

2. Sewage Works Development In Japan

Presenter

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1. Abstract

This paper explains the history of construction of sanitary facilities and sewerage system as well as their present situation. Before modernization, Japanese people used to apply night soil from latrine toilet to farmland as a fertilizer, while sewerage was constructed mainly for stormwater drainage. However, as urbanization, industrialization and modernized agriculture progressed, and as the problem of water pollution became more obvious, construction of sewerage centering on the treatment of night soil and household wastewater started in earnest.

Concerning the factors that contributed to the rapid spreading of sewerage in the postwar Japan, it is possible to name the appropriate sharing of responsibilities by the central and the local governments, introduction of public funds, foundation of Japan Sewage Works Agency etc. In addition, the connection duties, tariff system and regulation of industrial wastewater discharged into the sewerage are stipulated under the postwar Sewerage Law, so that the sewerage construction could contribute to improvements in living environment and water quality conservation on a sustainable management basis. The local governments as the sewage works managers are performing such duty, while maintenance-related works that does not involve governmental authority are transferred to many private businesses. In sewage works today, there is a need for advanced treatment and countermeasures against pathogenic microorganisms and micro-pollutants, due to increasing public awareness of environmental issues. New approaches to the legal system based on watershed management might therefore be needed.

2. Introduction

The current state of sewage works in Japan (as of fiscal year 2001) is as follows.

Percentage of sewered population: 63.5% (of total population of 126.48 million) **Fig.1**

Percentage of area adequately served by stormwater drainage system: 50.6%

Number of municipalities conducting sewage works: 2,255 (of total number of 3,224)

Investment in sewerage system: 3.26 trillion yen (cf. GNI = 500.2 trillion yen)

Treatment method: Based on the conventional activated sludge process, more advanced treatment should be performed according to the state of the public water body to which the effluent is discharged.

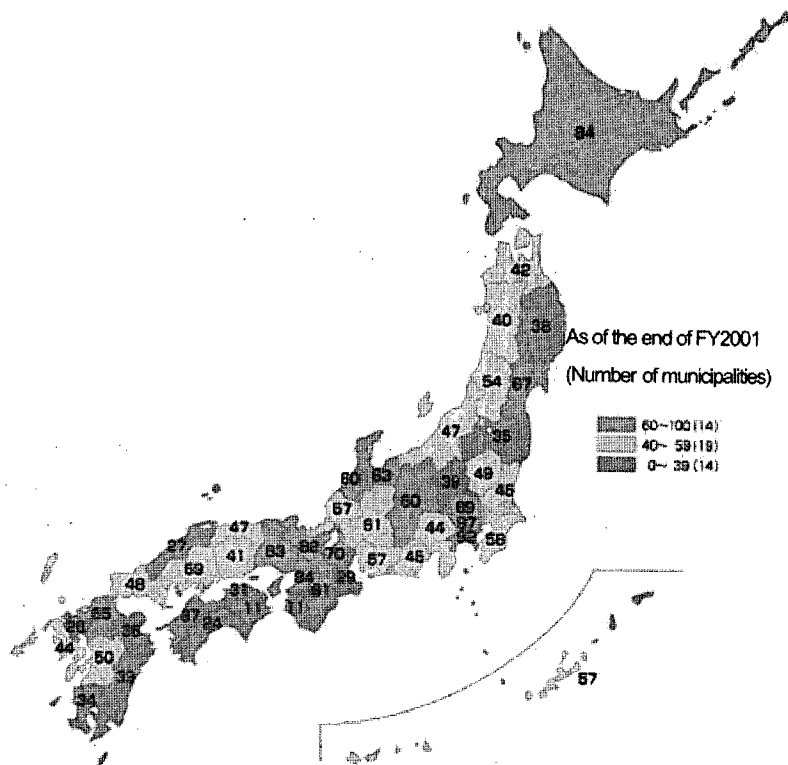


Fig.1 Percentage of Sewered Population (%)

3. History of sanitary system construction in Japan

3-1 History of sanitary system construction

Before entering its industrialized stage, Japan was an agricultural country, and human excreta including those generated in urban areas were used as a fertilizer on farmland without causing any significant problem. As a result, all toilets were the pit latrine type. However, as Japan receives much rainfall, urban districts with many inhabitants constructed water conduit system for drainage. Thus, throughout the country the main purpose of sewerage construction was to drain away storm-water as well as gray water.

