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The possibility of wide-area cooperation

– A study of unified wide-area waterworks management

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<Abstract>

A. Although the curve of Japan's declining water supplied population has a little more gentle gradient than that of the decline in the overall population, it shows a tendency to keep declining. This decline has pushed down income from water charges, having a profound impact on the waterworks business.

B. To address the three major problems—the small scale of business, economic efficiency, and aging—with our country's waterworks business, an increasing number of member entities have come to rely on common treatment again after the completion of municipal mergers. Unified wide-area waterworks management is a form that allows for the most exhaustive control of organizations.

C. The water supply authorities in Kagawa and Hiroshima, which are advanced in unified wide-area waterworks management, have several noteworthy characteristics.

1. Since the water supplied population has consistently declined since before the integration of operators' businesses, a combination of unified wide-area waterworks management and a timely revision of charges would be able to assure sustainable development of the waterworks business.
2. Water supply authorities will be able to manage assets and liabilities in a well-balanced manner by focusing expenditures on investments for wide-area waterworks management.
3. Water supply authorities have consolidated water purification plants in an effort to cut back on depreciation expenses, which helped them keep down water supply cost.
4. This paper provides details of quantitative analyses on how water supply authorities with unified wide-area waterworks management have obtained certain positive effects, including (a) reduction in the unit price of water supply, (b) correction of regional disparities in the unit price, (c) optimization of facilities, and (d) reinforcement of organizational and control systems.

D. It is necessary to continue the verification of the effects of wide-area water-works while accumulating data. It would be essential to focus the verification on those works directly linked to the lives of residents. It will be increasingly important from now to think about the issue of "what is the business form that would allow waterworks operators to keep down the unit price of water supply and try to correct regional disparities in the unit price in the waterworks sector in a society faced with the declining population."

Introduction

According to the population estimates as of January 1, 2023, Japan has a population of 124,770,000, representing a steady year-on-year decline of 0.43%. In particular, the population aged less than 15 years came to just 1,4563,000, recording a marked decrease of 1.79% from the same period a year earlier. Given these circumstances, the prime minister of Japan referred in his policy speech on January 23 to a rapidly declining birthrate and a fall in the estimated number of births for last year that failed to reach 800,000. He said this trend had brought our country to the brink of collapse of social functions that we should maintain.

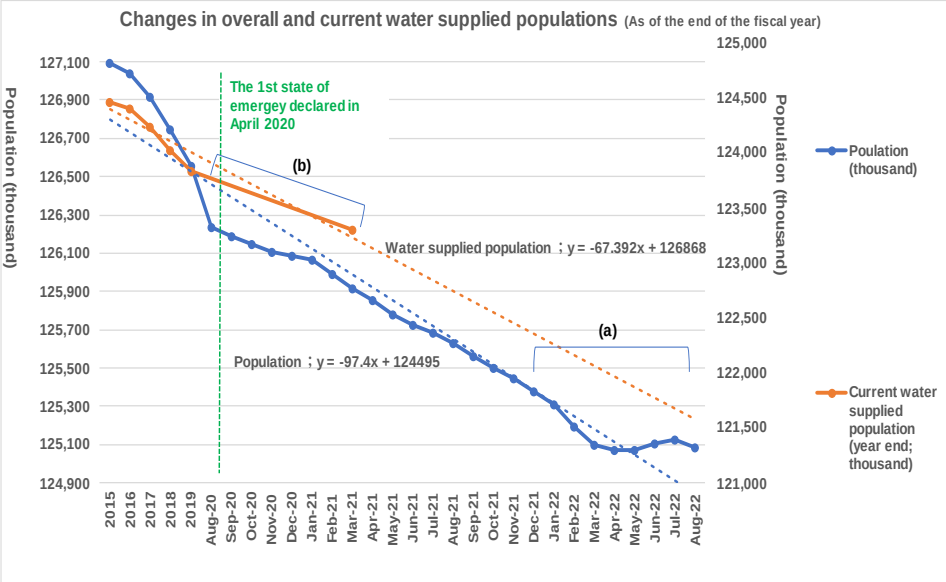
In such a depopulating society, one of the measures underpinning our country's administrative services is wide-area cooperation among local governments.[1] However, the dwindling population—a trend which has lingered since 2008—has had various impacts on local government services, one of which is the waterworks business run by municipalities.

This is why this paper addresses wide-area cooperation in the waterworks business and particularly looks at how wide-area waterworks management through business integration across all waterworks operators within a single prefecture (hereinafter referred to as "unified wide-area waterworks management") has influenced the management of the waterworks business. In other words, a form of wide-area waterworks management that allows for the most thorough control of organizations is unified wide-area waterworks management that integrates services provided by all waterworks operators in the prefecture[2]. Then, what are (or will likely be) the effects of the wide-area waterworks management exercised by business entities that have already adopted or plan to adopt unified wide-area waterworks management (these entities are partial administrative unions under the Local Autonomy Act but hereafter referred to as "water supply authorities")? This is the issue to be addressed in this paper.

I. Changes in the overall and current water supplied population

First, let's look at the recent trends in Japan's population decline (**see Figure1**).

<Figure1> Changes in water-supplied populations



This figure was created by the author.

According to population estimates,[3] while the declining trend began in 2008, the population marked a significant fall in August 2020 following the state of emergency on COVID-19 declared

[1] The Regional Revitalization "Long-Term Vision" "General Strategy," formulated in January 2014, states "create regions fitted with the times, keep our lives safe and facilitate cooperation among regions" as one of the basic goals for the development of future measures.

[2] Patterns of wide-area waterworks management are discussed in the chapterⅢ below. See Table1 below.

[3] The production of population estimates is overseen by the Statistics Bureau, the Ministry of Internal Affairs and Communications.

in April of the same year. The population continued to decline slightly slowly after September until February 2022, when it started to stop declining on a monthly basis (section (a)).

On the other hand, the (approximate) curved line showing Japan's water supplied population declines with a little more gentle gradient than that of the change rate of the population decline (-97.4) (section (b); a gradient of -67.392), but it has a tendency to continue to decline. Such a decline in the water supplied population associated with the dwindling population has lowered revenues from water charges, having a serious impact on the water supply business.

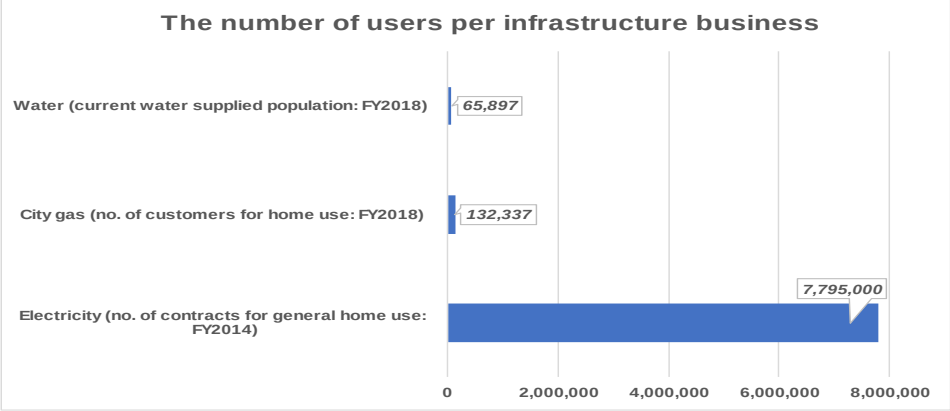
II. The situations of the water supply business

Then, let's look at the current situations of the structural problems of the water supply business in terms of scale, economic efficiency, and aging.

A. Small scale of business

First of all, when compared with electricity, gas, and other infrastructure supply services, one of the notable characteristics of the water supply business is the small number of users per operator. The number of users per operator is 7,795,000 for electricity, 132,000 for city gas, and 65,000 for water (**see Figure2**).

<Figure2> The number of users of infrastructures



This figure was created by the author.

This is one of the consequences of Article 6.2 of the Waterworks Act stating that the water supply business should be operated by municipalities in principle. The small-scale management base also causes financial instability and disparities in charges, presenting structural challenges that the water supply business needs to confront and deal with constantly.

