Chapter 18 LAKE BIWA

1. Introduction

Lake Biwa is the largest lake in Japan, being located in the uppermost reaches of the Yodo River Basin in central Honshu Island. The lake occupies one sixth of the prefectural territory of Shiga as shown in **Fig.18-1**. In the downstream reaches of the basin, there are metropolises such as Kyoto, Osaka and Kobe and other small municipalities in Kyoto, Osaka and Hyogo Prefectures. The total population of this region is 13 million. The lake supplies water for domestic, industrial, hydroelectric and irrigation purposes in the region.

In this paper, firstly, we will survey the changes in social and natural condition of the catchment area and the water quality in Lake Biwa with increase in human activities including LBCDP. Secondly, measures for improvement of water quality carried out or planned by Shiga Prefectural government will be presented.

2. Lake Biwa-Yodo River Basin

To understand the history of water resource development and water quality conservation of Lake Biwa, it is important to recognize the unique geographical feature of the Lake Biwa-Yodo River Basin and upstream-downstream relations with respect to water resource development of Lake Biwa.

2.1 Lake Biwa

Outline of the lake is shown in **Fig.18-2**. The lake has a total surface area of 671 km^2, a volume of 27.5 billion m^3. Its catchment area is 4.7 times the area of the lake itself, and its boundary more or less coincides with that of the prefecture, constituting 96% of prefectural land (**Fig.18-3**). The catchment area consists of forest-covered hills and mountains (60%), paddy fields and other farmlands (25%), and urban and industrial areas (**Fig.18-4**). The prefectural capital, Otsu, has an approximate population of 270,000 and is located at the southern end of the lake. Some 400 rivers and streams flow into the lake, but there is only one natural water course flowing out of the lake, Seta River, and two canals passing lake water to Kyoto.

The lake serves as a source of domestic and industrial water for both populations within the lake catchment area and the downstream population and industrial centers in the Keihanshin Area (**Fig.18-5**). It also serves for irrigation of paddy fields in the lake basin flat lands and for hydropower generation at some distance downstream of the outflowing river. Lake Biwa has been the most important natural asset for the prefecture, and Shiga residents have had a special attachment to the lake throughout history because of their dependency on the lake for fishing and transportation.

In the past century or so. the water-use pattern has changed significantly due to various water resource development activities (**Fig.18-6**). The two canals linking the lake and Kyoto were constructed in 1890 and 1912, respectively. The City of Kyoto, therefore, has had direct access to lake water unlike other downstream metropolises. The Seta River reaches to the prefectural boundary between Shiga and Kyoto. Within Kyoto Prefecture, it is called Uji River. Uji River is met by Kizu River and Katsura River at the Kyoto-Osaka Prefectural boundary, and the downstream stretch from this point is popularly called the Yodo River. The flow contribution to the Yodo River of the Uji, Kizu and Katsura Rivers are, respectively, 64%, 18% and 15%.

Economics in Shiga Prefecture was primarily dependent on agriculture before World War II, however, the prefecture has experienced remarkable economic growth from 1960's. The economic growth was realized by the advantageous location of the prefecture, i.e., easy

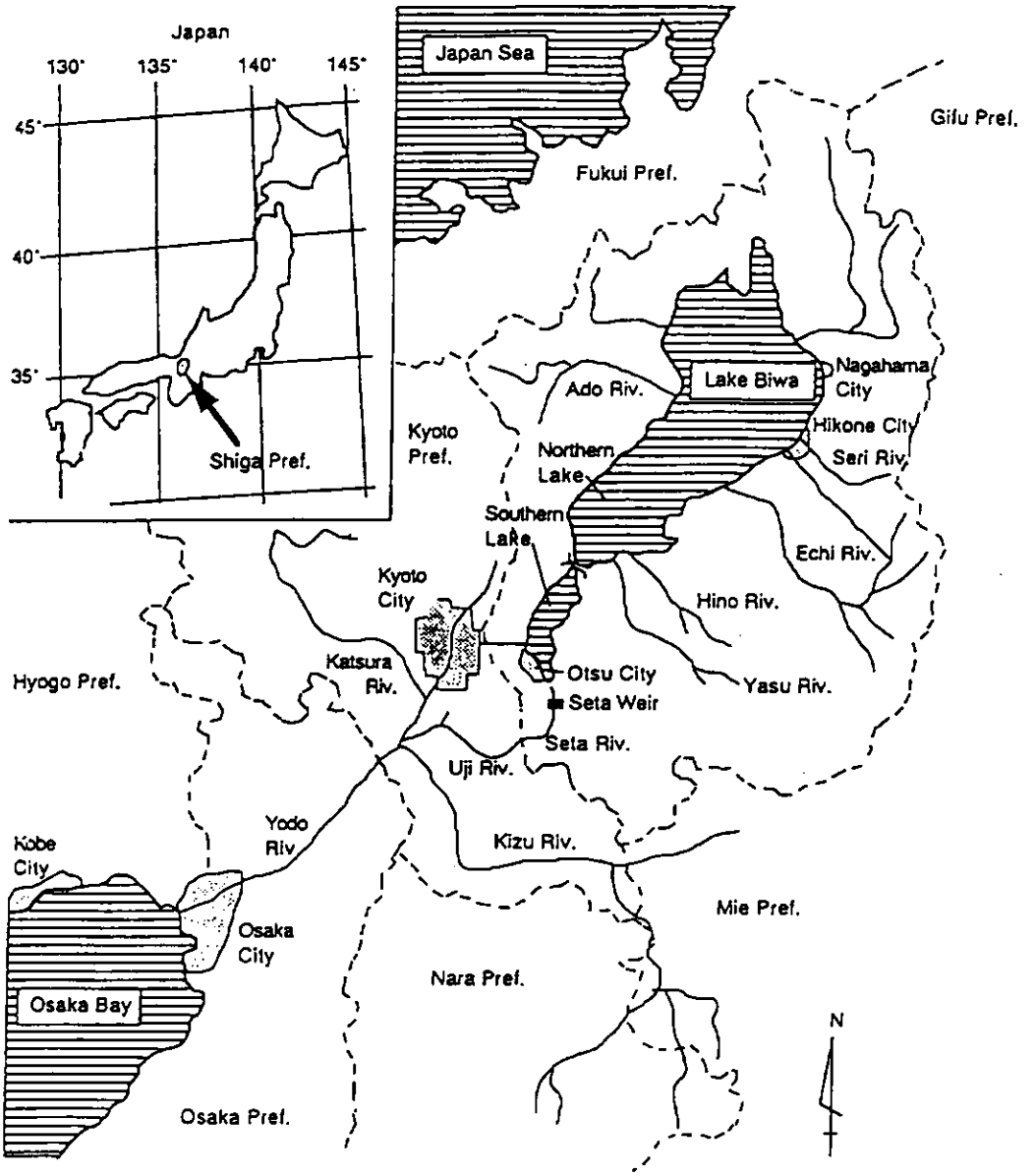


Fig.18-1 Lake Biwa and the Yodo River Region

Source: "Lake Biwa", Shiga Prefectural Government, 1991

accessibility to national-wide transportation network (Meishin Highway and Shin-kansen), which accelerated shipments of factories into the prefecture. As a results, the prefecture became an active inland industrial area. In addition, population migration, seeking for low cost house or apartment, into the prefecture from Kyoto, Osaka and Kobe increased the prefectural population up to 1.3 million in 1996 (**Fig.18-7**).

2.2 Yodo River System

The official designation of the whole of the Yodo-Uji and Lake Biwa water bodies is the Yodo River System. Its total catchment area, as observed at Hirakata, some 20 km upstream of the river mouth, is 7231 km^2.

At present, the metropolitan regions of Osaka, Kyoto and Kobe depend almost exclusively on the Yodo River for industrial and municipal water supplies. Thus, Lake Biwa accounts for water supplies amounting to 20 billion tons per year, and serving as many as 13 million people living in the Keihanshin Area including Shiga. Lake pollution, therefore, has been of serious concern not only for those living around the lake but also for those receiving water from the Yodo River.

The outline of Lake Biwa.

The whole area of Shiga	4,017㎢
The catchment area of Biwa	3,174㎢
The area of Lake Biwa	670.51㎢
The length from north to south	63.49㎞
The widest part	22.80㎞
The narrowest part	1.35㎞
The circumference of Lake Biwa	235.20㎞
The deepest point	103.58 m
The average depth	41.20 m
The amount of water stored in the lake	275×10^8 ㎥
The average depth of the northern basin	ca. 43 m
The average depth of the southern basin	ca. 4 m