With the progress of modernization, however, the human excreta generated in urban districts were not supplied to farmland; urban areas with high concentrations of inhabitants and industries started to suffer problems such as outbreaks of infectious diseases caused by stagnant sanitary sewage and contaminated drinking water sources. To promote the development of sewage works in response to urbanization, the old Sewerage Law was enforced in 1900. At that time, however, the sewerage system did not develop because there was a greater need to build the infrastructure for industrialization with the limited financial resources available, and because there was little public recognition of sewage problems. After World War II, as demand for water rapidly increased, top priority was placed on building the water supply system, and sewerage construction received little attention.

3-2 Rapid increase of sewerage construction after World War II

The present Sewerage Law was enforced in 1958 to establish legal conditions for the construction of sewerage systems as the population and industries in urban districts started to grow rapidly. Furthermore, as water pollution of rivers, lakes, reservoirs and sea areas worsened as a result of rapid economic development, the objective of “conservation of water quality in public water bodies” was added to the Sewerage Law in 1970, and subsequently sewerage construction took off in many cities as fundamental urban facilities.

The government recognized that sewerage systems are a basic national service for all people in Japan, and that such facilities have a beneficial economic impact on other industries and social fields, and so gave financial aid to sewage works projects carried out by local public bodies in the form of national subsidies. In 1963, it settled on the “Five-year Program for the Sewerage Construction” according to the Law to secure a certain amount of investment in sewage works. Up to the 8th Plan currently conducted, it has promoted activities of individual local public bodies, centering on such financial support as governmental subsidies.

However, sewage works involve a wide range of sophisticated technologies, and particularly small local public bodies did not have the requisite engineers. The Japan Sewerage Works Agency was therefore established in 1972 to secure the necessary engineers and to assist local public bodies. **(Fig.2)**

Since the latter part of the 1970s, the policy of constructing sewage systems centering on the combined sewer system was shifted to the separate sewer system for the new ones to be constructed. That is, sanitary sewage and stormwater flow are handled separately in order to preserve water quality. The number of municipalities that are currently conducting sewage works is 2,225, of the total number of 3,224.

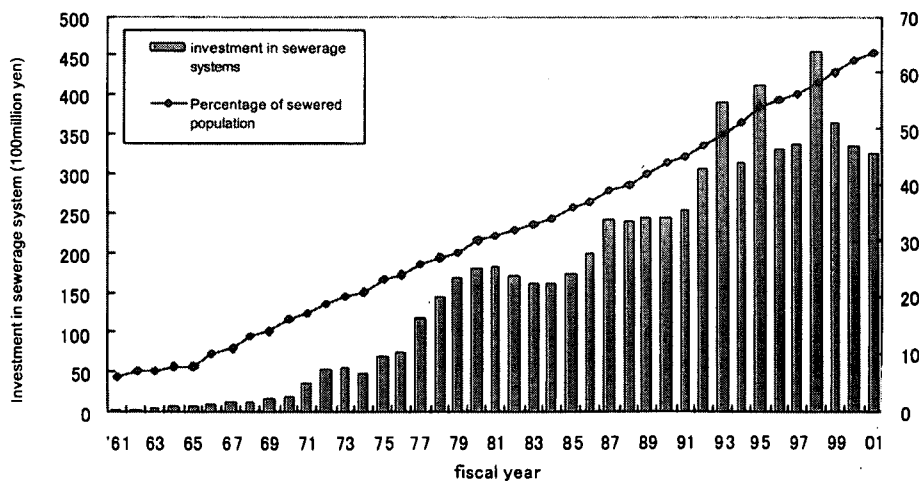


Fig.2 Sewerage Investment Amount and Percentage of Sewered Population

4. Efficient sanitation system construction

- Concept of appropriate treatment of sanitary sewage throughout prefecture areas

The Ministry of Land, Infrastructure and Transport published the “Concept of appropriate treatment of sanitary sewage throughout prefecture areas” in 1993, and has promoted its implementation. The concept covers commercial and industrial wastewater as well as household sanitary sewage, and establishes an optimum combination of two types: public sewerage, which is publicly managed for collective treatment to conserve the water quality in public water bodies; and “johkasou”, which is publicly or privately managed to treat household sanitary sewage separately or collectively relying to regional characteristics. All the prefectures in Japan have already formulated this kind of plan. (Fig.3)

As a reference of the prefectural plan, the Ministry of Land, Infrastructure and Transport issued the “Manual on the prefectural master plan of appropriate wastewater treatment (Draft)”, and, in cooperation with the Ministry of the Environment and the Ministry of Agriculture, Forestry and Fisheries, which are responsible for sanitary wastewater treatment facilities other than public sewerage, prepared and published a standard guideline for economic comparison according to local characteristics.

