

Source: Own elaboration from Japan Water Works Association (2012).

Difficulty in financing

Japanese water utilities use internal reserve, state government subsidies, and enterprise bonds to procure funds for building facilities. With the government suffering from unfavourable financial conditions, however, budgeted state government subsidies and enterprise bonds are shrinking year on year. Figure 8 shows an inter-annual breakdown of capital income and capital expenditures.

Municipality utility bonds and their redemption increased in 2007 and 2008 as the country promoted a refinancing programme to replace high interest bearing bonds with low ones. It does not mean that it was then easier to procure financing for facility renewal. On the contrary, capital expenditure for facility renewal or improvement is on a downward trend, suggesting difficulty in securing funds through municipal utility bonds or subsidies.

Figure 9 and Table 3 present trends in the breakdown of costs. It is shown that total costs are declining due to a decrease in interest expenses by the government's refinancing programmes for municipal utility bonds and personnel reduction. However, the depreciation cost shows a steady increase, foretelling continued increase in facility renewal costs for the future.

Clearly, the redemption of municipal utility bonds affects water supply revenues. Figure 10 shows a partial view of the cash flow for tariff revenues. Interest expenses and redemption of bonds greatly affect the cash flow. In particular, SSWU and SSWS had to allocate half of their tariff revenues for redemption of bonds.

Raising tariffs can be an effective strategy for utilities to meet rising costs of infrastructure and operations, but can also have significant impacts on poor people (OECD 2005). To deal with the challenge of financing new water

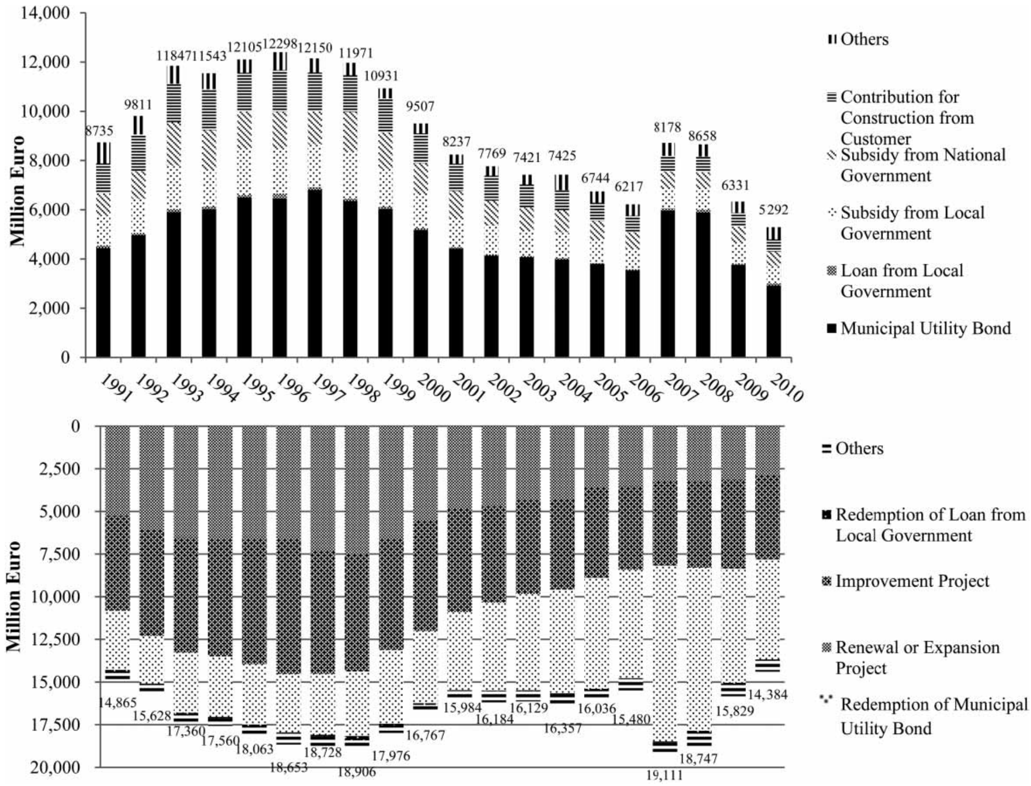

Figure 8 | Transition of capital income and capital expenditure. *Source:* Own elaboration from Japan Water Works Association (2012).