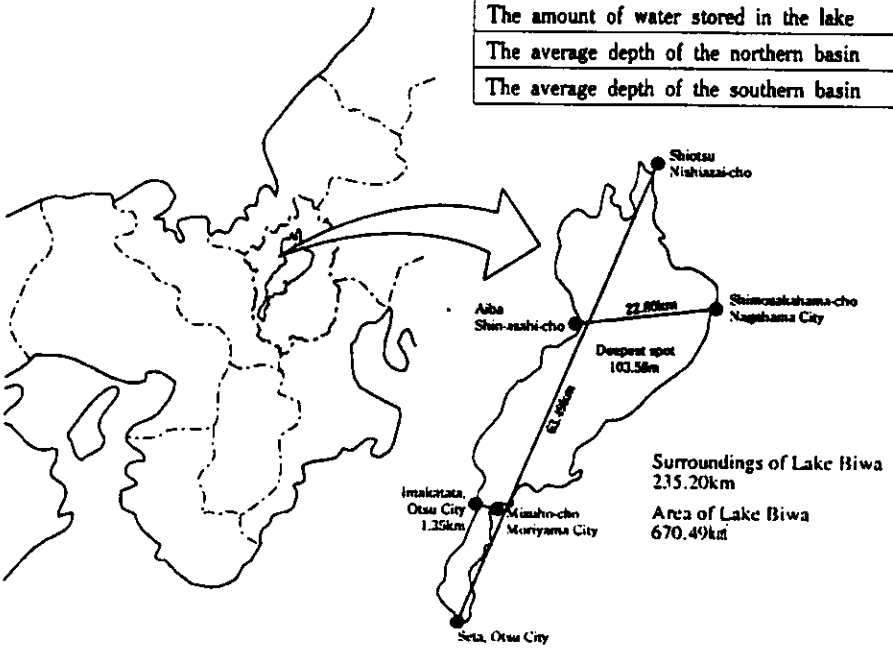


Fig.18-2 The Location of Shiga. (Source:ref.5)

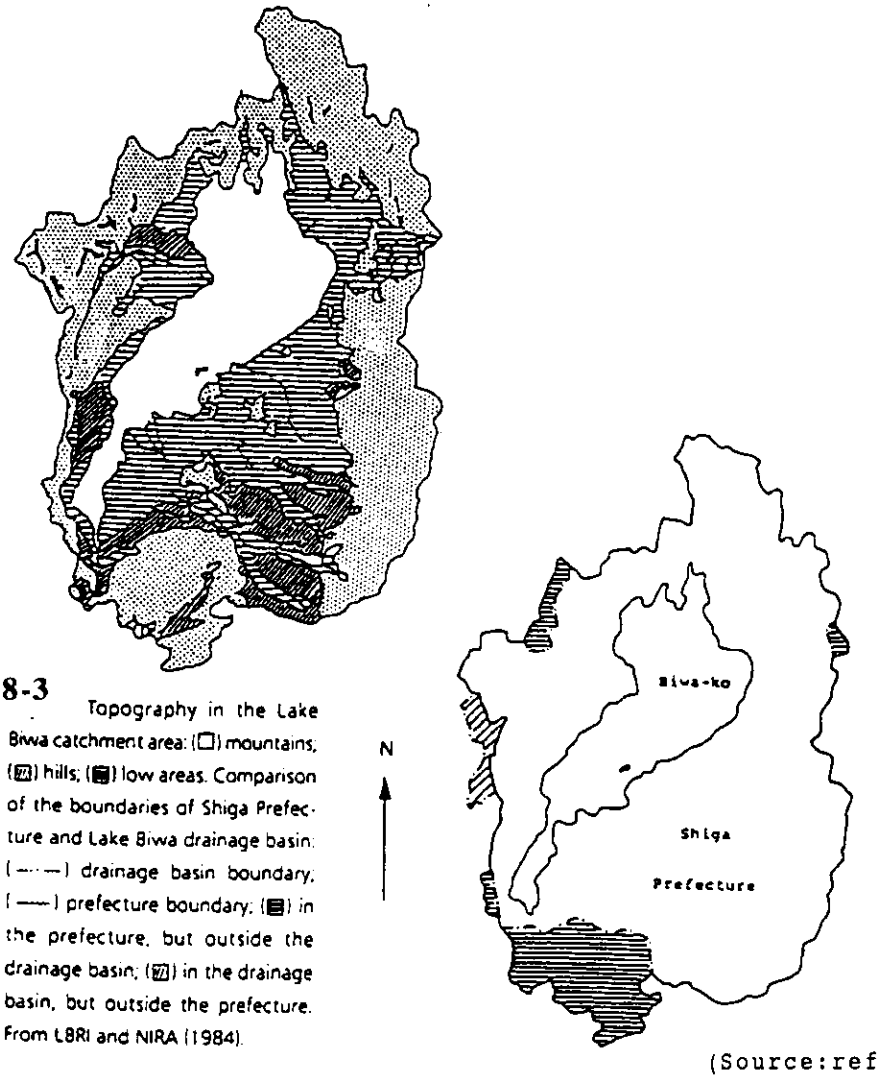


Fig.18-3 Topography in the Lake Biwa catchment area: (□) mountains; (▨) hills; (▤) low areas. Comparison of the boundaries of Shiga Prefecture and Lake Biwa drainage basin: (—·—) drainage basin boundary; (——) prefecture boundary; (▤) in the prefecture, but outside the drainage basin; (▨) in the drainage basin, but outside the prefecture. From LBRI and NIRA (1984).

(Source:ref.7)

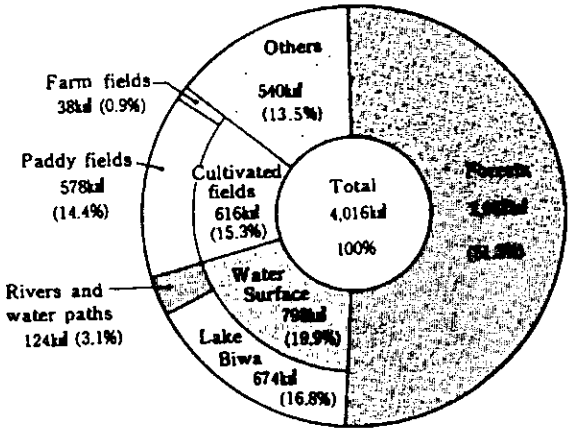


Fig.18-4 Land Use

(Source:ref.1)

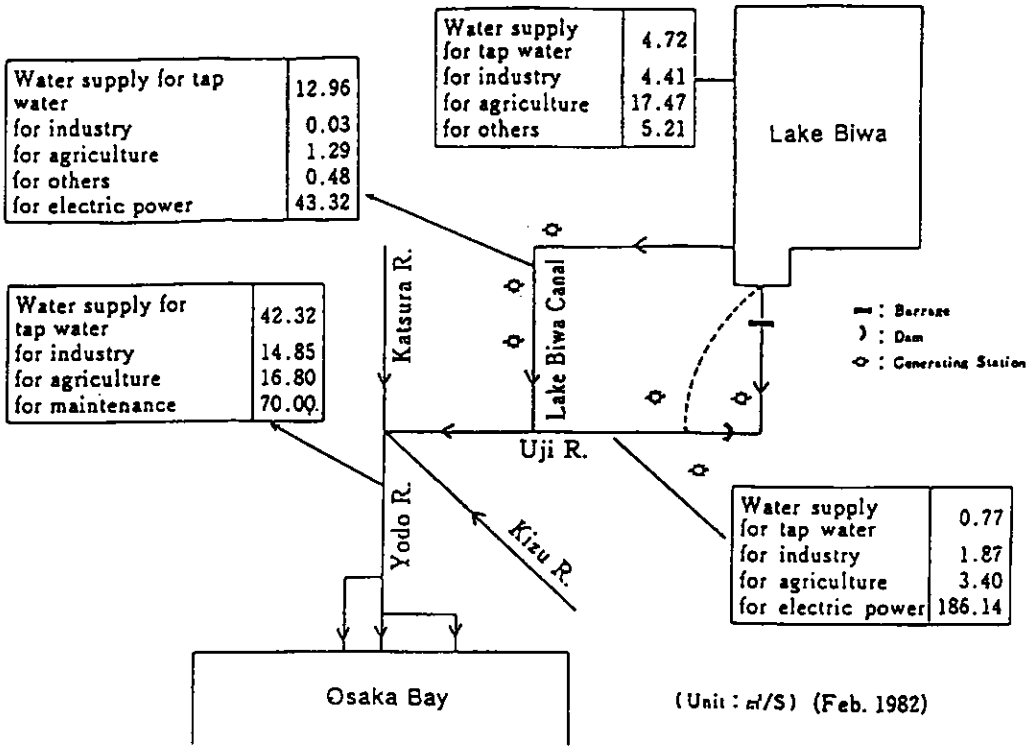


Fig.18-5 Water uses in the Lake Biwa-Yodo Basin (Source: ref.1)

The history of Lake Biwa and Yodo River water management was one of a conflict of interests and the resolution between Keihanshin Area downstream, particularly the Greater Osaka Region, and the Shiga Prefecture upstream For centuries. The communities in the immediate surroundings of Lake Biwa experienced severe flooding of their agricultural fields before the government finally agreed, about a century ago, to a major dredging of the Seta River at the outlet of the lake, in combination with the construction of Seta Weir, the only artificial water-flow control facility of the lake outflow. It is located a few kilometers downstream from the lake outlet. The weir, constructed in 1905 and renovated in 1961, controls the lake water level and discharge rate to Yodo River. The flood frequency and the flood damage in the lake catchment were drastically reduced after the weir construction. The demand for water, particularly for industrial uses, began to increase sharply as the country entered the era of economic growth a decade or so after the end of the War.

In the downstream stretch of Yodo River, the Hanshin Industrial Belt established in pre-war years began to thrive with unfulfilled demands for more water. Exploitation of groundwater soon became constrained due to competition of use among industrial establishments and to land subsidence caused by overdrafts of water. Industries were then forced to look for alternative sources of water. Domestic water supply needs also began to increase in the Yodo River areas after suburban cities joined Osaka in gaining access to Yodo River water.

Japanese economic growth gained momentum by the mid-1950s, and there was significant interest in the development of a comprehensive development plan of Lake Biwa water resources by the down stream population and industrial centers. After nearly two decades of political pressure on Shiga Prefecture, consisting of demands by downstream interests and the initiatives by the national government ministries, Shiga Prefectural Government finally agreed to a scheme for the comprehensive development of Lake Biwa.