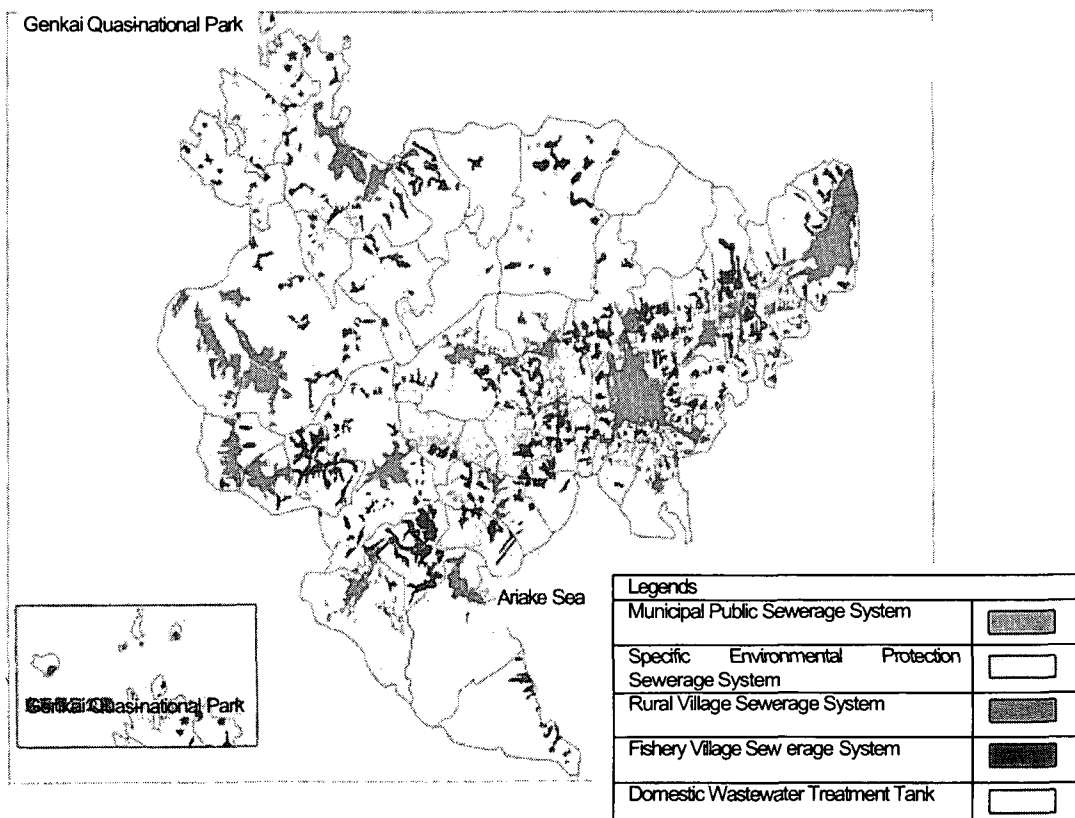


Fig.3 Example of Prefectural Plan for Appropriate Wastewater Treatment (Saga)

The method offers the following benefits.

- (i) Systematic and efficient construction of sanitary sewage treatment facilities
- (ii) Better understanding of sewage works among public bodies that have not adopted appropriate method.
- (iii) Identification of the necessary scale of sewage works as a long-term objective

5. Watershed management approach

5-1 Scheme of Comprehensive Basin-wide Planning of Sewerage System

As in other countries, rivers in Japan are a water source, but also receive sewage and wastewater, which may cause sensitive conflicts of interest between those living in upstream and downstream areas. Such problems relating to the river basin are raising concerns as the quantity of sewage, wastewater, and storm-water coming through the sewerage system has increased following the development and spread of sewerage systems. Hence, the impact and role of sewerage facilities in the control of both water volume and water quality of a basin are particularly important.

Regarding the conservation of water quality of closed water bodies such as lakes and bays, it is essential to limit the total discharge load over the whole area of the basin, not solely limiting the quantity discharged by adjacent local public bodies.

Japan therefore adopts a basin-wide approach in which the national government coordinates issues regarding a basin involving more than one prefecture to determine the share of pollution load elimination. Based on the determined share of load elimination, each prefecture conducts “Comprehensive Basin-wide Planning of Sewerage Systems”, which forms the master plans of sewerage.

The “Comprehensive Basin-wide Planning of Sewerage Systems” is a representative policy for the watershed management in terms of sewerage and set out in the Sewerage Law in 1970. It is a basic plan for sewerage construction regulated by prefectures, covering the public water body whose water pollution is caused by the pollution load flowing in from more than two municipal areas and the plan should be formulated so that the water quality may be improved to fulfill the environment standard mainly through sewerage systems.