B. Economic efficiency

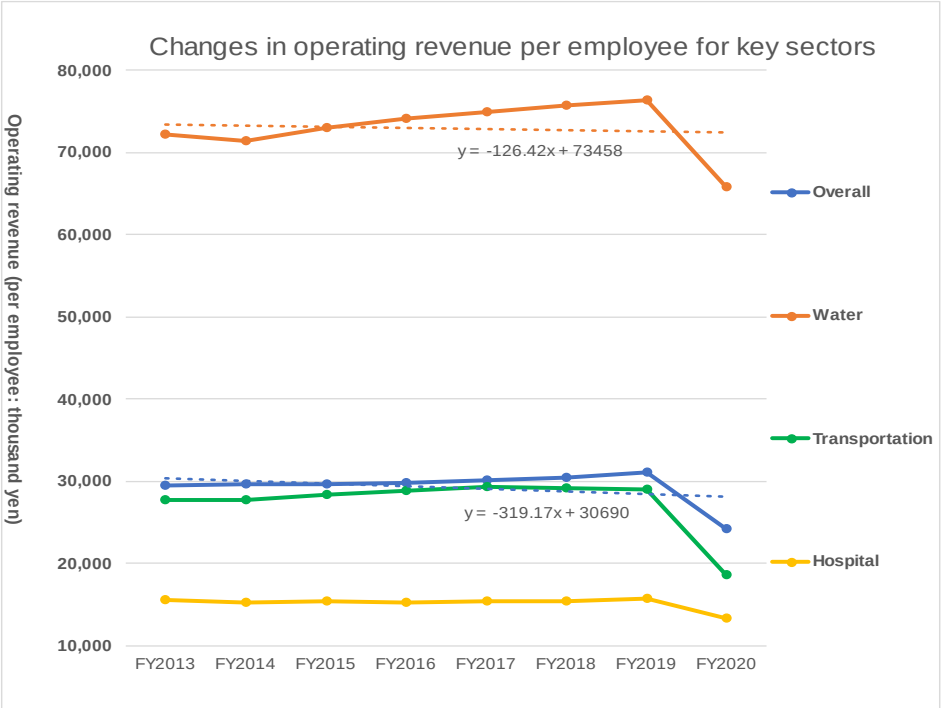
Municipal enterprises are required by law to demonstrate economic efficiency and publicness.[4] However, comparing changes in operating revenue per employee in each of the key operations of municipal enterprises highlighted the following.

1. The water supply business earns a relatively higher level of operating revenue (70 million yen or over) than the average of all services (around 30 million yen) (**see Figure3**).
2. Looking at how operating revenues changed from fiscal 2013 to 2020, many local governments

[4] As a basic operational principle of municipal enterprises, Article 3 of the Local Public Enterprise Act sets out that "municipal enterprises should constantly demonstrate economic efficiency as a business enterprise and should be operated to meet its intended purpose of promoting public welfare."

took measures to allow delay in the payment of water charges in fiscal 2020 to deal with COVID-19.[5] In addition, lower consumption of water for business use led to a significant fall in operating revenue (and as a result, the approximate curved line showing the growth rate for the entire period had a gradient of -126.42). For the period until fiscal 2019, operating revenue of the water supply business tended to remain unchanged and showed no remarkable increase in revenue.

<Figure3>



This figure was created by the author based on a yearbook by the Ministry of Internal Affairs and Communications.

As such, the water supply business, which once demonstrated stable economic efficiency among municipal enterprises, became a business with structural operating problems, with operating revenue per employee hitting the ceiling due to the declining water supplied population.

C. Aging

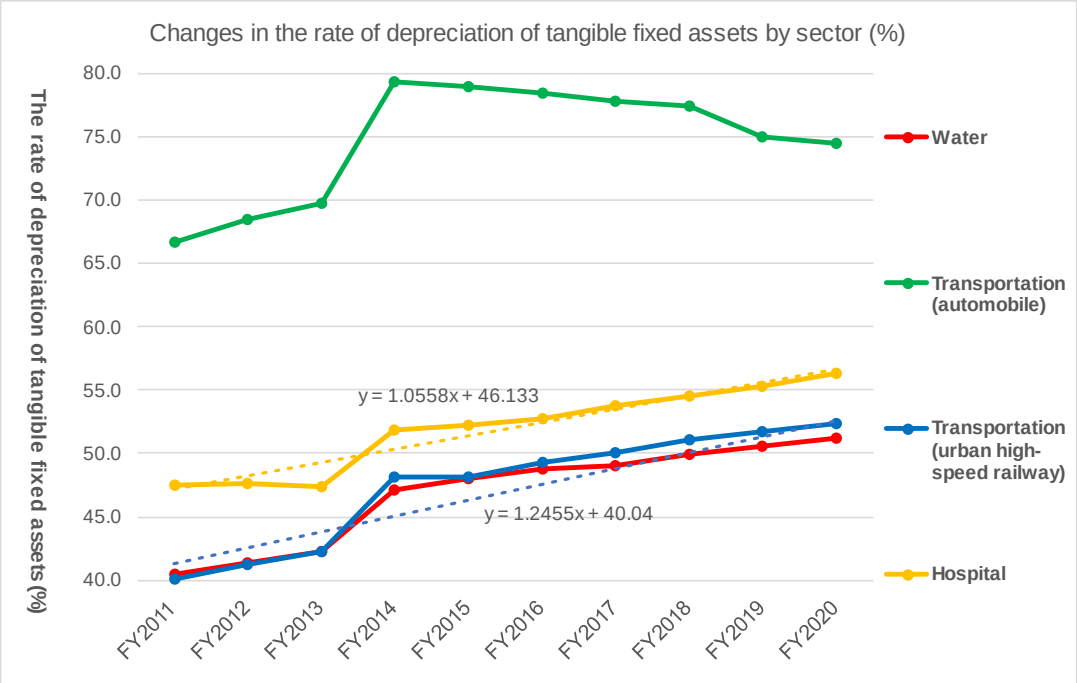
For asset utilization businesses, which obtain operating revenue by utilizing assets, aging of assets can give rise to various undesirable effects in terms of economic efficiency of the business (such as water leakage), assurance of health, and vulnerability to disaster. A comparison of major businesses using the rate of depreciation of tangible fixed assets,[6] an indicator of aging of municipal enterprise facilities, shows the following characteristics of the water supply business.

a. When compared with other major businesses categorized as asset utilization businesses, the water supply business has a relatively lower rate of depreciation of tangible fixed assets than the transportation (by automobile and urban high-speed railway) or hospital business (**see Figure4**).

[5] In a notice dated March 18, 2020, issued by the Ministry of Health, Labour and Welfare (MHLW), the central government requested local governments to consider grace of payment for those who have temporal difficulties paying water charges.

[6] The rate of depreciation of tangible fixed assets, also called the rate of aging assets, is an indicator showing how aged municipal enterprises' assets are. The rate of depreciation of tangible fixed assets is calculated by dividing accumulated depreciation by acquisition cost.

<Figure4> Changes of the rate of depreciation of tangible fixed assets



The figure was created by the author.

b. However, this rate has consistently increased for the water supply business at a pace higher than that of the hospital business (with the approximate curved line having a gradient of 1.2455 and 1.0558, respectively). In other words, although upgrading aging pipes used for the water supply business has been an issue for many years, these data show that recent asset aging in the water supply business has been progressing faster than the hospital business.

III. Wide-area waterworks management

A. Efforts toward wide-area waterworks management

1.Background

Given the situations as described above, the government has proceeded with measures to promote wide-area waterworks management primarily among municipalities.

Specifically, the Water Supply Vision developed by the Ministry of Health, Labour and Welfare (MHLW) in 2004 paved the way for prefectures to formulate wide-area waterworks management plans and initiate measures to promote the new concept of wide-area waterworks management, including integration of software.

Then, given the continued decline in the overall and water supplied populations since 2008 (**see Figure1 above**), it became increasingly important to further promote wide-area waterworks management. The 2014 New Water Supply Vision requested small-scale waterworks operators in particular to consider incorporating their tap water supply and adjacent waterworks businesses into the progressive system of wide-area management. Moreover, in 2018, (a) the central government set out basic policies on infrastructure reinforcement, and (b) made a partial amendment to the Waterworks Act to allow prefectures to formulate plans to reinforce waterworks infrastructure and set up councils for water supply business operators and other stakeholders.

In 2019, the Ministry of Internal Affairs and Communications (MIC) and the MHLW issued a

notice titled “The formulation of a ‘plan to promote wide-area waterworks management’” [7] requesting prefectures to develop a plan to promote wide-area waterworks management through fiscal 2022. This plan intends to deepen discussions for medium- to long-term future through comparison and review of simulations on wide-area waterworks management.

2. Types of wide-area waterworks management

There are various methodologies currently used for wide-area waterworks management, including setting up water supply authorities and alternative execution of administrative procedures (**see Table 1**).

<Table 1> Patterns of wide-area waterworks management

Common treatment method	Type		Local Autonomy Law, etc. (governing rules)
Water supply authority/wide-area confederations	Business integration (of management bodies and waterworks businesses into a single organization)	Horizontal integration (of waterworks businesses)	Article 284 (Article 39.2.1 of the Local Public Enterprise Act)
		Vertical integration (of water supply for industrial and end users)	
	Management integration (of management bodies. Keep waterworks businesses as they are)		
Proxy service for paperworks	Provided by prefecutres		Article 252.16.2
	Including cetntral cities		
Other methods	Agreement on the formation of autonomous areas for settlement		
	Shared use of facilities	Shared installation and use of waterworks facilities, connection systems for emergency contact	
	Shared management	Foundation of third-sector entities	
		Shared use of systems	
		A de-facto council	
		Common outsourcing (of water quality testing, facility management, and other services in an integrated way)	
		Common order	

The table is created by the author.