3. Social and natural environment of Lake Biwa

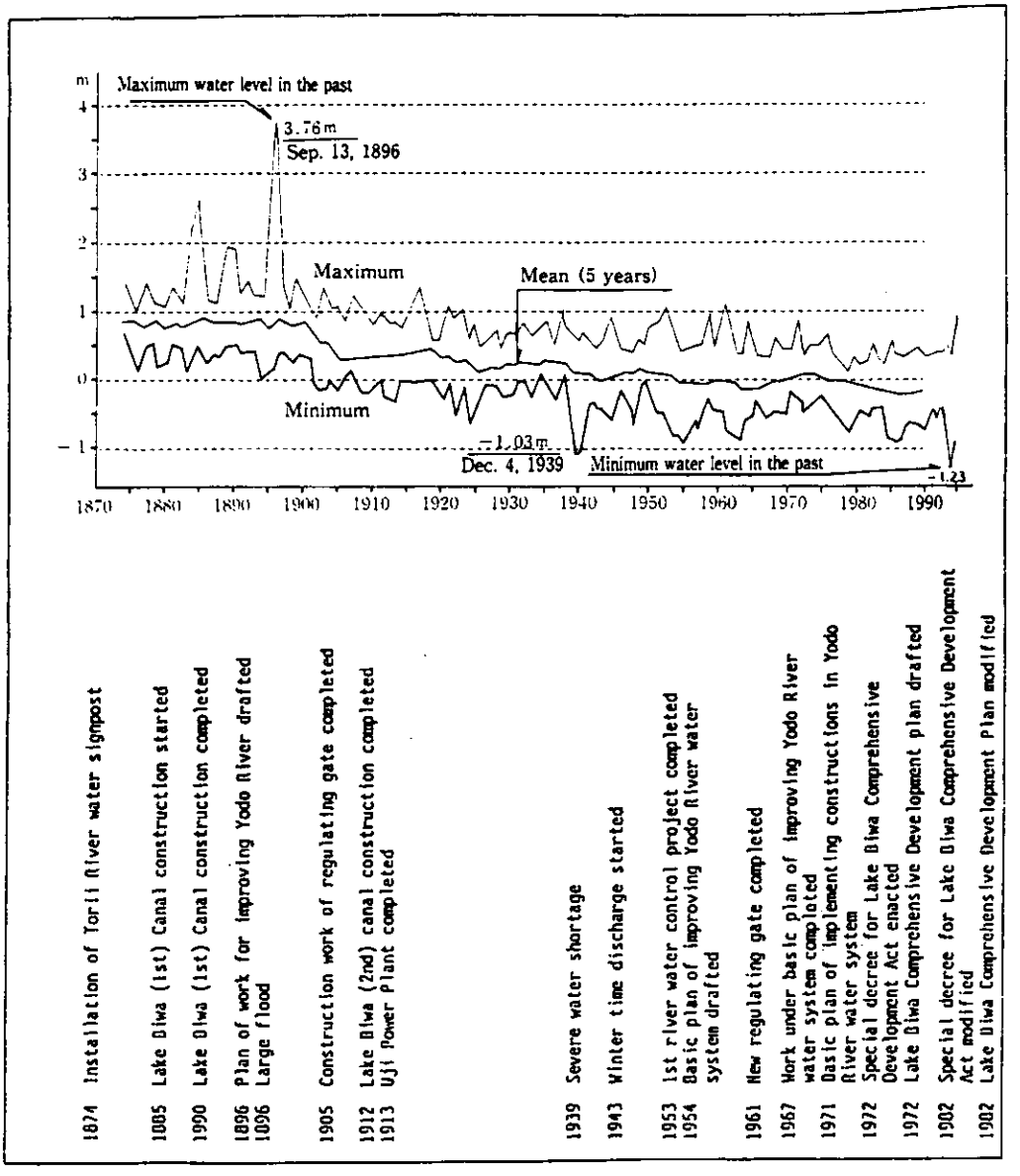


Fig.18-6 Changes in Water Level of Lake Biwa

Source: "Lake Biwa", a brochure published by Kinki Regional Construction Bureau, Ministry of Construction, Japan

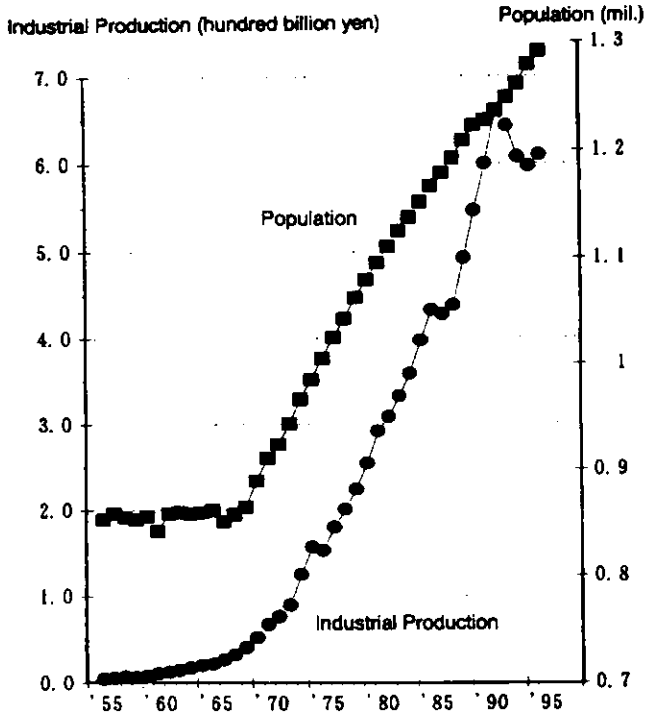


Fig.18-7 Annual trend of population growth and industrial production in Shiga Prefecture.

(Source:ref.1)

3.1 Outlook

Lake Biwa is among the oldest lakes in the world, to be compared with the Caspian Sea in the central Asia, Baikal in Russia and Lake Tanganyika in East Africa. As one manifestation of Lake Biwa's longevity, there are approximately 60 different species of fish and 40 kinds of shellfish, and various kinds that can be identified as indigenous to Lake Biwa.

At the mouth of the Yasu River, Lake Biwa narrows to a width of 1.35 kilometers. At this narrowest point we have the Biwako Bridge. From the bridge upwards, we have designated the northern Lake as the main basin and downwards, the southern lake, the secondary basin. The average depth of the northern lake is 43 meters, while that of the southern lake is only 4 meters. Owing to the difference in the basin configuration between these two lakes, the one is a striking contrast to the other in many respects, such as water quality and aquatic organisms.

The surface area of the northern lake is 616 square kilometers and it occupies approximately 90 percent of the whole Lake. As shown in **Fig.18-2**, the northern lake (mean depth 43 meters) is deeper in depth than the southern lake (mean depth 4 meters) and it has two concavities in the bottom on the western side. The southern lake is very shallow and with a surface area of about 58 square kilometers.

3.2 Water use

One of the most outstanding modern features of Lake Biwa water use and allocation is that the agricultural sector has the biggest share (amounting to 93% of the total) of the water withdrawn from the lake, despite the fact that the prefecture has undergone significant industrialization and urbanization in recent decades. Throughout history also, the agricultural

sector has had the oldest and most complex water-use practices and well-established customary rules of withdrawal. Industrial and municipal demands, which began to increase in the 1960s, had to compete against agricultural demand. The resulting impacts were twofold: (i) the establishment of a new rule to supersede the current destabilized and ad hoc water use and allocation rules; and (ii) the need for serious efforts to control of point as well as non-point pollution. It became clear also that there was a need to balance water uses where they competed for scarce water supplies. The variety of sources serving to supply Shiga communities is indicated in **Fig.18-8**.

Because of this importance of Lake Biwa as water resources for residents and industries in the Yodo River Basin, especially for those in downstream megalopolises, the Lake Biwa Comprehensive Development Project (LBCDP) commenced in 1972 (Nakamura 1991; Nakamura and Akiyama 1991). In this projects, the development of new water resources amounting to 40 m3/s has been agreed upon by Shiga and downstream prefectural and municipal governments, as well as by the National Government.

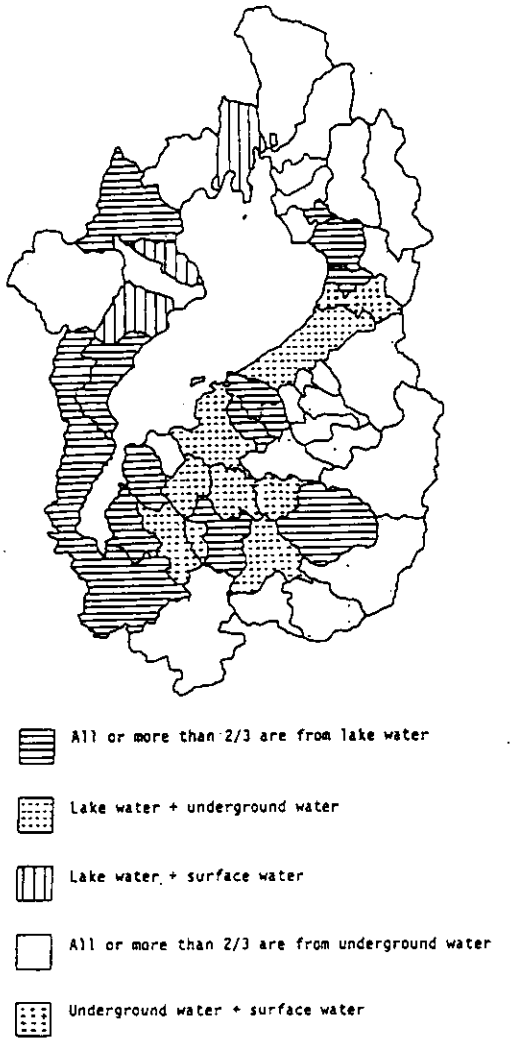


Fig.18-8 Water Sources Serving Shiga Communities (Source:ref.8)

This additional amount of water was to be made available upon completion of all originally scheduled lakeshore reinforcement works and other compensatory public works projects for Shiga Prefecture (**Appendix 1**). This project was scheduled to be terminated in 1982, however, experiencing difficulties in implementation of an array of component projects, the project term was extended for an additional 15 years up to the end of 1996, with integration of additional projects for environmental conservation.