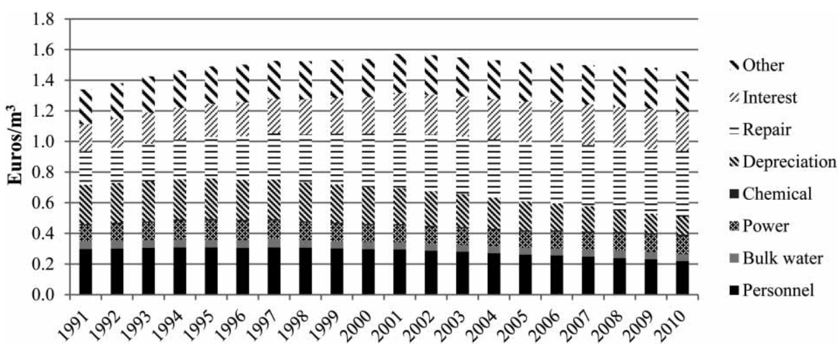

Figure 9 | Inter-annual variability of cost breakdown. *Source:* Own elaboration from Japan Water Works Association (2012).

utilities, government regulations may play a significant role. The paradigmatic case of England and Wales, where the water utilities were fully privatised in 1989 and the entire water infrastructure is privately owned (Barrett & Wallace 2011), should be highlighted. Privatisation was chosen as one of the solutions for addressing the lack of funding (May 2006). Nevertheless the annual growth rate of the water price for every company is regulated by OFWAT (Office of Water Services) following a model that creates incentives to increase efficiency and innovation (De Witte & Marques 2010). In general, it is reported that privatisation in England and Wales has led to water quality and environmental improvements and has enabled the industry to catch up with years of under-investment (Rachwal 2007; Barrett &

Table 3 | Inter-annual variability of cost breakdown expressed in %

	Personnel	Bulk water	Power	Chemical	Depr.	Repair	Interest	Other
1991	22.2	3.9	7.6	0.7	19.1	16.4	13.3	16.8
1992	21.8	3.8	7.8	0.7	18.7	16.7	13.6	16.9
1993	21.4	3.6	7.8	0.6	18.3	17.2	14.3	16.6
1994	21.1	3.6	8.3	0.7	17.8	17.7	14.3	16.6
1995	20.7	3.4	8.4	0.7	17.7	18.2	14.6	16.3
1996	20.3	3.3	8.2	0.7	17.4	19.0	14.8	16.3
1997	20.2	3.8	7.7	0.6	17.0	19.7	14.8	16.2
1998	20.1	3.1	7.6	0.5	16.7	20.6	15.1	16.4
1999	19.7	3.1	7.5	0.5	16.3	21.6	15.3	16.2
2000	19.3	3.1	7.2	0.5	15.7	22.5	15.5	16.3
2001	18.8	3.0	7.0	0.5	14.9	23.2	16.4	16.2
2002	18.3	2.9	7.0	0.5	14.4	23.7	16.7	16.5
2003	18.1	2.9	7.1	0.5	13.9	24.3	16.9	16.4
2004	17.7	2.9	7.1	0.5	13.2	24.9	17.1	16.6
2005	17.2	3.0	6.9	0.6	12.4	25.8	17.2	17.0
2006	17.0	3.0	7.2	0.6	11.7	26.6	17.3	16.7
2007	16.5	3.1	7.2	0.6	11.0	26.9	17.5	17.1
2008	16.0	3.4	7.5	0.7	9.5	27.7	17.6	17.8
2009	15.6	3.1	7.7	0.7	8.5	28.4	17.8	18.2
2010	15.0	3.2	8.0	0.8	8.0	29.3	17.4	18.3

Source: Own elaboration from Japan Water Works Association (2012).