5-2 Comprehensive Basin-wide Planning of Sewerage System relating to Osaka Bay

The Osaka Bay basin (**Fig.4**) covers much of Shiga, Osaka, and Nara prefectures and a part of Kyoto, Hyogo, and Mie prefectures. Owing to its geological structure, Osaka Bay, which forms a closed water body with little exchange of sea water, does not satisfy legally specified environmental standards for COD, nitrogen, and phosphorus. (**Fig.5**)

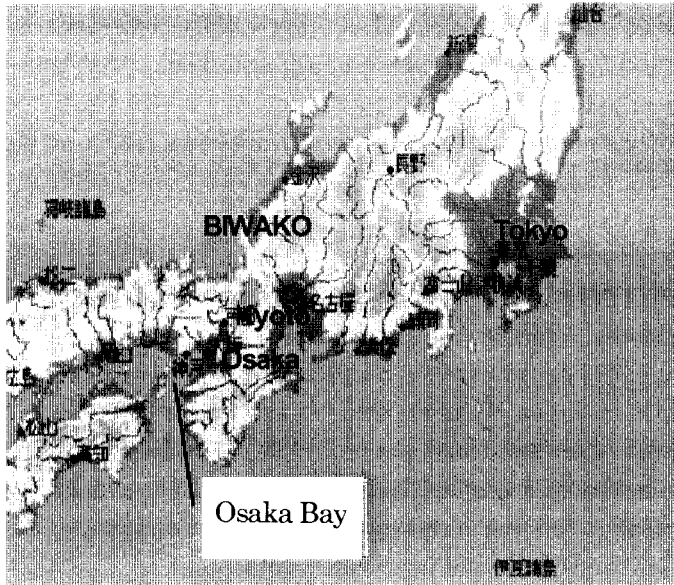


Fig.4 Osaka Bay-Map

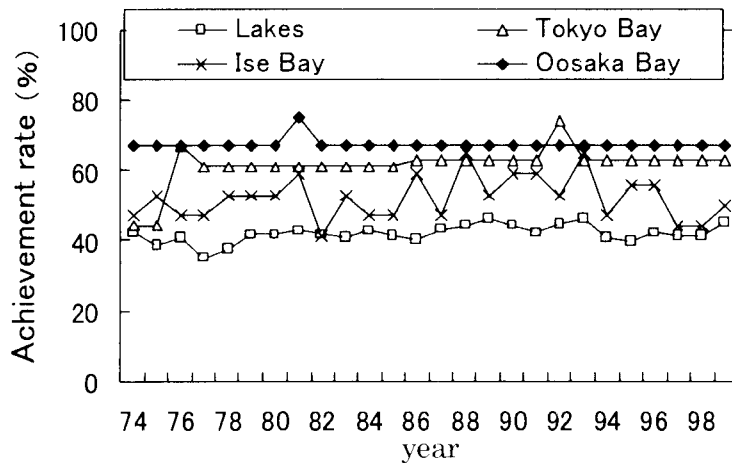


Fig.5 Achievement Rate Change in Environmental Quality Standards (COD) with Lakes and 3 Major Gulfs

In 1995, the Ministry of Land, Infrastructure and Transport issued the policy on the allocation of allowable discharge pollution loads for Kyoto, Osaka, Hyogo, and Nara after long discussion among related prefectures chaired by the Regional Bureau of the Ministry. (Fig. 6, Table 1)