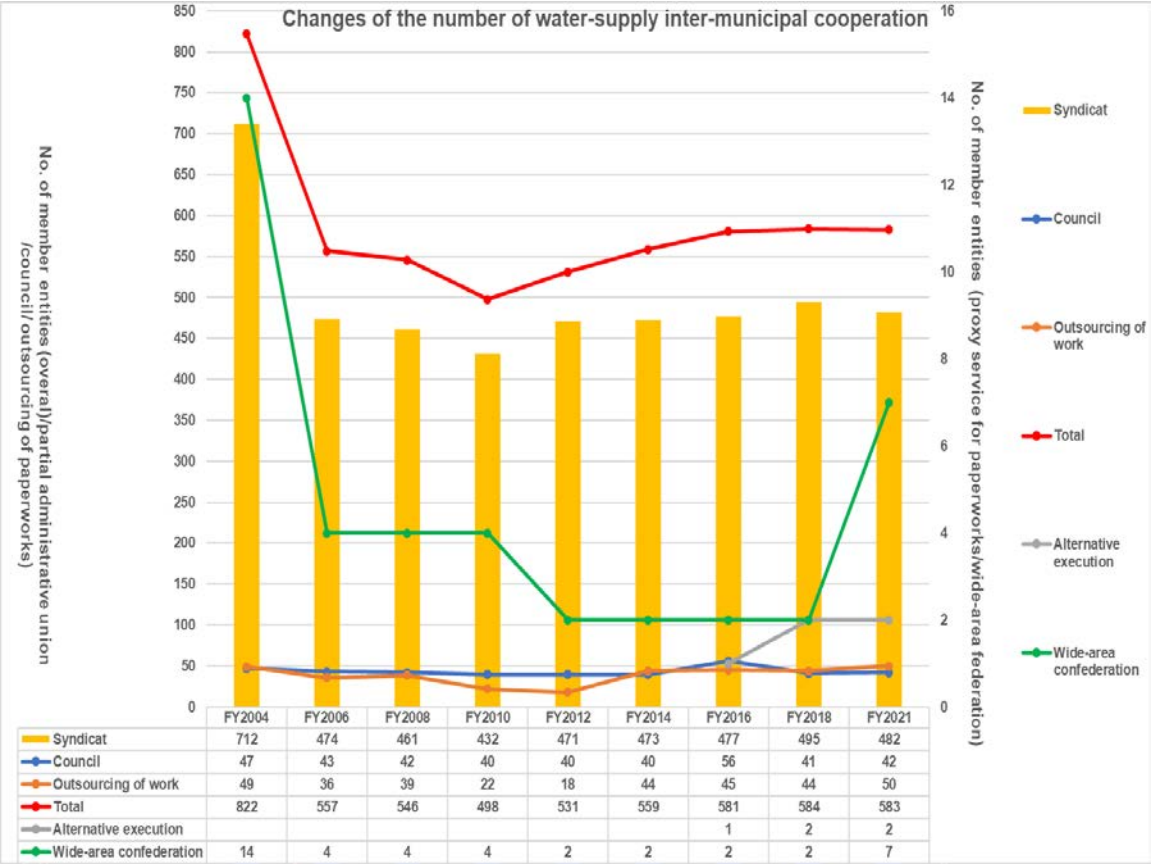
As described above, wide-area waterworks management is a type of business integration methods listed in table1. It means a business integration for all waterworks operators within the same prefecture and is a form of wide-area waterworks management that allows for the most thorough control of organizations.

[7] The No. 85 notice dated January 25, 2019, general finance management/life and food, No. 0125 No. 4 issued by MIC Director-General of the Local Public Finance Bureau, Deputy Director-General, Environmental Health/Food Safety Bureau, the Minister’s Secretariat of MHLW.

3. The present status of wide-area waterworks management

This section provides an overview of the present status of wide-area waterworks management. As water supply operators, some municipalities find it difficult to provide adequate services on their own due to their small scale of business, shortage of financial resources, lack of technology, or for other reasons. They have used common treatment systems under the Local Autonomy Law, including water supply authorities (a type of partial administrative unions) and wide-area confederation authorities (a type of wide-area confederations) (**see Figure5**).

<Figure5> Changes of Cooperation



	FY2004	FY2006	FY2008	FY2010	FY2012	FY2014	FY2016	FY2018	FY2021
Syndicat	712	474	461	432	471	473	477	495	482
Council	47	43	42	40	40	40	56	41	42
Outsourcing of work	49	36	39	22	18	44	45	44	50
Total	822	557	546	498	531	559	581	584	583
Alternative execution							1	2	2
Wide-area confederation	14	4	4	4	2	2	2	2	7

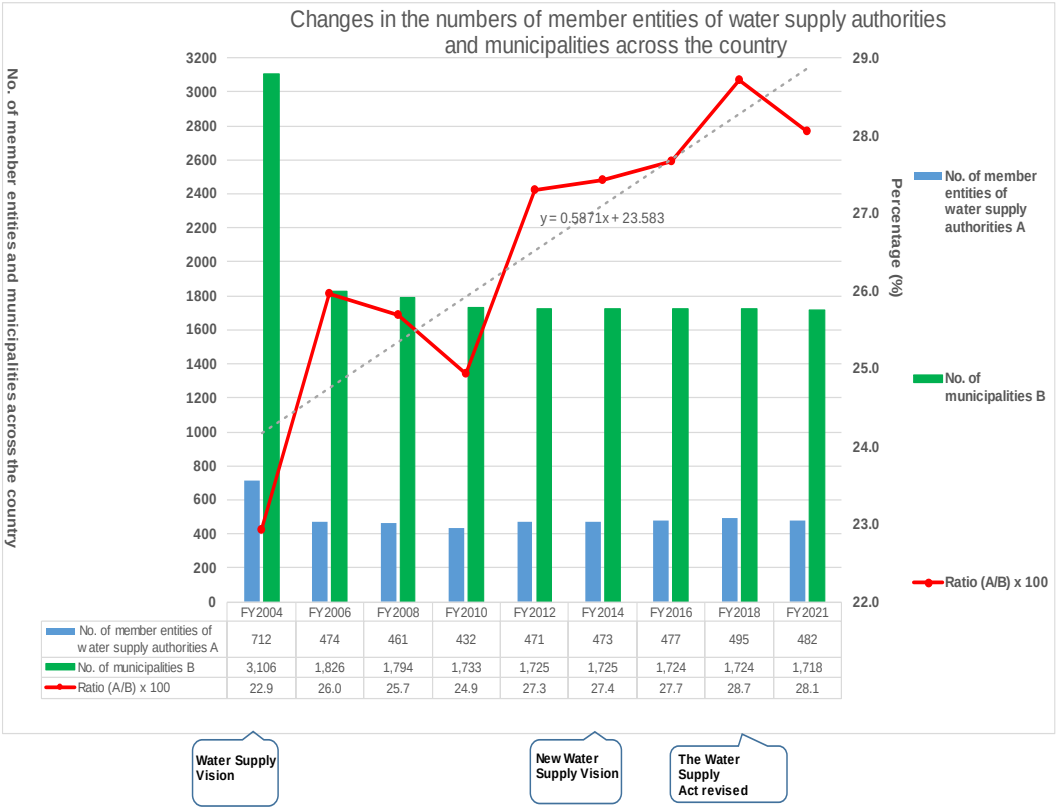
This chart was created by the author.

These common treatment systems diminished in number during the period of municipal mergers from 1999 to 2010. However, the number of entities using common treatment systems has resurged since 2010. Among other options for common treatment, the number of entities participating in water supply authorities has steadily increased (the [approximate] line showing the growth rate had a gradient of 13.2 for the period from fiscal 2010 to 2018) (**see Figure5 above**).[8]

In fiscal 2021, there was also a shift to wide-area confederation authorities and other forms of common treatment systems. However, the number of entities participating in water supply authorities had shown consistent growth until fiscal 2018. From fiscal 2004 to 2018, the proportion of entities to municipalities across the country also continued to increase, with the (approximate) line showing the growth rate climbing with a gradient of 0.5871 (**see Figure6**).

[8] As common treatment systems were streamlined, entities participating in water supply authorities decreased by 13 in fiscal 2021 from fiscal 2018, while the number of entities constituting wide-area federal water supply authorities increased by six, and the number of entities outsourcing administrative procedures increased by five.

<Figure6> Changes in the number of member entities



	FY2004	FY2006	FY2008	FY2010	FY2012	FY2014	FY2016	FY2018	FY2021
No. of member entities of water supply authorities A	712	474	461	432	471	473	477	495	482
No. of municipalities B	3,106	1,826	1,794	1,733	1,725	1,725	1,724	1,724	1,718
Ratio (A/B) x 100	22.9	26.0	25.7	24.9	27.3	27.4	27.7	28.7	28.1

This chart was created by the author.