3.3 Fisheries

Long term changes in annual catch of fish and shellfish in the lake is shown in **Fig.18-9.** Total catch of fish and shellfish decreased from about 1955 to now gradually due to the decrease in shellfish catch. On the other hand, fish catch did not decreased. The decrease in shellfish is considered to be caused by discharge of agricultural pesticides and deterioration of environment at lake bottom.

3.4 Water quality

1) Long term Changes in Water Quality

As stated, the Lake Biwa catchment saw significant changes taking place following

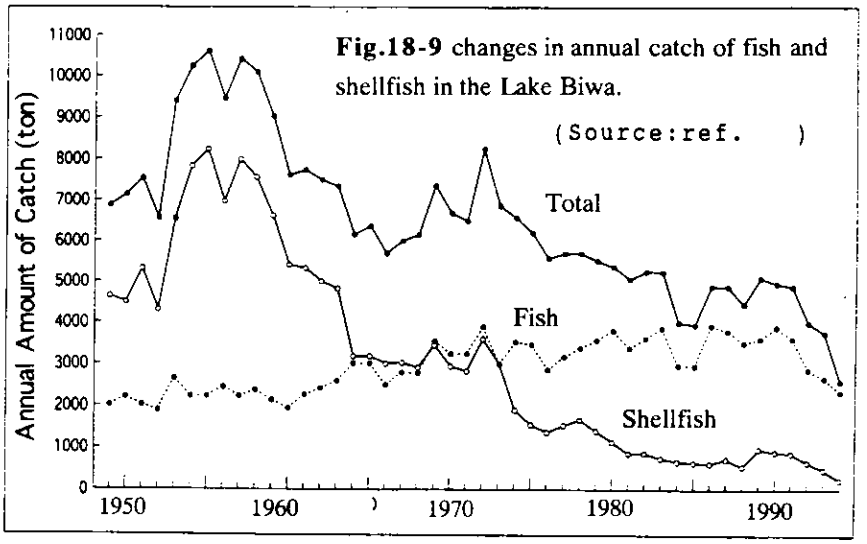


Fig.18-9 changes in annual catch of fish and shellfish in the Lake Biwa.

(Source:ref.)

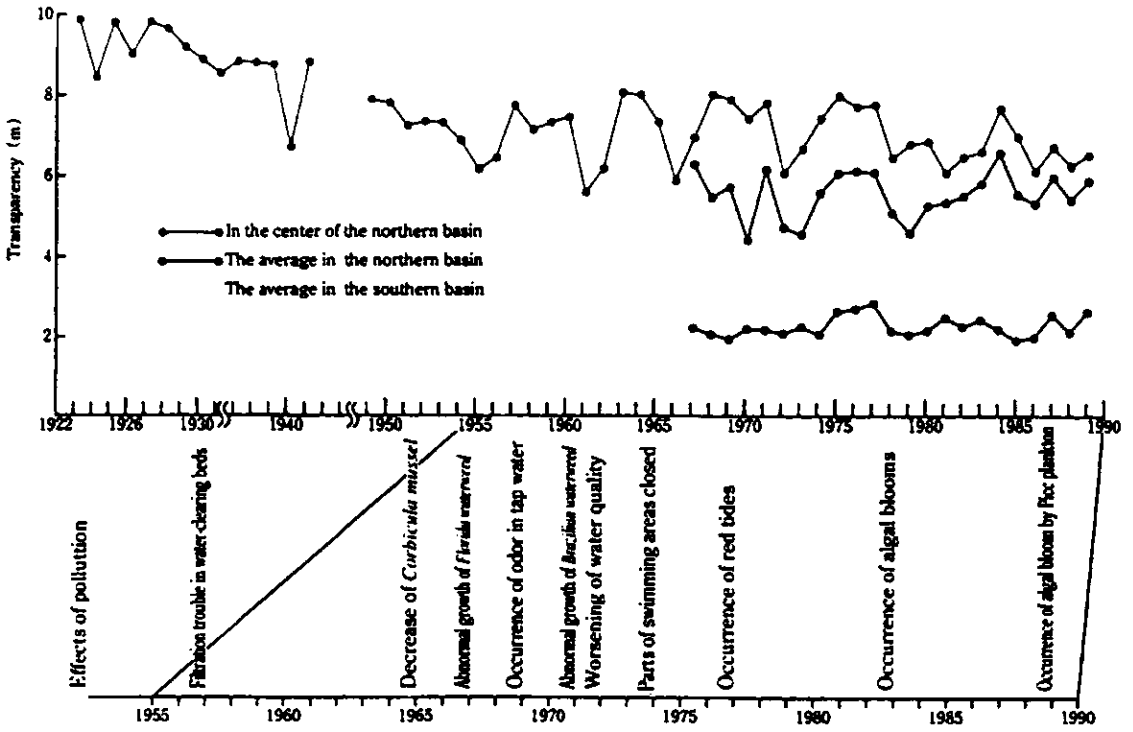


Fig.18-10 **Annual changes of water transparency.**

(Source:ref.1)

insurmountable development pressure exerted by the national development policy and which resulted in intensification of development activities downstream of the lake system (Imai et al. 1988, 1989). The most obvious outcome was an almost sudden surge of environmental stress on the lake, particularly its southern basin (the Southern Lake). To illustrate this, **Fig.18-10** indicates the long term decrease in lake transparency and shows major events attributed to lake pollution.

2) Eutrophication of Lake Biwa

The changes in water quality in the lake and inflowing rivers for recent two decade are shown in **Fig.18-11** and **Fig.18-12.**

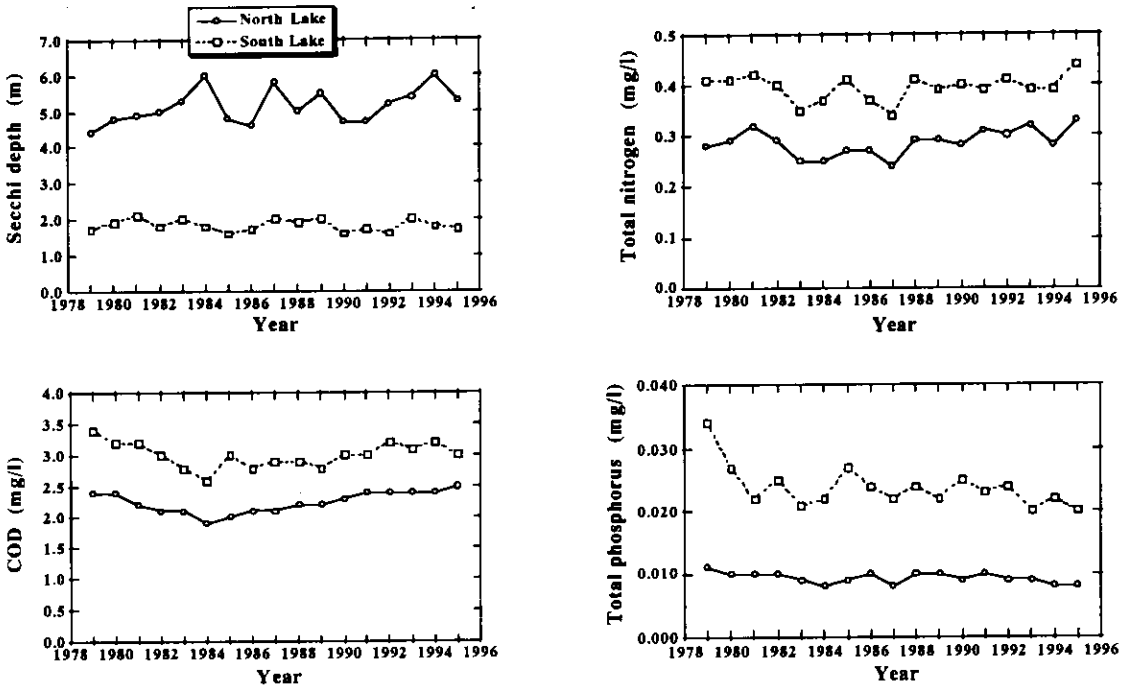


Fig.18-11 Long term changes in water quality of Lake Biwa.