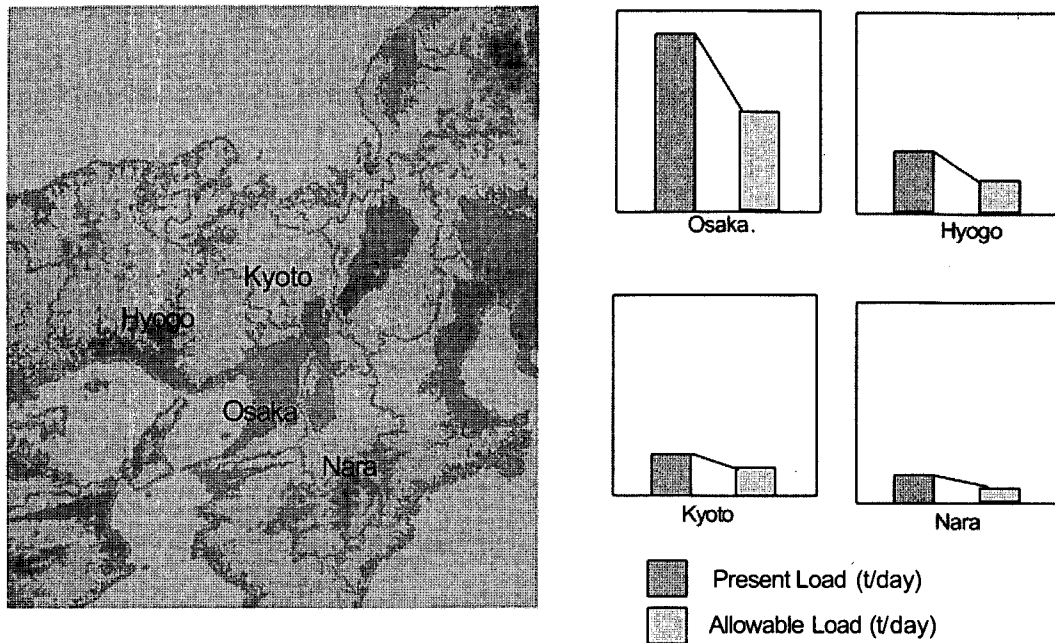


Fig.6 Allocation of Allowable Pollution Load Distribution among Prefectures

Table 1 Result of Allowable Load Allocation among Prefectures (t/d)

Prefecture	COD	T-N	T-P
Kyoto	28	20	2.1
Osaka	100	56	4.8
Hyogo	40	25	2.3
Nara	14	9	0.8
Total	182	110	10

Note: If figures in each item summed up, the value will not be congruous to the figure in "Total" because each figure is rounded off.

Based on the determined share, each prefecture has prepared Comprehensive Basin-wide Planning for the Sewerage System, which covers all sewerage construction in the prefectures concerned. (Fig.7)