B. Unified wide-area waterworks management

As described above, entities participating in water supply authorities and wide-area confederation authorities have steadily increased. Among them, unified wide-area waterworks management allows for the most thorough control of organizations. As examples of this concept, let us overview the Kagawa Water Supply Authority (hereinafter referred to as the “Kagawa Authority”) and the Hiroshima Water Supply Authority (hereinafter referred to as the “Hiroshima Authority”).

1. The case of the Kagawa Authority

The Kagawa Authority is a water supply authority comprised of the prefecture and eight cities and eight towns within the prefecture, excluding Naoshima Town. It built the first unified wide-area waterworks management system in Japan and oversees water supply businesses for general and industrial uses.

Water supply businesses in the prefecture have faced a pile of problems, including declining water supply revenue resulting from a declining population, aged waterworks facilities, responses to a massive earthquake that is predicted to occur in the near future, and succession of technology among water supply service personnel. To resolve these problems, the prefectural authority devised measures to consolidate water supply businesses within the prefecture and thereby eliminate or integrate facilities, improve operational efficiency, and cut down expenses in order to reinforce the operational foundation. In May 2015, the preparation council held its first meeting and proceeded with discussions. In November 2017, Kagawa Authority was founded with the permission of the Minister for Internal Affairs and Communications and started the operation in April 2018.

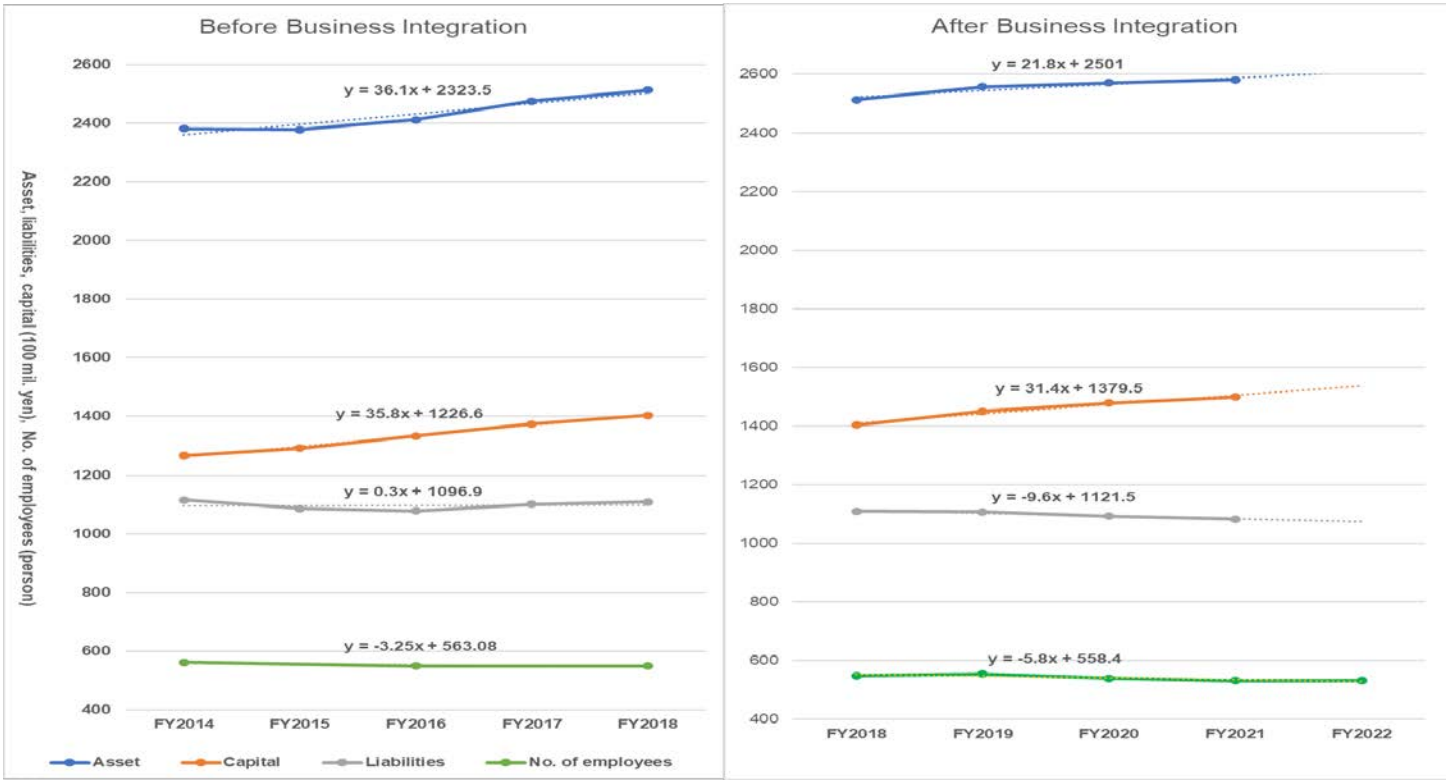
Under the 2017 Master Plan on Kagawa Prefecture's Wide-Area Waterworks Management, water charges will be unified in fiscal 2028 after the wide-area waterworks facility building projects are completed. Faced with the need to unify different schedules of water charges, the master plan sets out the basic policy of unifying those schedules based on the one of Takamatsu City, which has the largest number of consumers in the prefecture.

The master plan also mentions the upgrading of aged facilities, stating that facilities will be shut down or abolished through integration or by other means where possible, while efficiently using the functions of operative facilities to keep down demand for upgrading.

Looking at changes in the balance sheets before and after the business integration in fiscal 2018, they can be characterized as follows (**see Figure7**).

a. After the business integration, assets are expected to continue stable growth (the [approximate] line showing the growth rate had a gradient of 36.1 before the integration and 21.8 after the integration).
b. Capital is expected to increase after the business integration as liabilities are likely to diminish after the business integration (the line showing the growth rate had a gradient of 35.8 before the integration and 31.4 after the integration).
c. Liabilities, which had remained unchanged before the business integration, will likely start to diminish after the business integration (the line showing the growth rate had a gradient of 0.3 before the integration and -9.6 after the integration).
d. The number of employees has already started to decline before the consolidation, but the consolidation will push up the rate of decline (the line showing the growth rate had a gradient of -3.25 before the integration and -5.8 after the integration).

<Figure7> The Kagawa Authority–Comparison of BS and the number of staff before and after business integration

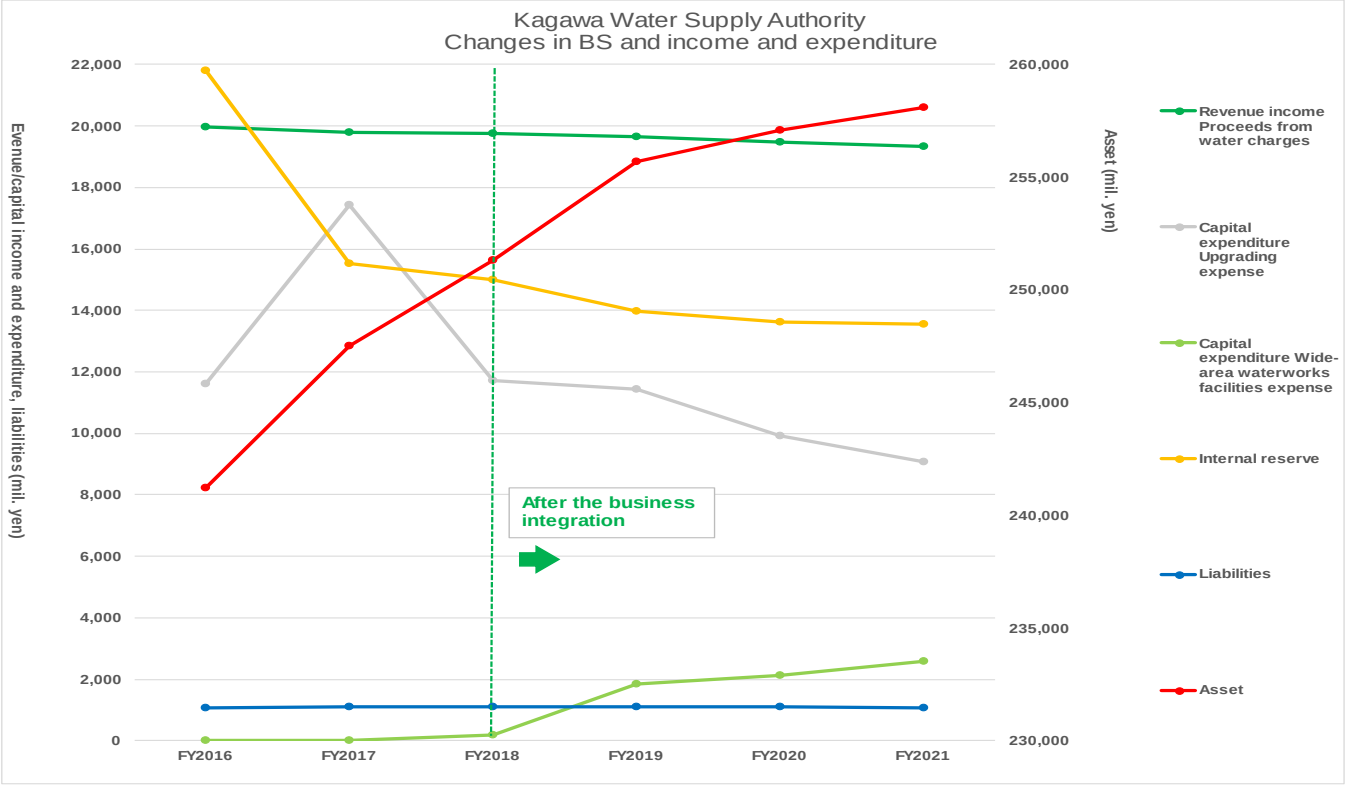


The chart was created by the author based on the Master Plan on Kagawa Prefecture's Wide-Area Water Supply System.