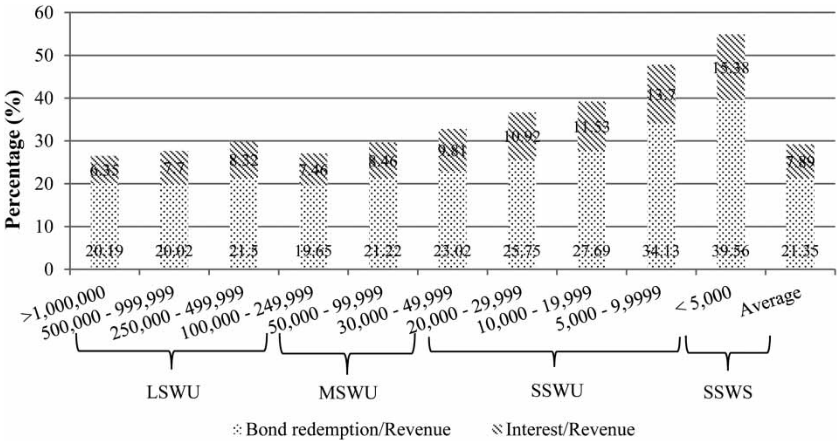

Figure 10 | Percentage of redemption of bonds in revenue on water supply. *Source:* Own elaboration from Japan Water Works Association (2012).

Wallace 2011). There are also case studies where water privatisation was not the solution to financial problems. Megginson & Netter (2001) reviewed 204 privatisations in 41 countries reporting that one-fifth to one-third of privatised firms have registered very slight to no improvement, and even worsening situations occasionally. A further discussion about public private partnerships in the water sector can be found in Mandri-Perrott & Stiggers (2014).

Vulnerability of technical base

Insufficient number of engineers

SSWU and SSWS are operated by a few engineers and 60% of them are over the age of 50. There are important difficulties in handing down technical know-how. Table 4 shows the number of staff members per water utility for each business scale. Other significant information is the ratio of volume of water supplied annually and the number of employees for each water utility. This ratio is one of the indicators commonly used to assess the performance of water utilities (IBNET 2011). In Japan, SSWU and SSWS not only have fewer staff but also suffer from lower amounts of water supply per staff member and consequently inferior management performance (Figure 11). This issue is also related to cost recovery considerations since, as reported in Table 3, staff cost is the major component of operating costs for Japanese water utilities. Although IBNET stated that the ratio 'total number of staff per thousand people' can serve as an indicator of the performance of water utilities, this information was not available for any of the 87 countries analysed. Hence, it was not possible to use this ratio with Japanese water utilities to identify understaffing.

Table 4 | Number of staff by scale of population

Scale of population		Administrative staff	Technical staff	Skilled staff
LSWU	> 1,000,000	385.4	526.7	190.7
	500,000–999,999	87	134.7	15.3
	250,000–499,999	45.3	69.1	16
MSWU	100,000–249,999	21	17.9	4.1
	50,000–99,999	10.2	10.7	1.2
SSWU	30,000–49,999	7.1	5.3	0.5
	20,000–29,999	5.1	3.7	0.3
	10,000–19,999	3.5	2.1	0.2
	5,000–9,999	2.5	1.2	0.1
SSWS	< 5,000	1.8	0.1	0.1
	Average	12.6	14.1	3.4

Source: Own elaboration from Japan Water Works Association (2012).

Water supply is a demanding and responsible task which requires highly qualified personnel. The procedures, techniques and requirements in this field develop continuously, therefore additional training of personnel is of key importance for a sustainable and high quality supply (OECD 2005).

Backup function in emergency

Regarding the impacts of earthquakes on water utilities, it should be highlighted that a 9 magnitude earthquake hit the Tohoku region (Northeastern Japan) in March, 2011. The earthquake damaged water systems from Sendai, China, Tokyo, Kanagama and others. Moreover, the earthquake triggered a tsunami event which seriously damaged many wastewater treatment plants located near the coastline (Eidinger & Davis 2012).