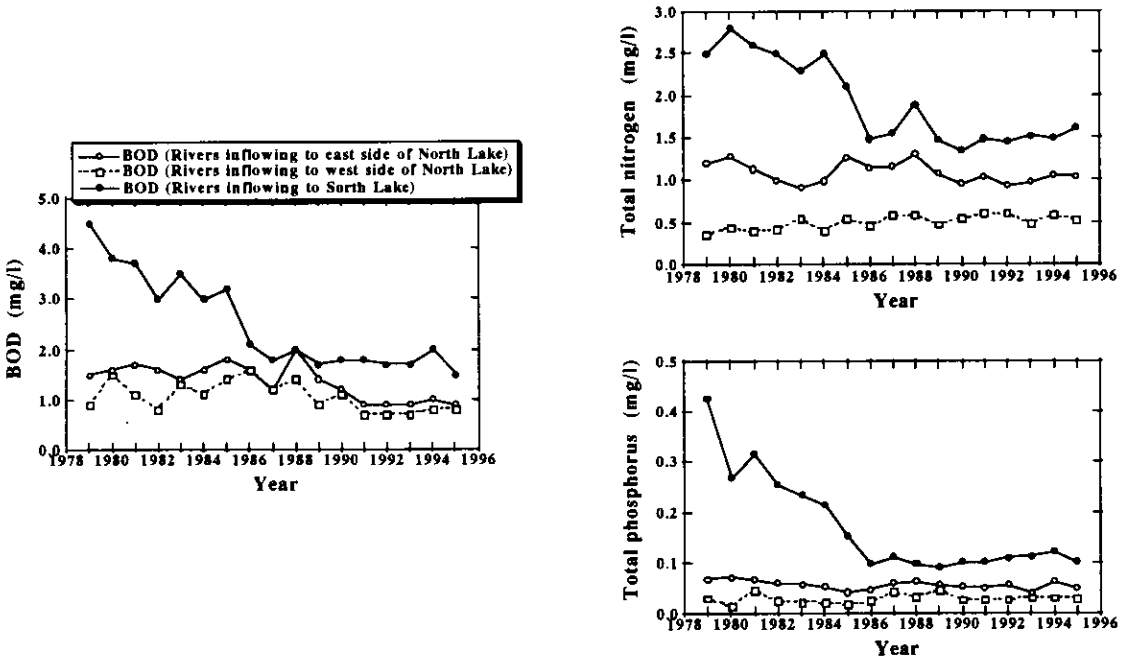


Fig.18-12 Long term changes in water quality of rivers inflowing to Lake Biwa.

In the past, Lake Biwa was oligotrophic but in recent years it has become eutrophic. From guidelines adapted from the OECD (Organization for Economic Cooperation and Development), it was determined that the northern lake is mesotrophic and the southern lake has gradually shifted from mesotrophic to eutrophic.

when the number of plankton increase up to certain level, bad effects such as freshwater red tide and/or uncomfortable odor in water occur. Those types of phenomena have observed in the southern lake in recent years.

Outbreaks of fresh water red tide from 1977, to this year (1996), excluding 1986, indicate eutrophication of Lake Biwa. This red tide phenomenon extends from the end of April until the beginning of June. The water temperature ranges from 15°C to 20°C. Large outbreaks of the flagellate *Uroglena americana* cause the Lake to change color to a reddish brown and are accompanied with a rotten fish smell.

On 21 September 1983, "water bloom" by *Anabaena* mixed with *Microcystis*, typical indicators of entrophication, occurred for the first time in Lake Biwa. This phenomenon was observed intermittently along the shore of Otsu City, some 10 kilometers long and 10 meters wide, though it disappeared in a day. Since then "water bloom" has occurred in the southern lake on a small scale every year to this year (1996) except in 1984.

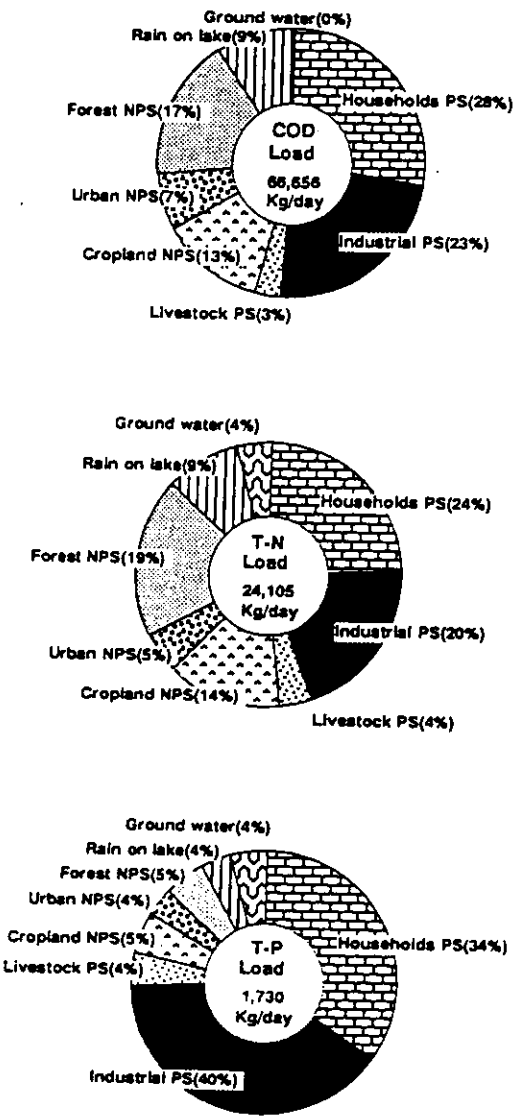


Fig.18-13 Pollution load into Lake Biwa (1990)

3.5 Water plants

There are about 70 kinds of water plants confirmed in Lake Biwa at present. Nutrients inflow to Lake Biwa have increased suddenly in recent years. For this reason native species such as *Vallisneria biwaensis (Miki) Ohwi* and *Potamogeton biwaensis Miki*, which are not suited to the changes in such environment decreased while naturalized species such as *Elodea nuttallii St. John* and *Egeria densa Casp.*, which, did not exist in Lake Biwa formerly, invaded the Lake and live in stock.

In order to mow and remove these growing water plants, a water plant mowing boat, "Kaitsuburi I" and a carrying boat, "Kaitsuburi II" were built in 1977. Furthermore, a water plant mowing machine, "Super Kaitsuburi," was purchased in 1988 and these water plants are now being mowed.

4. Pollution load into the lake

Percentages of pollution load from various sources in total load into the lake in 1990 are shown in **Fig.18-13**. As for every parameter (COD, T-N, T-P), loads from households and industrial activities occupy relatively larger ratio in total. However, pollution load from non-point sources, e.g., crop land, urban area, forest, is not determined sufficiently. It is difficult to determine the load from non-point sources because such load is discharged into a lake with runoff during short period in rainy day. Furthermore, effects of the discharged nutrients, mainly particulate form, from non-point sources on the growth of algae are not well known.

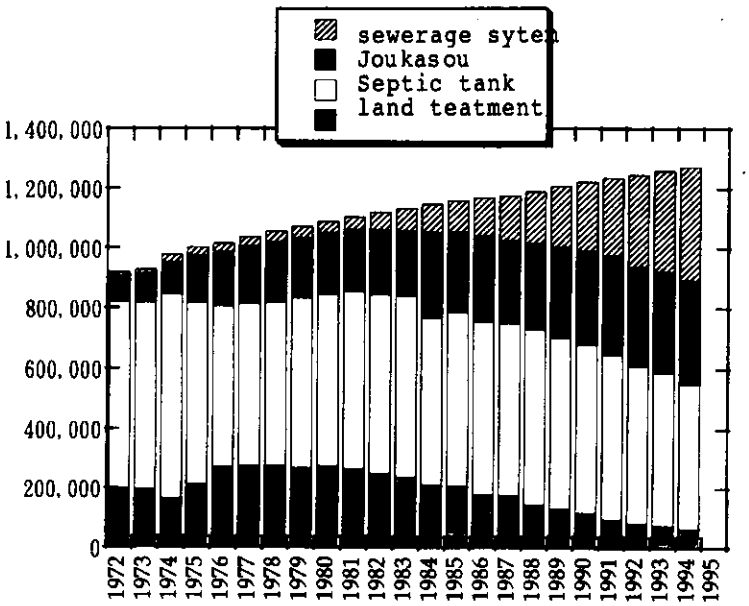


Fig.18-14 Changes in population characterized by the treatment types of human wastes

Figure 18-14 shows changes in population in Shiga Prefecture and several types of population characterized by the treatment types of human wastes. Increase rate in sewered population is not enough comparing to the rate of total population growth. Population served by on-site small treatment facilities (Joukasou) has increased gradually.

5. Water Pollution Control Measures

5.1 Regulatory measures and administrative plans

1) Environmental Quality Standards

According to the Environment Agency Notification No.59 in 1972 based on the provision of the Basic Law for Environmental Pollution Control (1972 Statute No. 132), the northern lake is categorized as AA(1) and the southern lake as AA(3). As for total nitrogen and total phosphorus in terms of eutrophication, both lakes are categorized as Class II (1985 Statute No 24). The standards are shown in **Table 18-1** and **Table 18-2**.

2) Water pollution Control Law and the Shiga Prefectural Environmental Pollution Control Ordinance

Japan Government enacted the Water Pollution Control Law (1971 Statute No. 138) in 1971 in response to the growing threat of water pollution effects on human health and the environment. In Shiga Prefecture, the Shiga Prefectural Environmental Pollution Control Ordinance was already legislated in 1969 and enacted by applying a more stringent prefectural standard to industrial wastewater effluents. In 1973, the ordinance was completely revised to make the regulations stricter.