Taking advantage of the business integration, the master plan sets out a clear policy of cutting back on liabilities and reducing the number of employees, assuming that these measures will have positive effects.

Next, changes in key revenues and expenditures are shown in **Figure8**.

<Figure 8> Kagawa Water Supply Authority



The chart was created by the author based on the Master Plan on Kagawa Prefecture's Wide-Area Waterworks Management.

The changes can be characterized as follows;

a. Water charge revenue is expected to continue gradual decrease even after the business integration.

b. Facility investment is focused on integration or abolishment of water purification plants and the building of facilities that will help assure flexible provision of water across different areas, and budgets are allocated to build a wide-area water supply facilities. Government subsidies are used, while budgets for upgrading projects for capital expenditure are kept down.

c. To ensure fairness among operators, water charges will be determined rightly considering a balance between revenues and expenses for each former water supply operator, so that internal reserve will account for around 50% of water charge revenue in fiscal 2027 and that the balance of outstanding enterprise loans will represent 350% of water charge revenue or less through solid financial management.

After the business integration, the Kagawa Authority seems to have a financial management policy of using government subsidies and other resources effectively, while focusing capital expenditure on facility investments for wide-area waterworks management and cutting down budgets for general upgrading projects so as to reduce liabilities and expand assets. This suggests that the authority aims to cut back on liabilities as indicated in **Figure8**, while continuing to increase

assets incrementally.

2. The case of the Hiroshima Authority

Hiroshima Prefecture's water supply business is expected to worsen rapidly in the future due to a fall in water supply revenue stemming from a declining population, a potential increase in upgrading expenses for aged facilities, and other factors. Some cities and towns might even become unable to maintain themselves. Therefore, the prefecture considered measures to reinforce the foundation of the water supply business through wide-area cooperation beyond the municipal boundary.

In this context, the prefecture and 21 cities and towns operating water supply businesses set up a council for wide-area water supply cooperation in April 2018. With reference to opinions from the council, the prefecture formulated the Policy on the Promotion of Hiroshima Prefecture's Wide-Area Water Supply Cooperation in June 2020, outlining the prefecture's view in favor of "cooperation through integration" to unify the management organizations of water supply operators in the prefecture.

In April 2021, the Preparatory Council for the Foundation of the Hiroshima Water Supply Authority started reviews and preparations toward integration of water supply businesses under the Master Agreement on the Integration of Water Supply Businesses in Hiroshima Prefecture. As a result, 14 cities and towns and the prefecture integrated their respective tap water businesses (1), water supply businesses for city water (2), and water supply businesses for industrial use on April 1, 2023. As the management body, they set up the Hiroshima Authority in fiscal 2022 as a wide-area confederation authority.

It has a characteristic financial management policy. Firstly, accounts for municipalities are segregated from those for the prefecture, and water charges are maintained at the current levels for municipalities and the prefecture respectively at the initial stage of the Hiroshima Authority. After a decade, they will examine outcomes of wide-area cooperation initiatives and future business forecasts, and then look into the possibility of integrating accounts and water charges. For the tap water supply business, they plan to use financial resources derived from the business integration and reduce charges on member entities by 8%.

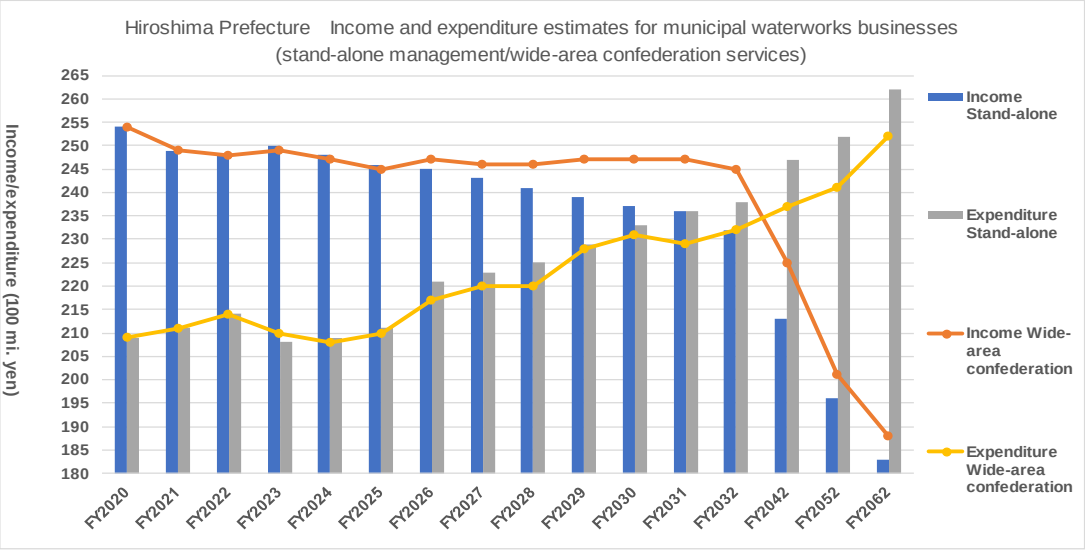
Secondly, the Hiroshima Authority has the following policies on facility development.

a. Facilities should be reorganized and developed not for each city or town, but for each of the five areas (Ota River, Oze River, Yahata River, Nuta River, Ashida River, and Gono River), which are formed based on river basins where natural water flow can be utilized and wide-area waterworks facilities for the tap water supply business, considering future demand for water and as described below, in order to reduce expenses for upgrading and maintenance costs in the future.
    - Abolish water purification plants that are inefficient due to declining demand for water and concentrate functions on those that have high and extra water purification capabilities as much as possible.
    - Abolish or adjust the scale of distribution reservoirs in light of progress in the reorganization and development of water purification plants.
    - Downsize pipelines at the time of upgrading.

b. Facilities should be reorganized and developed to optimize their capabilities to deal with an expected decline in water demand, such as by halving the size of water purification plants, using government subsidies as much as possible.

Thirdly, Hiroshima Prefecture verified the effect of the foundation of the Hiroshima Authority in the Hiroshima Prefecture Water Supply Authority Business Plan formulated in July 2022 by comparing estimated revenue from stand-alone water supply businesses by individual entities without setting up a wide-area confederation authority, with those that would be obtained by a wide-area confederation authority. This comparison demonstrates that income and expenditures would start to balance out in fiscal 2032 for stand-alone businesses, while the wide-area confederation authority's service would be able to stay in the black in a stable manner (with income exceeding expenditures) through fiscal 2032. In such case, however, it is estimated that expenditures will surpass income by fiscal 2042 unless water charges are revised (increased) (**see Figure9**).

<Figure 9> Hiroshima Prefecture Waterworks; Income and Expenditure Estimates



This chart was created by the author based on the Business Plan of Hiroshima Water Supply Authority.

It is expected that waterworks business can be continued by introducing unified wide-area cooperation in combination with a timely revision of charges.

IV. The effect of unified wide-area waterworks management

As seen in the examples of the Kagawa Authority and the Hiroshima Authority, unified wide-area waterworks management has already taken shape as business projects. But what effects these unified wide-area waterworks management projects are expected to and actually bring about (or are bringing about)?

In view of previous local government discussions, unified wide-area waterworks management will turn out effective for the water supply business in that it will help: (a) keep down the unit price of water supply service, (b) correct regional disparities in the unit price, (c) optimize facilities, and (d) reinforce control of organizations. The following describes more about these four points.