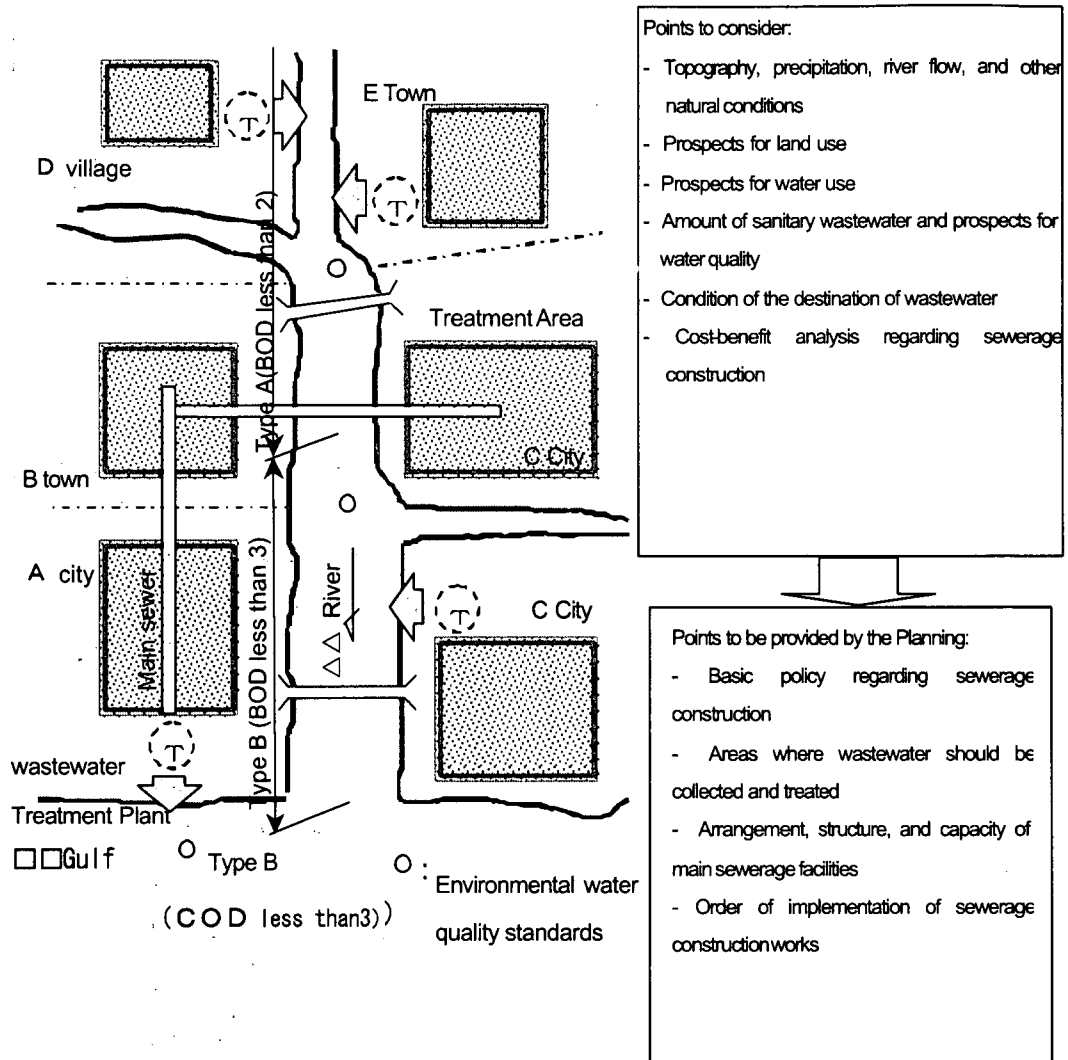


Fig.7 Comprehensive Basin-wide Planning of Sewerage System (outline)

The plan of each prefecture was intended not only to satisfy the standard for the water quality environment of Osaka Bay, but also to satisfy the standard for the water quality environment of the Yodo River, which is an important city water source.

5-3 Existence of risks in water system, which cannot be treated by the Comprehensive Basin-wide Planning of Sewerage System

As the development of the water supply and sewage system progressed by individual local public bodies, there has been an increase in the number of cases where the intake of water by a local public body is located directly downstream of the discharge point of sewage-treated effluent of another upstream local public body, as seen in the case of the Yodo River. The Comprehensive Basin-wide Planning of Sewerage Systems can address only a limited number of targets of the standard for the water quality environment, and focuses only on the average water quality environment concerned, thus the water quality in an emergency is outside its scope.

Various urban and social activities lead to the discharge of many types of substances along with wastewater, and large percentages of these substances enter the sewerage system. As a result, the sewage-treated effluent contains not only organic and toxic substances which are controlled by wastewater regulations, but also various pathogenic microorganisms, trace toxic substances, and endocrine disrupting chemicals. Outbreaks of infectious diseases and accidental spill and discharge of pollutants in sewerage areas may cause serious injury to human health through the water cycle system from wastewater to water supply. A mass infection by *Cryptosporidium* of about 8.8 thousand inhabitants occurred at Ogose Town in Saitama Prefecture in June 1996, raising concerns about the circulation of water from wastewater, to river water, to drinking water, and back to wastewater. Many relatively large cities that have operated sewerage system for a long time adopt a combined sewer system, but the drainage of storm-water may affect water use in the areas where water is discharged. Surveys to assess the actual state of the influence have just begun.

The discharge of sewage-treated effluent into source areas of municipal water supply is a critical problem particularly in a water basin containing intricate intake and discharge systems, as seen in the case of the Yodo River, (Fig. 8). Even without unexpected problems such as accidents, when the flow of river water reduces during drought, the percentage of sewage-treated effluent in river water increases, thus increasing the risk accordingly. The percentage of sewage-treated effluent in river water at Hirakata Ohashi Bridge, which is in the lower reaches of the Yodo River, is around 5% under normal conditions, and increased to almost 25% during the drought in 1994 (Fig. 9).

Consequently, to control the risks in the water system particularly in an emergency, the basin-wide approach is required. Nevertheless, the Comprehensive Basin-wide Planning of Sewerage Systems cannot handle this problem; this issue remains to be solved.