Furthermore, the **Eutrophication Prevention Ordinance** was legislated in 1979 in order to regulate nitrogen and phosphorus discharges into the lake **(Table 18-3,4)**.

Following this movement, the regulations of nitrogen and phosphorus discharges were

Table 18-1 **The Environmental Quality Standards relating to "health items"**

(harmful substances)

Item	Cd	CN	Org.P	Pb	Cr^{6+}	As	Total Hg	Alkyl Hg	PCB
Standard	0.01mg/ℓ or less	ND	ND	0.1mg/ℓ or less	0.05mg/ℓ or less	0.05mg/ℓ or less	0.0005mg/ℓ or less	ND	ND

Table 18-2 **The Environmental Quality Standards relating to "living environment items"**

Lakes (natural lakes and artificial lakes having pondage of more than 10 million cubic meters)

(a)

Item / Category	Purpose of utilization	Standard					Objective
		pH	COD	SS	DO	Entero bacilli Number of coliform groups	
AA	Water supply, Tap water class 1 Fisheries, class 1	more 6.5 less 8.5	1mg/ℓ or less	1mg/ℓ or less	7.5mg/ℓ or more	50MPN/ 100ml or less	Southern lake (3) Northern lake (1)

(1): Expected to fall under the standard immediately.

(3): Expected to fall under the standard as soon as possible.

(b)

Item / Class	Purpose of use	Standards	
		Total nitrogen	Total phosphorus
II	Tap water Class 1, 2 and 3 (except special cases) Fisheries Class 1 Bathing and those listed in and after III	0.2mg/ℓ or less	0.01mg/ℓ or less

Note: As shown above, Lake Biwa is categorized as Class II. However, the provisional target to be achieved by 1995 is total nitrogen 0.26 mg/ℓ or less for the northern lake and total nitrogen 0.35mg/ℓ or less and total phosphorus 0.015mg/ℓ for the southern lake.

(Source:ref.1)

introduced to the **Water Quality Corruption Prevention Ordinance** in 1985.

3) The Shiga Prefectural Ordinance Concerning the Prevention of the Eutrophication of Lake Biwa

The **Eutrophication Prevention Ordinance** was enacted to regulate the discharge of nitrogen and phosphorus in order to prevent the eutrophication of Lake Biwa. This kind of ordinance was enacted in Shiga firstly in Japan.

The features of this ordinance are listed below.

(1) It regulates the concentration of nitrogen and phosphorus discharges from factories and businesses.
(2) It prohibits the sale and use of domestic synthetic detergents that contain phosphorus.

Table 18-3 **Effluent Standards for the discharge from industries and facilities**

a. substances related to the protection of human health

Item	Maximum Permissible Limits	
	The Water Pollution Control Law	Regulation standard in Shiga Prefecture
Cd and its compounds	0.1 mg/ℓ	0.01 mg/ℓ
Cyanides	1 mg/ℓ	0.1 mg/ℓ
Organic phosphates	1 mg/ℓ	ND
Pb and its compounds	1 mg/ℓ	0.1 mg/ℓ
Cr^{6+} compounds	0.5 mg/ℓ	0.05 mg/ℓ
As and its compounds	0.5 mg/ℓ	0.05 mg/ℓ
Total Hg	0.005 mg/ℓ	0.005 mg/ℓ
Alkyl Hg compounds	ND	ND
PCB	0.003 mg/ℓ	0.003 mg/ℓ
Trichloroethylene	0.3 mg/ℓ	
Tetrachloroethylene	0.1 mg/ℓ	

(Source:ref.1)

(3) It regulates the suitable application of agricultural fertilizers and water management.
(4) It regulates the improvement of treatment facilities for the disposal of domestic animal waste and the suitable application such as recycling to soil.
(5) It states that household garbage should not be washed down the sink and into public water bodies.

In order to operate this Prefectural Ordinance, the following concrete measures were carried out, e.g. the distribution of domestic water-softeners to hard-water regions, withdrawal of P synthetic detergents from houses, guidance and loaning to factories and businesses for installing N & P treatment plants.

After this Prefectural Ordinance was established, most domestic synthetic detergents became non-phosphoric. At the same time, the Special Measure Law for Preserving Lake Water Quality was enacted in 1984 and the regulations of draining for nitrogen and phosphorus were introduced to the Water Quality Corruption Prevention Ordinance by the Government in 1985.

4) Plan for Conserving Water Quality of Lake Biwa

In order to preserve the lake water quality the **Special Measure Law for Conserving Lake Water Quality** was enacted in 1984 (1984 Statute No. 61). This law applies to nine lakes including Lake Biwa. According to this law, a plan for conserving lake water quality pertaining to Lake Biwa was made (first term: 1986—1990, second term: 1991-1995).

In order to pursue this plan synthetically and systematically, included in this plan are the target values of water quality to be achieved in 1990 which was obtained through water quality simulation and working programs for this target such as water quality preserving projects including preparation for well equipped sewerage, measures for draining from factories and domestic sewage and monitoring of water quality (**Fig.18-15**).

5) Comprehensive Environmental Conservation Plan

Table 18-4 b. Items related to the protection of the living environments

Item	Maximum Permissible Limits	
	The Water Pollution Control Law	Regulation standard in Shiga Prefecture
Displacement (㎥/day)	50 or more	30 or more
pH	5.8~8.6	6.0~8.5
BOD	160㎎/ℓ	20~120 ㎎/ℓ
COD	160 ㎎/ℓ	20~120 ㎎/ℓ
SS	200 ㎎/ℓ	70~150 ㎎/ℓ
T-N	120 ㎎/ℓ	8~80 ㎎/ℓ
T-P	16 ㎎/ℓ	0.5~25 ㎎/ℓ
Mineral oil	5 ㎎/ℓ	5 ㎎/ℓ
Animal and vegetable fat	30 ㎎/ℓ	20 ㎎/ℓ
Phenols	5 ㎎/ℓ	1 ㎎/ℓ
Cu	3 ㎎/ℓ	1 ㎎/ℓ
Zn	5 ㎎/ℓ	1 ㎎/ℓ
Dissolved-Fe	10 ㎎/ℓ	10 ㎎/ℓ
Dissolved-Mn	10 ㎎/ℓ	10 ㎎/ℓ
Cr	2 ㎎/ℓ	0.1 ㎎/ℓ
F	15 ㎎/ℓ	8 ㎎/ℓ
Number of coliform groups	3,000cells/㎖	3,000cells/㎖
B		2 ㎎/ℓ
Sb		0.05 ㎎/ℓ

N.B.1 The figures of regulation standard in Shiga Prefecture lie in "More Stringent Prefectural Standard", "The Environmental Pollution Control Ordinance", or "The Shiga Prefectural Ordinance Concerning the Prevention of the Eutrophication of Lake Biwa".

N.B.2 As far as BOD, COD, SS, T-N and T-P are concerned, the figures of regulation standard in Shiga Prefecture vary according to the industry.

(Source:ref.1)

Besides preserving the water quality of Lake Biwa, in order to promote more overall preservation of the environment in other areas of Shiga Prefecture, the local government is positively taking overall measures for preserving the environment, such as assessing the environment, forming a plan for improving the environment of Shiga Prefecture and enacting an ordinance for preserving scenery as a figure of environment and culture **(Fig.18-16)**.

i. Environmental impact assessment

In 1981 the Shiga Prefectural Government enforced measures for evaluating the influence of the environment. In other words, before starting large-scale development works such as reclamation of lakes and marshes and building industrial complexes, the local government undertakes research, and forecasts and evaluates the influence of these works on the environment and then opens the outcome to the public to hear their opinion.

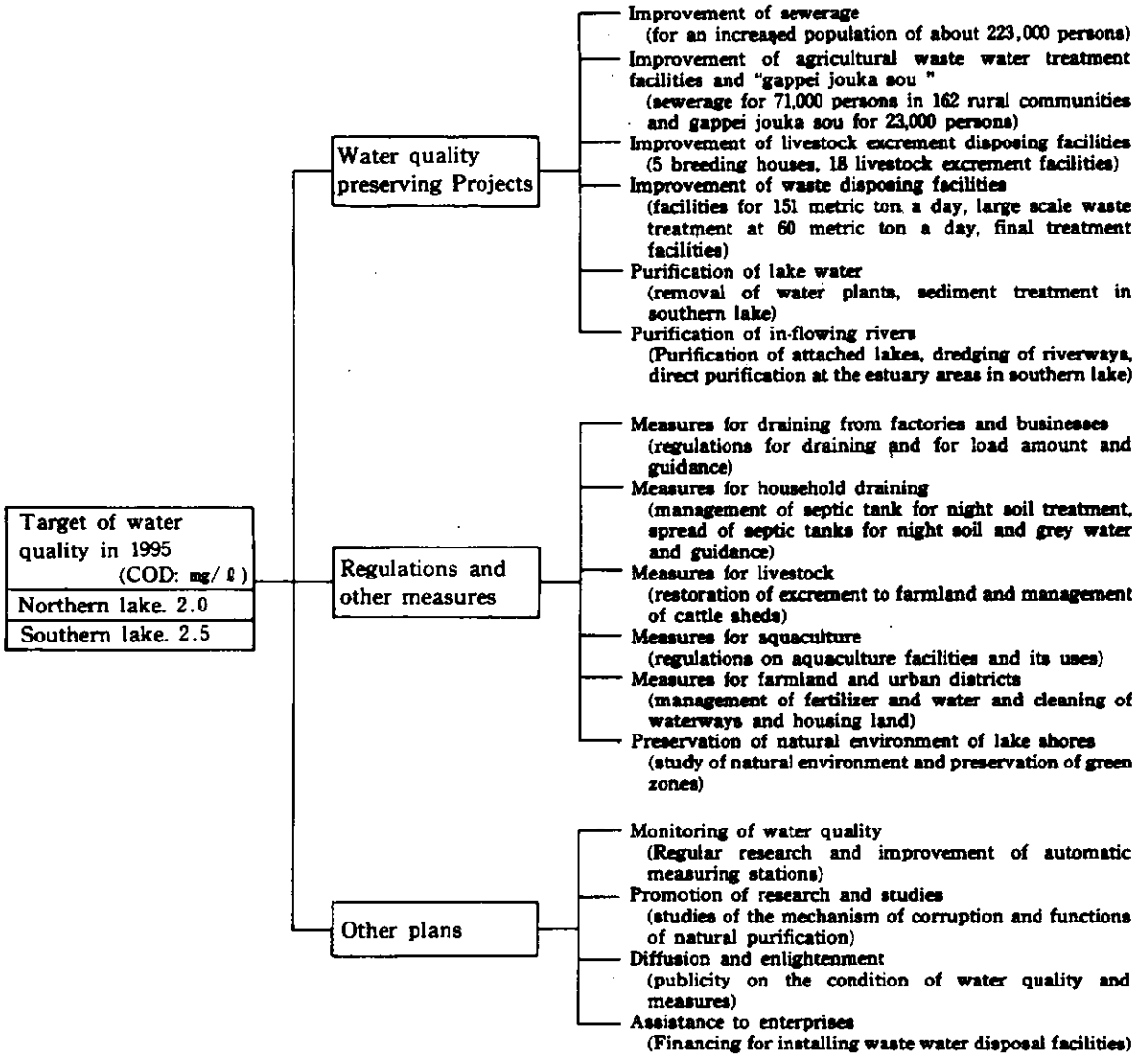
ii. Residents participation for the improvement of environment