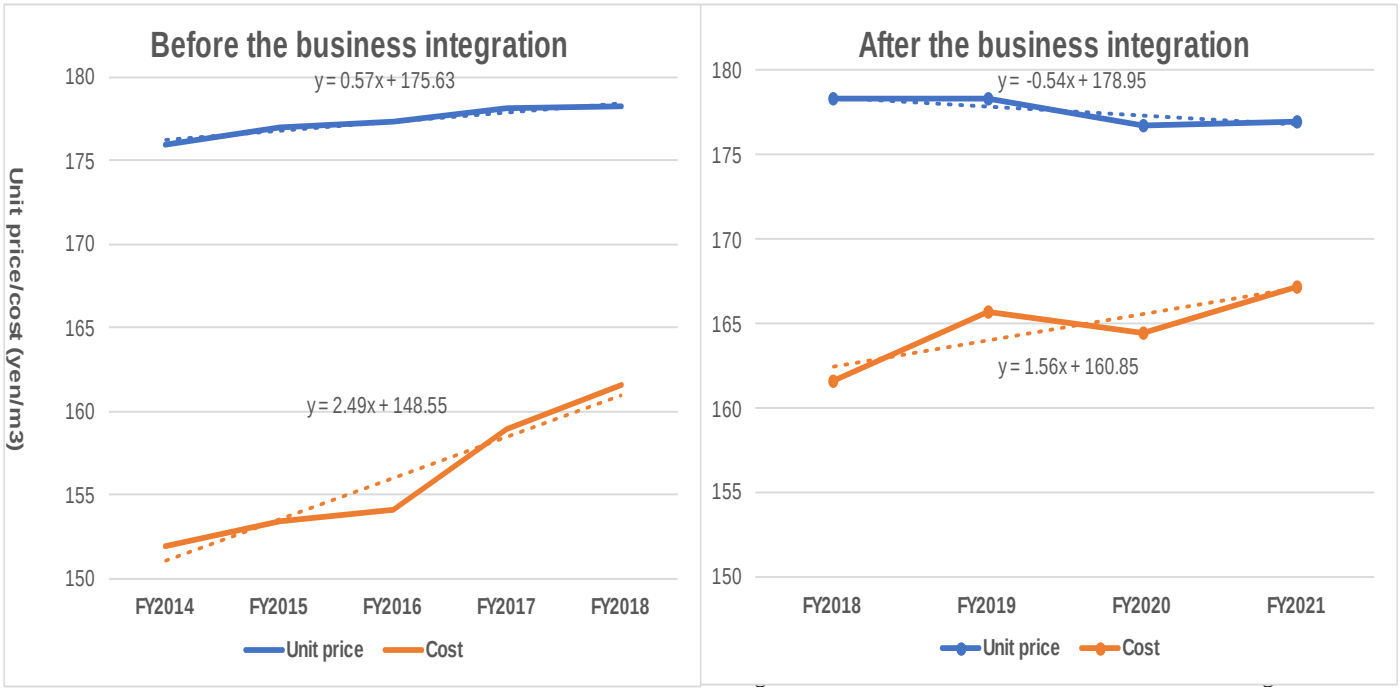
1. Reduction in the unit price of water supply

Firstly, a large-scale business integration across the prefecture will solidify its financial base, integrate assets and organizations, and enable the use of subsidies and other resources meant to promote wide-

area waterworks management. Unified wide-area waterworks management is expected to exercise an effect in helping waterworks operators to keep down the unit price of water supply.

In this regard, data from the Master Plan on Kagawa Prefecture's Wide-Area Waterworks Management indicate the following trends as to how the cost and unit price of water supply will likely change at the Kagawa Authority after the business integration (**see Figure10**).

<Figure10> Kagawa Prefecture; The unit price and cost of water supply service before and after the integration



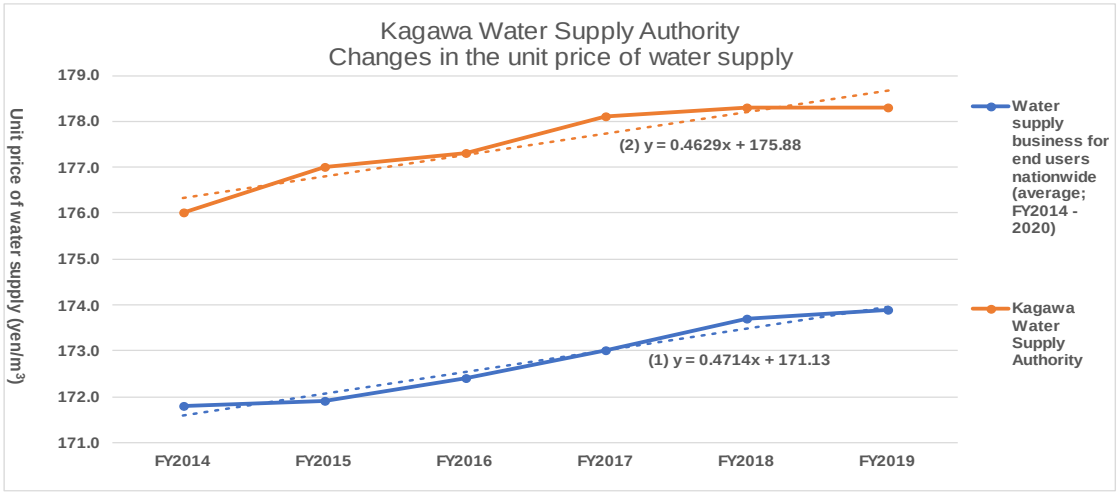
The chart was created by the author based on the Master Plan on Kagawa Prefecture's Wide-Area Waterworks Management.

a. The increase in water supply cost will be kept down after the business integration (with the gradient of the [approximate] line showing the growth rate of 2.49 before the integration and that of 1.56 after the integration). This seems to represent the effect of efforts to cut back on the number of employees and thereby keep down maintenance and other expenses, as shown in Fig. 7.
b. The rate of growth in the unit price of water supply service is assumed to fall to minus 0.54 after the integration from 0.57 before the integration. Although this assumption is based on a cutback in water supply cost, it indicates the authority's policy to reduce the unit price of water supply toward the integration of charges in fiscal 2028.

A comparison between the forecasted unit price of water supply by the Kagawa Authority and the Hiroshima Authority and the growth rate of the average unit price of water supply by end-water supply operators across the country reveals the following facts.

a. When the actual unit price of the water supply service by the Kagawa Authority (from fiscal 2014 to 2019) is compared with the average unit price of water supply by end operators nationwide in the same period, the growth rate (approximate line) came to 0.4714 for the national average, while that of the Kagawa Authority was 0.4629, meaning that it was able to keep the unit price of water supply below the national average **(see Figure11).**

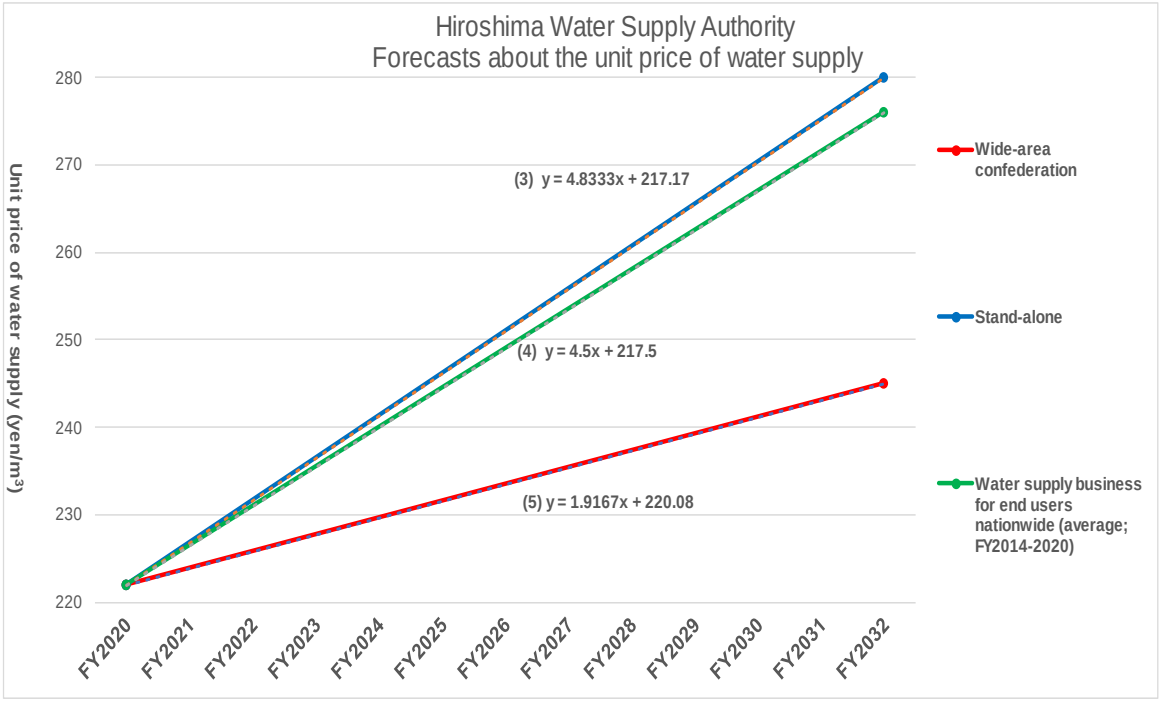
<Figure11> Kagawa Water Supply Authority; Unit Price



This chart was created by the author based on the Master Plan on Kagawa Prefecture's Wide-Area Waterworks Management.

b. For Hiroshima Prefecture, the (approximate) line showing the growth rate of water supply services by stand-alone operators has a gradient of 4.8333, while that of the Hiroshima Authority's service has a gradient of 1.9617, suggesting that the authority plans to substantially cut down on the unit price of its water supply service. Estimated unit price for fiscal 2032 for end water supply operators were calculated on their actual and forecasted national average figures (from fiscal 2014 to 2020). The (approximate) line showing the growth rate of the national average unit price has a gradient of 4.5, while that of the Hiroshima Authority has a gradient of 1.9617. This means that stand-alone operators will have a unit price higher than the national average, while the Hiroshima Authority will have a unit price of water supply service at a substantially lower level **(see Figure12).**

<Figure12> Hiroshima Water-supply Authority; Unit price



This chart was created by the author based on the Business Plan of Hiroshima Water Supply Authority.