Due to the many large earthquakes in Japan's history many of the Japanese LSWU have undertaken extensive and expensive seismic countermeasures over the past 20

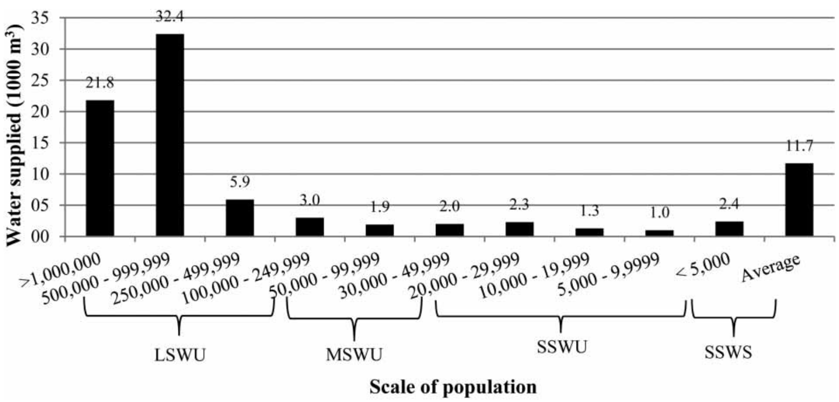

Figure 11 | Annual water supply volume per number of staff. *Source:* Own elaboration from Japan Water Works Association (2012).

years or so including seismic upgrade of tanks and water treatment plant facilities; installation of underground emergency store tanks; and wholesale replacement of older pipelines with new seismic resistant ones (Eidinger & Davis 2012). However, these prevention measures have not yet been implemented in SSWU and SSWS (JWWA 1998, 2007).

It can be summarised that in terms of preparedness for earthquakes and other emergencies, SSWU and SSWS have limitations in the following respects (JWWA 1998, 2007):

- Alternative water resources in emergency: only a few SSWU and SSWS have multiple water resources. Many of them purify water by simply injecting chlorine. A degradation of water quality at water resources due to disasters results in extended water outage.
- Emergency preparedness of personnel: smaller water operators, because of the limited number of staff, cannot adequately respond to emergencies.
- Backup materials and equipment: smaller operators are naturally limited in stockpiles. In the event of earthquakes or other disasters, SSWU and SSWS restore affected water facilities with the assistance from nearby LSWU and MSWU.

CONCLUSIONS

The assessment of the current state of water management in Japan based on statistical data has illustrated that Japanese water utilities face two main challenges: namely, vulnerability of financial resources and vulnerability of technical base.

In Japan (and in most developed countries), water facilities were built when the country expanded and now they are drawing near the renewal period; therefore, water operators must quickly accelerate facility renewal works. In this context, it has been identified that financial sustainability of Japanese water utilities is conditioned by three factors: (i) the decrease in the total revenue from water tariff; (ii) the difficulties in achieving the full cost recovery; and (iii) the difficulties in financing.

The financial sustainability of water utilities is essential to: (i) guarantee the provision of high quality services aimed to meet the current and future needs; (ii) avoid the degradation of infrastructure resulting in worse quality services; and (iii) provide services to citizens at the lowest possible costs. Currently, Japanese water utilities have maintained a high level of water supply services such as high-level drinking water quality, superior leakage control technologies and high preparedness for earthquakes and other emergencies. To ensure that this high-quality service continues, water utilities and water authorities should implement some measures and policies.

Regarding water rates, the adoption of sustainable tariffs, allowing recovery of the full cost of water services while ensuring affordability, should be promoted. Since it has been illustrated that one of the main barriers to achieving full cost recovery is tariff revision, local governments should revise their criteria to approve tariffs revisions including the full cost recovery criterion. Water authorities should raise awareness about the importance of recovering costs to guarantee high-quality water supply services. With a better understanding of the benefits of full cost recovery, governments will be more likely to adopt, implement and enforce rationally-based water pricing policies. An improvement of the operational efficiency of the water utilities would allow a reduction in their vulnerability of financial resources and technical base. In doing so, innovative practices and cost saving methods should be adopted. It has been illustrated that the percentage of unbilled water is almost the same as the percentage of water consumed by industry. Hence, developing non-revenue water policies and programmes is a key point. The adoption of best practices to reduce input costs (energy and chemicals) may be very useful. Regarding the insufficient number of qualified staff, training programmes to improve staff performance and capabilities should be promoted.

To conclude, it should be highlighted that planning is essential for both water utilities and water authorities to identify priority projects and timeframes for their implementation.

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