In June 1987, the Shiga Prefectural Government made a plan for improving the environment of Shiga Prefecture as a guideline for a better living environment towards the 21st century.

In this plan overall measures are considered from a wide viewpoint including history and scenery, based on pollution control and preservation of nature. Especially, regarded as important are consideration for preserving the environment in using land and making a better environment by the residents themselves. The plan aims at realizing "a ring (coexistence) of lakes, green and human being"... a figure in which human beings and nature harmonize naturally through the overall measures for preserving the environment and combined efforts

Fig.18-15

System of the plan for conserving water quality of Lake Biwa



(Source:ref.1)

for preserving the environment, and for creating a better environment by each and every resident in Shiga Prefecture.

iii. Establishment of an ordinance for preserving scenery

In order to cope with sudden changes in the social and economic situations in recent years, an ordinance was established in 1984 to preserve the nature and scenery of the local country surrounding Lake Biwa. The outline is as follows:

(1) Promotion of measures for preserving scenery by designating. important areas and districts,
(2) Measures for protecting scenery from high and large buildings,
(3) Promotion of measures for preserving scenery through positive efforts for enhance a better environment for local residents,

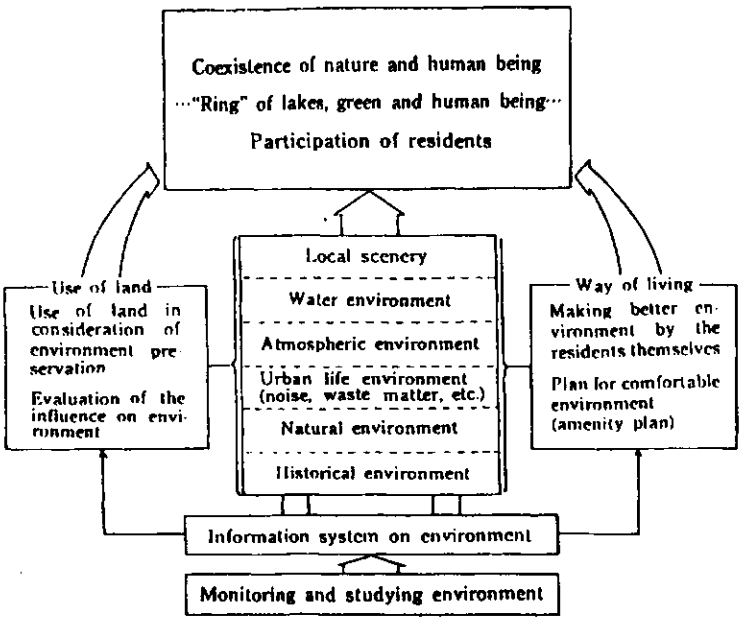


Fig.18-16 Conceptional Drawing of the plan for improving the environment of Shiga Prefecture.

(Source:ref.1)

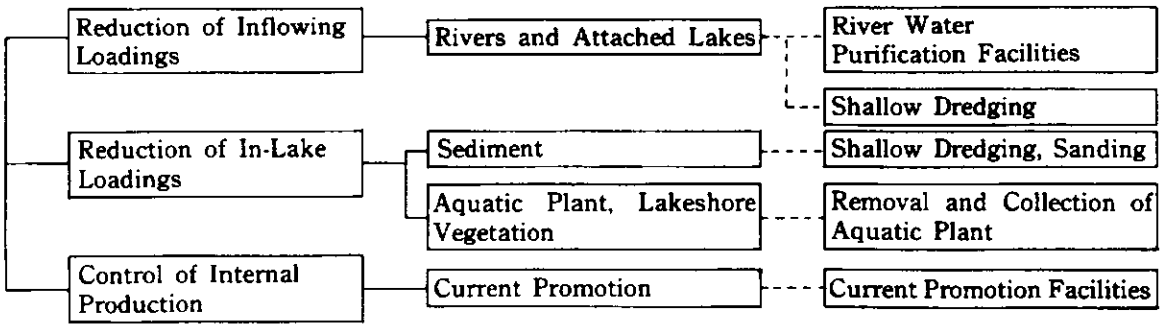


Fig.18-17 Main frame of the Special Project for the Water Quality Improvement of the Southern Lake (1992 - 2001).

(Source:ref.1)

(4) Measures for preserving scenery by making the most of the local characteristics of the cities, towns and villages.

6) Special Project for the Water Quality Improvement of the Southern Lake

Recent Southern Lake's water quality is at the critical status into the eutrophication. To prevent the eutrophication, the special project was initiated by using some measures applied in the lake besides the ongoing measures for pollution sources in the catchment area.

During the period from Fiscal 1988 to Fiscal 1991, the detailed survey of the Southern Lake's environments and the pilot project were conducted. The pilot project included pollution loadings reduction measures at estuaries and rivers, utilization of **inner lakes** to decrease the loadings, **removal of sediment** and so on (**Fig.18-17**).

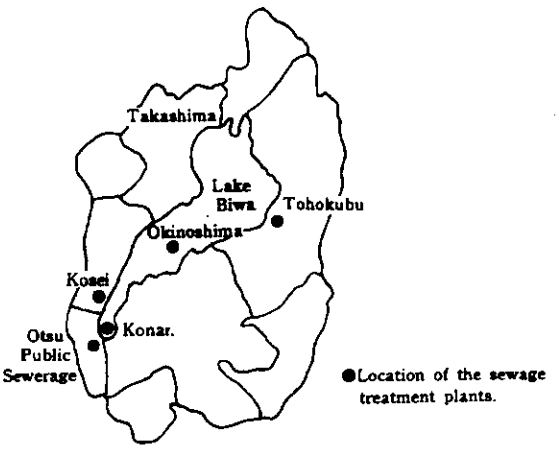


Fig.18-18 Location of the Sewage Treatment Plants and Outline of Sewage Treatment Plan

Division	Sewerage surrounding Lake Biwa				Otsu Public Sewerage	Okinoshima Special Public Sewerage
	Konan	Tohokubu	Kosei	Takashima		
Pre-estimate treatment area	25,500ha	12,700ha	2,600ha	2,000ha	1,338ha	9ha
Pre-estimate Population	790,000	525,000	250,000	62,000	128,000	1,010
Pre-estimate water quantity	1,020,000 ㎥/day	505,000 ㎥/day	120,000 ㎥/day	45,000 ㎥/day	95,000 ㎥/day	420 ㎥/day
Related cities and towns	5 cities 14 towns	2 17	1 1	5 towns	1 city	1 city

(Source:ref.1)

In March 1992, the Advisory Board for the Project revealed the Report. The Report indicated that eutrophication of the Southern Lake is caused by (i) loadings through the inflowing rivers, (ii) high rated release of nutrients from sediment at the stagnated water areas and rolled-up sediment by waves or artificial activities and (iii) release of nutrients from the dead aquatic plants.

7) Ordinance Concerning the Prevention of Litter

Litter and rubbish around the lake shore, on roads and footpaths, in parks and gardens, and rivers and streams degrade the beautiful scenery of Shiga and influence the water quality considerably. In order to deal with this problem positively the Prefecture of Shiga Ordinance Concerning the Prevention of Litter was put into effect on 1 July 1992.

5.2 Adapting technical measures for improvement of the lake environment

1) Construction of large-scale sewerage treatment systems

In order to preserve the water quality of Lake Biwa, construction of wastewater treatment facility is actively promoted. The prefecture is divided into 4 management districts, excluding Otsu City (**Fig.18-18**). Sewerage systems in southern districts are partly in operation, and nitrogen and phosphorus are removed through extensive sewage treatment.