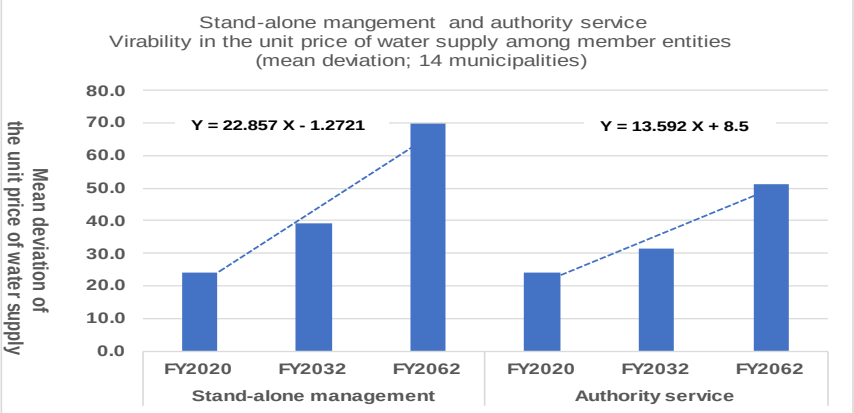
For both prefectures, it is recognized that they are achieving certain effects by solidifying the financial base through the business integration across the prefecture, reducing water supply cost through the integration of assets and organizations, and politically reducing the unit price of water supply for users through the use of subsidies and other resources for the promotion of wide-area waterworks management as capital receipt.

2. Correction of regional disparities in the unit price of water supply

Water supply operators have faced the issue of regional disparities in water charges for many years. In Hiroshima Prefecture, for instance, water charges set by entities (per 20 m^3 as of April 1, 2020) vary from 3,036 to 5,049 yen per month, representing a gap ratio of one to 1.7.

In relation to this, the Business Plan of the Hiroshima Water Supply Authority contains data on forecasted unit price of water supply by nine cities and five towns (**see Figure13**).

<Figure13> Hiroshima Prefecture; Unit Price



This chart was created by the author based on the Business Plan of Hiroshima Water Supply Authority.

The data suggest that if the municipalities continue their stand-alone operations, the disparity (mean deviation) in the unit price of water supply among different entities is likely to expand significantly over time from fiscal 2032 to 2062 (until the [approximate] line showing the growth rate has a gradient of up to 22.857). In contrast, when their businesses are integrated into the Hiroshima Authority, the business plan predicts that the expansion of the disparity (mean deviation) in the unit price of water supply will likely be curbed if they “examine outcomes of wide-area cooperation efforts and future management forecasts and look into the possibility of unifying their schedules of charges” and proceed with consolidation and abolishment of facilities in fiscal 2033 (ten years after the authority starts operation). As shown in the above cases, it is verified that unified wide-area waterworks management has the effect of reducing water supply cost and regional disparities in water charges.

3. Optimization of facilities

Optimization of facilities means re-examining the capabilities of water supply facilities based on demand within the designated areas in the process of business integration and downsizing water purification plants, reservoirs, and other facilities through the development of connecting pipes and other facilities for smooth water provision among different regions.

For instance, the Kagawa Authority and the Hiroshima Authority have specific goals for facility optimization included in their business plans (**see Table 2**).

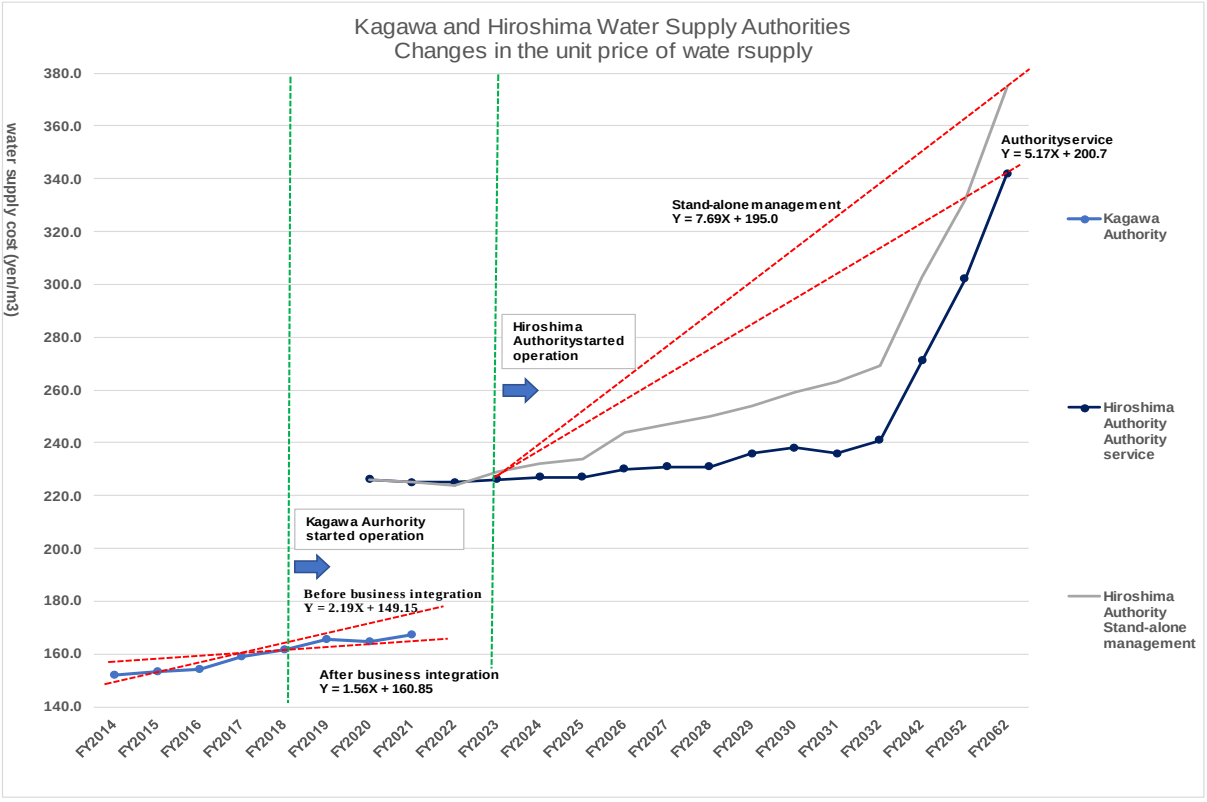
<Table 2> Kagawa and Hiroshima Authorities; Optimization of facilities

Kagawa Authority		Hiroshima Authority			
Purification plant	17 plants were reduced to 38 through consolidation and abolishment		Fiscal year	Number	Capacity
Authority office	17 authority offices were integrated into five control centers.	Purification plant	2020	166	592 Km³/day
			2032	77	387 Km³/day
			2062	70	313 Km³/day
		Pipeline	2020	7,441 km	
			2032	7,633 km	
			2062	7,645 km	

This table was created by the author based on Master Plan on Kagawa Prefecture's Wide-Area Waterworks Management and the Business Plan of Hiroshima Water Supply Authority.

The Kagawa Authority's business plan includes a project to reduce the number of water purification plants from 71 to 38. The authority actually consolidated 17 of its offices into five control centers. The Hiroshima Authority plans to consolidate 166 water purification plants to 70 facilities over the four decades from fiscal 2020 to 2062. It also plans to extend the length of water pipelines, including facilities for smooth water provision among different regions, from 7,441 km in fiscal 2020 to 7,645 km in fiscal 2062. The authority expects such optimization of facilities to help reduce facility development expenses by 23.7 billion yen[9] in four decades. Optimization of facilities conducted in line with these business plans will produce effects that will eventually be reflected in water supply cost (**see Figure14**).

<Figure14> Kagawa and Hiroshima Authorities; Unit Price



This chart was created by the author based on the Master Plan on Wide-Area Waterworks Management and the Business Plan of the Hiroshima Water Supply Authority.

[9] Facility development expenses are estimated to reach 623.6 billion yen for stand-alone management for the 40-year period from fiscal 2020 to 2062, compared to 599.9 billion yen when the operators' businesses are integrated.