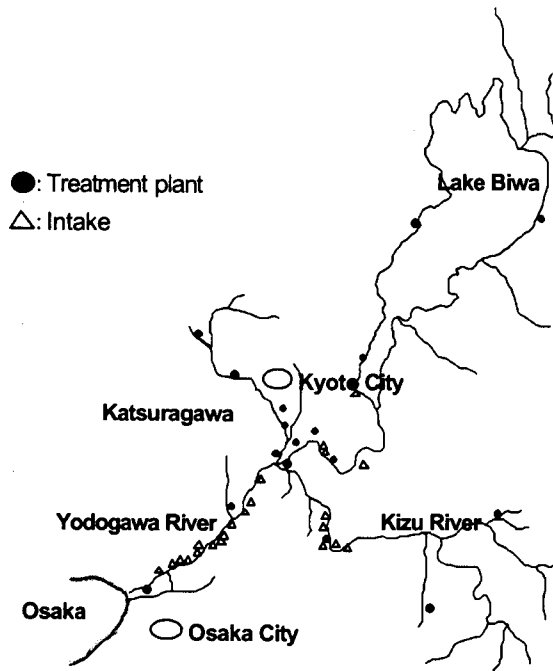


Fig.8 Intake/drainage system along Lake Biwa and the Yodo River

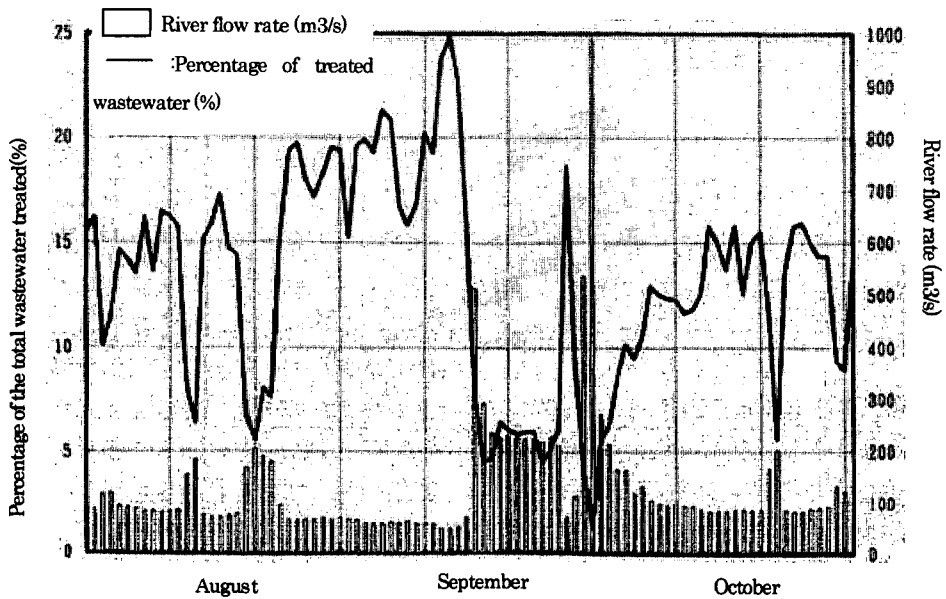


Fig.9 Daily variation in the percentage of treated wastewater in the flow of the Yodo River (August – October 1994)

6. Legal Systems on Sewage Works

6-1 Responsibility for connection, charges and control of discharges from industrial facilities

Japan has various legal systems governing sewerage to ensure that the projected benefits are attained, and to contribute to the living environment and conservation of water quality.

The household pays the cost of constructing house connection facilities from where sewage is discharged from individual houses to where it enters a sewer, because the section lies within the area of the house and the property belongs to the household. Because sewerage is basic urban infrastructure to play the public role in such areas as public health including prevention of infectious diseases, prevention of disasters caused by flooding, conservation of water quality in the public water body, and because these objectives should not be sufficiently achieved if we left it to individuals whether to use it or not, the Sewerage Law specifies that households and commercial bodies have a “responsibility to connect” to a sewer within three years after the completion of sewerage. And it is also stipulated that, as in the case of tax, user charge should be set and collected by the administrator, i.e., local governments, according to tariff system based on ordinance. Wastewater discharged from commercial or industrial facilities often contains high concentrations of various hazardous substances. If such wastewater enters a treatment facility, biological treatment at the facility may be damaged and the treated water may fail to satisfy the legal limits for water quality. The Sewerage Law therefore specifies a “discharge standard” for limiting the inflow of wastewater of a quality outside the scope of treatment by the facility and for adequately controlling the effluent water quality. Through these legal frameworks, official powers are given to the sewerage manager to ensure that sewerage works projects function effectively.

6-2 Work-sharing among national government, prefectures and municipalities ; public expenses for storm-water management and users expenses for sanitary wastewater treatment ; and what about advanced treatment?

In Japan, the relevant local public bodies conduct the construction, operation, and renewal of sewerage facilities. However, sewerage facilities in Japan also serve to drain storm-water and conserve the water quality in public water bodies. As a single public body has limited ability to plan and to fund projects covering all these, the national and local governments broadly share the work. Examples include a specification of the Sewerage Law that requests approval of the ministers concerned or of the prefectural governor for executing sewerage works of municipalities, and national subsidies are given to the construction project of major facilities of sewerage.

Regarding financial resources, in principle the discharger is responsible for treating wastewater, that is, the beneficiary must pay the cost: the charge and benefit principal expenses. On the other hand, the cost of draining stormwater is paid by the local municipality similar to the cost of flood control, in other words, is paid from taxes. Taking into account the objective of sewerage works projects, the national policy that people should receive equal sewerage services, the fact that the construction of sewerage

system requires a large investment which is a major burden on the local public body concerned, and that the sewerage system has external economic impacts on other industrial and social fields, the government and local public bodies pay a certain proportion of the necessary expenses.