Firstly, in the case of the Kagawa Authority, the initiatives shown in Table 2 above have worked to keep the rate of growth of water supply cost down, with a gradient of the (approximate) line showing the growth rate coming to 1.56 after the business integration, compared to a gradient of 2.19 before the business integration in fiscal 2018.

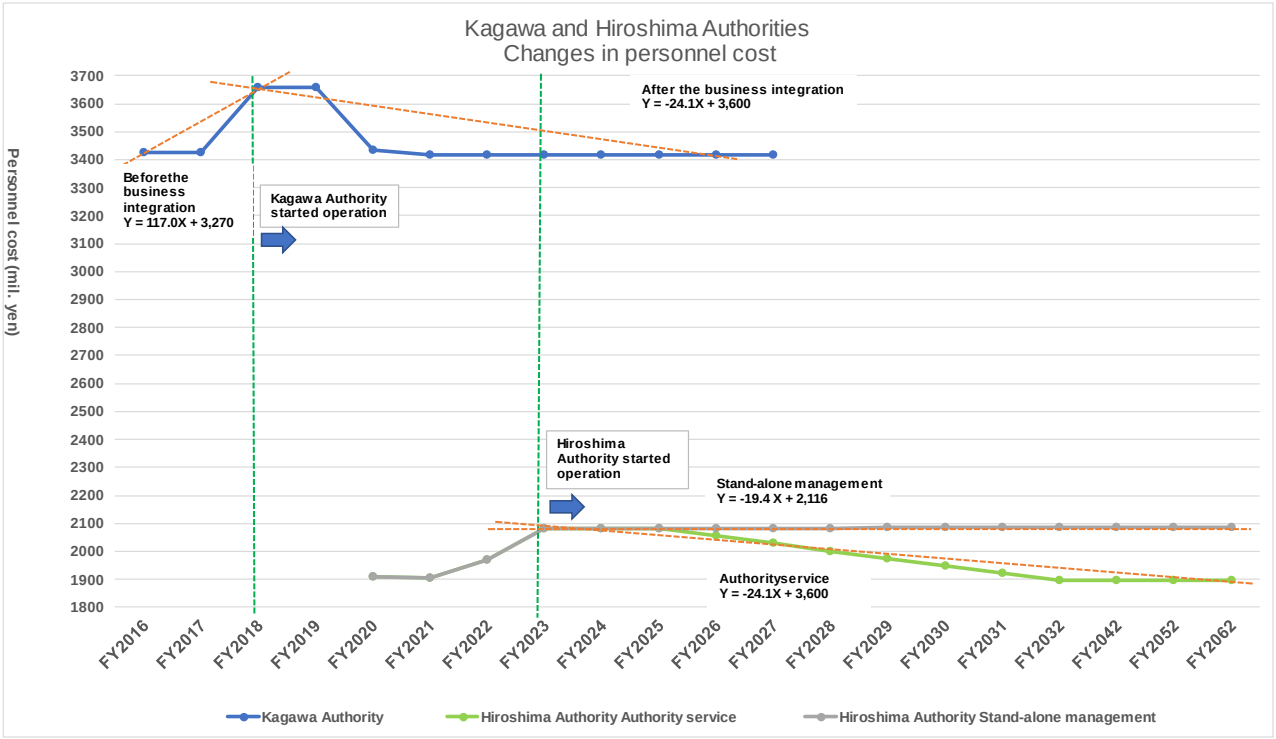
Then, in the case of the Hiroshima Authority, its business plan includes estimated water supply costs that would be incurred when operators continue stand-alone management and when their operations are integrated into the authority's water supply business. According to the data, the (approximate) line showing the growth rate has a gradient of 7.69 for stand-alone management, compared to a gradient of 5.17 for the business operated by the authority. The data show a clearly curbed water supply cost that would be incurred after the business integration.

4. Reinforcement of organizational and control systems

As to organizational and control systems, the Kagawa Authority adopted a policy to further reduce the number of employees after the business integration, as shown in Fig. 7. For the Hiroshima Authority, the Business Plan of the Hiroshima Water Supply Authority (formulated in July 2022) states that "although construction works will increase in volume for reorganization and development of facilities, we will take measures to raise efficiency through a review of the organizational system and cut back on workloads through concentration of paperwork tasks on the headquarters. The number of staff to be deployed at the start of the operation (in fiscal 2023) should be 327, much the same as 323, the number of full-time staff currently working with member entities. … The number and assignment of staff should be reviewed annually starting from fiscal 2024 by examining the workloads of the headquarters and offices and giving heed to member entities' opinions."

Under this business plan, downsizing of organizational and control systems will produce effects that will be reflected in personnel expenses. **(see Figure15).**

<Figure15>＞ Kagawa and Hiroshima Authorities; Personnel Cost



This chart was created by the author based on the Master Plan on Wide-Area Waterworks Management and the Business Plan of the Hiroshima Water Supply Authority.

For the Kagawa Authority, the (the approximate) line showing the growth rate of personnel expenses had a gradient of 117.0 before the business integration in fiscal 2018, whereas the gradient fell to -24.1 after the integration. It is evident that the business integration clearly served as a turning point in the reduction of personnel expenses.

For the Hiroshima Authority, its business plan includes estimated personnel expenses that would be required for stand-alone management and for a water supply authority formed through business integration. These data are provisional figures, and they will step up reviews after fiscal 2024. But even the current estimates based on the business plan indicate that (approximate) line showing the growth rate will have a gradient of -19.4 for stand-alone management and -24.1 for a water supply authority. The business plan quantitatively substantiates the authority's policy on organizational downsizing by comparison with stand-alone management.

IV. Summary

As seen above, the cases of the Kagawa Authority and the Hiroshima Authority provide an overview of effects that can be obtained from unified wide-area cooperation. These effects can be summarized as follows:

1. Although the curve of Japan's declining water supplied population has a little more gentle gradient than that of the decline in the overall population, it shows a tendency to keep declining. This decline has pushed down income from water charges, having a profound impact on the waterworks business. (**see Figure1 above**).
2. The water supply system of our country has three structural problems: the small scale of business, economic efficiency, and aging. Firstly, the small scale of business is prominent compared to other infrastructure businesses, which brings about problems including a weak financial base, vulnerability to the declining water supplied population and instable management, regional disparities in charges due to natural conditions, and other factors (**see Figure2 above**). Secondly, economic efficiency, or profitability per employee of a waterworks operator has recently been on the decline primarily due to the declining water supplied population (**see Figure 3 above)**. Thirdly, management, or timely upgrading, of (aged) water supply pipes is a major issue for waterworks operators in order to have a sufficient quantity of chargeable water. The tough management environment in recent years has highlighted the resolution and prevention of aging pipe as a major concern. In this context, the depreciation rate of tangible fixed assets for the waterworks sector has risen more than the hospital sector, indicating the significance of the asset aging problem. (**see Figure4 above**).
3. To address these issues, a diverse range of methods for wide-area water services and common treatment systems under the Local Autonomy Law, including water supply authorities, have been applied. After the completion of the Heisei-era merger of municipalities, the number of entities using common treatment systems in the waterworks sectors has increased again. In this sense, unified wide-area waterworks management is the form that allows for the most thorough control of organizations **(see Table 1, Figure1 and Figure6 above).**

4. The Kagawa Authority and the Hiroshima Authority, two of the entities advanced in unified wide-area waterworks management, are found to have several characteristics in terms of financial management.

a. Since the water supplied population has constantly declined in recent years, both before and after the business integration, unified wide-area waterworks management is not necessarily a panacea to resolve financial problems. A combination of wide-area waterworks management efforts and a timely revision of water charges will be able to ensure sustainable development (**see Figure1 and Figure9 above**).

b.Water supply authorities will be able to manage assets and liabilities in a well-balanced manner by focusing capital spending on investments for wide-area waterworks management (the development of wide-area waterworks facilities), including the integration and abolishment of water purification plants and the development of connecting pipes (**see Figure8 above**).

c. Water supply authorities have strived to reduce depreciation expenses through consolidation of water purification plants and other facilities, which allows them to keep down water supply cost (**see Figure14 above**).

5. Despite constraints on data availability, it can be said that quantitative analysis in this paper shows that water supply authorities that have introduced unified wide-area waterworks management have obtained positive effects to some extent in terms of (1) reduction in the unit price of water supply, (2) correction of regional disparities in the unit price, (3) optimization of facilities, and (4) reinforcement of organizational control.

Conclusion

There are only a few examples of local governments that have introduced unified wide-area waterworks management, so it is necessary to continue the verification of its effects while accumulating data. Among other effects of wide-area waterworks management, it would be essential to focus the verification on those directly linked to the lives of residents among others. In this sense, the author think it will be increasingly important from now to think about the issue of “what is the business form that would allow waterworks operators to keep down the unit price of water supply and try to correct regional disparities in the unit price in the waterworks sector in a society faced with the declining population.”

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