As for advanced treatment, the expenses might be paid by the private firms or inhabitants who are responsible for the treatment at the ultimate stage based on the polluter-pays principle (PPP) under the strengthened water quality regulation. However, for advanced treatment conducted earlier than that by other firms or local public bodies, local governments have to pay the expenses for themselves from the viewpoint of ensuring an equal burden, the responsibility to discharge and the beneficiary, and the capacity to pay the cost. It is pointed out that some kind of meetings should be organized to discuss the burden sharing among major dischargers in each basin.

7. Issues in the Public-Private Partnership

7-1 Guideline of entrusting to private sector

Japanese law specifies that the local public bodies are basically responsible for public sewerage works. Nevertheless, considering the severe financial situation of local public bodies and the trends of future maintenance works, some of the maintenance work which does not involve official authority may well be entrusted to private contractors. (Fig.10)

Conduit		(as of the end of 2000) Unit: %		
Conduit	Cleaning	80.8*	10.8	8.4***
	Survey	71.0	14.6	14.4
	Repair	80.7	8.8	10.5
Wastewater treatment plant		(as of the end of 2000) Unit: %		
Operation and maintenance	Pumps	78.5	8.0	13.5
	Water treatment	78.3	8.2	13.5
	Sludge treatment	84.2	8.0	7.8
Curve yards	Grit	91.5	2.5	6.0
	Sludge	95.4	1.8	2.8
Cleaning, etc.	Control building	77.9	12.9	9.2
	Care-taking of greens	72.2	17.5	10.3
Water quality and sludge analyses		62.4	31.3	6.3
Checking and Maintenance	Boilers	88.9	6.9	4.2
	Air conditioning	82.5	3.9	8.6
	Fire control	81.1	16.9	2.0
	Electricity	81.8	14.4	3.8
	machinery	77.6	16.0	6.4

Note: (*) Totally commissioned, (**) Partially commissioned, (***) Directly managed

Fig.10 Utilization of Private Businesses

Currently, around 90% of the local public bodies entrust the work of operating and maintaining treatment facilities, which accounts for much of the maintenance cost of sewerage facilities, to private contractors. Most of the transferred works are conducted under a single-year contract with a specification preliminarily determined. The Ministry of Land, Infrastructure and Transport issued the "Guideline for entrusting operation and maintenance works to private sectors based on the performance requirement and evaluation" in 2001 to encourage the entrusting of sewage works to private contractors, in the expectation of lower cost and increased efficiency. The guideline recommends the concept of "performance requirement and evaluation" in the contract agreement, which had not previously been adopted.

7-2 Making sewage works more efficient by properly utilizing the private sector's vitality

In order to introduce smoothly the entrusting of operation and maintenance works to private sectors based on the performance requirement and evaluation, it is necessary to have criteria and know-how for the evaluation and monitoring of services, techniques and performances of private enterprises. In other words, local governments should be equipped with ability to select appropriate private enterprises, the know-how for transfer-related contracts, ability to evaluate the performance of private contractors, and ability to monitor for preventing moral hazards of the contractors. Small and medium-sized municipalities, which do not have sufficient capabilities of sewage works, demand the supports from an appropriate independent institution.

8. The 3rd World Water Forum

The 3rd World Water Forum will be held at Kyoto, Shiga, and Osaka, which are in the river basin of Yodo River and Biwa Lake, from March 16 to 23, 2003. A ministerial international session will be held at the same time, led by the Japanese government, at Kyoto on March 22 and 23, 2003, at which ministers in charge of water issues in many countries will discuss a variety of water issues. We hope that the 3rd World Water Forum will be a great success in contributing to the solution of water-related problems worldwide.

In preparation for the Forum, Japan Sewerage Committee for the 3rd World Water Forum was set up, consisting of academic specialists and the staff of industries and governments, led by Tomonori Matsuo, Professor of Toyo University, as the chairman. The Committee will hold a workshop on wastewater treatment and water pollution control in the Forum.

"Wastewater Management and Sanitation" (URL <http://www.worldwaterforum.org/for/en/fshow.218>) in the virtual forum chaired by Dr. Fukui, President of Japan Sewage Works Association has already contributed greatly to international discussions, case studies on the effect of sewage works, the financing of sewerage system, and other subjects. The secretariat of the 3rd World Water Forum

gave the highest score to the above virtual forum in March, and the second highest in July.

The Committee held the “Workshop on Wastewater Management and Public-Private Partnership” toward the 3rd World Water Forum in Nagoya on July 26. At the workshop, reports on the current state of the sewerage system in Korea, Malaysia, Germany, France, and Japan were presented, and panel discussions were held on wastewater management and partnerships between the public and private sectors. A declaration was adopted at the end of the workshop. The Committee plans to hold a large session at the 3rd World Water Forum on the subject of “Wastewater Management and Water Pollution Control”.