2) Construction of small-scale sewerage treatment systems

In agricultural area with low population densities, small-scale wastewater treatment system is suitable from the viewpoint of construction cost. Approximately 220 facilities are planned for construction (**Fig.18-19**)

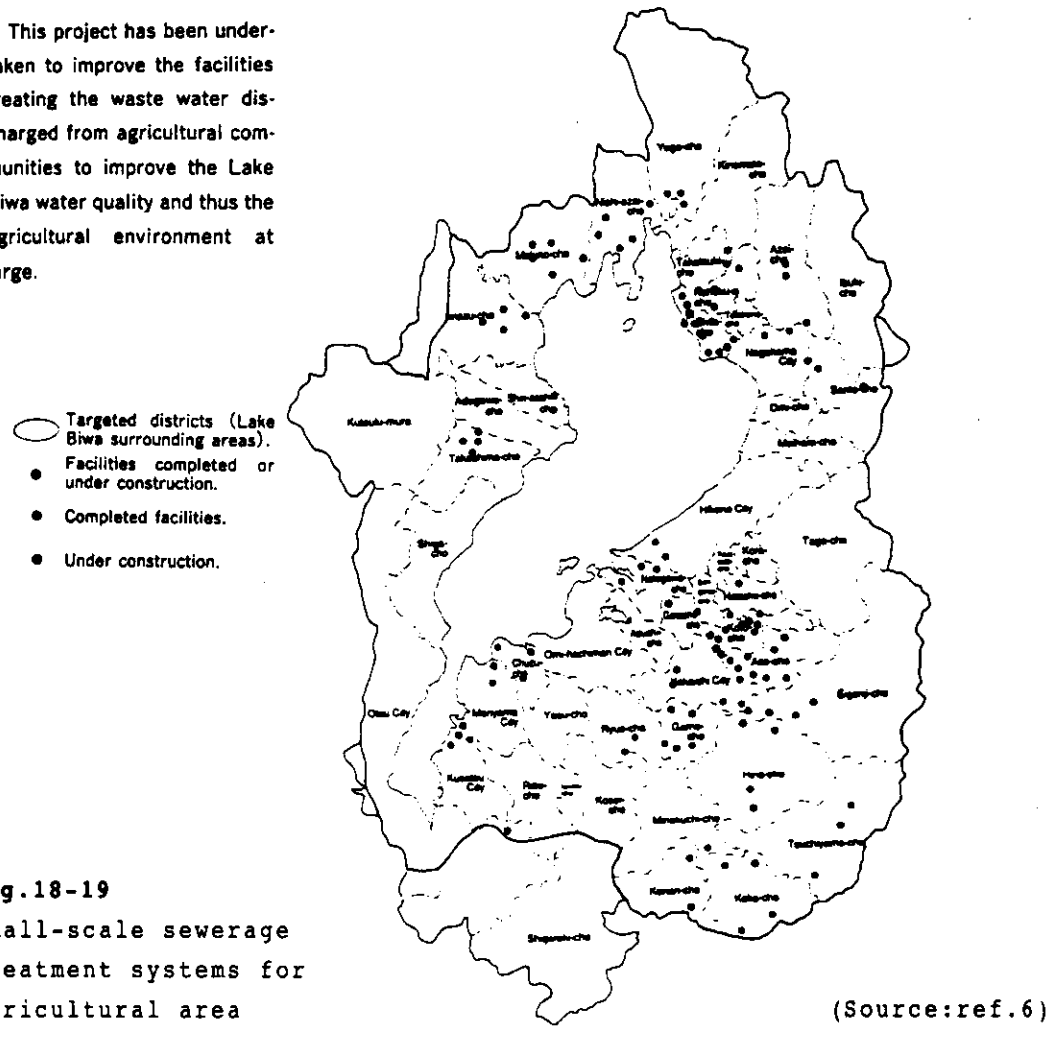


Fig.18-19
Small-scale sewerage treatment systems for agricultural area

(Source:ref.6)

In residential area where sewerage system is not planned or its service is not expected soon, small sewerage treatment facilities (Gappei Joka-so) for each communities or houses are constructed by the payment of residents or developers. Subsidies from local government for this system is not paid or lower than public sewerage system by local government in general. In shiga Prefecture, however, ordinance for promotion of installment of "gappei joka-so" was enacted in 1996.

Percentage of the population served by small-scale facilities in total population in the prefecture is approximately 11% in 1993. The parentage is rather small comparing to that of large-scale system (27%).

3) Human waste treatment facilities

In Shiga Prefecture, population served by septic tank is major (**Fig.18-20**). Therefore, human waste treatment facilities with high performance of removal of pollution load is necessary.

6. Environmental improvement by Citizens' Movement

6.1 History

Since 1975, resident groups in Shiga Prefecture have developed a concerted action to replace synthetic detergents by soap powder. This movement became an important trigger to enforce

the Lake Biwa Eutrophication Prevention Ordinance. At the time of the enforcement of this Ordinance, the ratio for using soap powder increased up to 80 percent. Although the ratio has now dropped down to 40 percent according to the popularization of non-phosphorous detergents, the ratio is still high compared with that of other prefectures (8 percent).

However, this movement by the residents was not limited to using soap powder. The movement was supported by a new sense of value that they live a life which harmonizes the environment surrounding water, sacrificing a little inconvenience and reflecting on their lifestyles. The idea has succeeded up to now. "The campaign for preserving water environment for Lake Biwa by all residents in Shiga Prefecture" which started in 1988 aims at decreasing the corruption load on Lake Biwa to a minimum

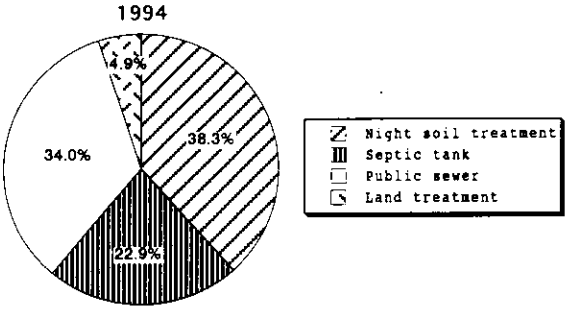


Fig. 18-20 Treatment measures of human waste in Shiga Prefecture in 1994.

Table 18-5 Areas of reed beds and willow stands.

	Emerged Macrophytes	Willow stands	Total
Northern Lake	65.4	36.8	102.2
Southern Lake	62.0	8.7	70.7
sub-total of Lake Biwa	127.4	45.5	172.9
Nishinoko Lake (an attached lagoon)	108.8	1.9	110.7
Other attached lagoons	88.3	11.7	100.0
Sub-total of attached lagoons	197.1	13.6	210.7
Ado-river delta	1.8	7.5	9.3
Grand total	326.3	66.6	392.9

(Source:ref.9)

Table 18-6 Components and tools of the Reed Beds Conservation Ordinance.

* Protection	- Zoning	- Preservation area	- Permission
		- Protected area	- Permission
		- Normal area	- notification
* Bring-up	- Restoration	- installation of anti-wave fence	
		- planting	
	- Maintenance	- cleaning	
		- mowing	
* Utilization	- Investigation and research for utilization of reed		
	- Environmental education and nature observation at reed beds		

(Source:ref.9)

with what they can do in daily life.

This object has been achieved in various ways. They include the decrease in load flowing out of household kitchens by fitting very fine strainers, the use of homemade soap made from waste oil used for cooking, and the restoration of broth and leftover soup to soil without letting them flow into the sink.

6.2 Actions for water-friendly life

It may be difficult for ordinary citizens to imagine or to know concrete methods for improvement of lake water quality. Therefore, making a leaflet showing the concrete methods being able to do for citizens is important. Some examples are shown below:

a. Treatment of leftover food and cooking waste

Use fine meshed strainers in your sink.
Put leftover food and cooking waste back into the soil. It turns into very rich fertilizer. (A composter is good for these processes.)

b. Treatment of oil

Wash dishes after wiping off oil with paper.
Do not drain waste oil. If possible use the oil again. Oil used for tempura, for example, should be kept in a cool dark place and can be used over and over again. Oil that needs to be thrown away should be soaked into paper first, or recycled through a collecting service.

c. Maintenance of neighboring river

We Want rivers and streams to be accessible and enjoyed by the whole community. The prefecture makes programs include rehabilitation of fireflies, ayu-fish and carp, construction of windmills and growing flowers.

6.3 Promotion of environmental education

1) Survey of Aquatic Organisms (Bio-monitoring)

In recent years, the survey of aquatic organisms has been used more and more as a method of monitoring river water quality, in addition to the traditional chemical analysis. The survey evaluates water quality through studying insects, water plants and fishes in aquatic systems such as rivers.

In Shiga the annual survey is conducted every year since its initiation in Fiscal 1984. In 1991, around 1,800 people from 33 organizations took part in the survey on 87 sites of 49 rivers.

Many water insects, with shells from several millimeters to several centimeters in size, can be observed on and under pebbles and in the sand. The types of those creatures vary depending on water quality.

2) Environment Seminar Boat

Aiming at a better understanding of Lake Biwa's water quality by direct observation of lake water and the lake shore, the Prefecture of Shiga operates an environment seminar boat.

3) Open Lecture on the Environment

The Shiga Prefecture has organized an "Open Lecture on the Environment "since Fiscal 1986. Many experts from various fields are invited as lecturers. The lecture is an opportunity for participants to understand Shiga's environments, think about their daily life in relation to

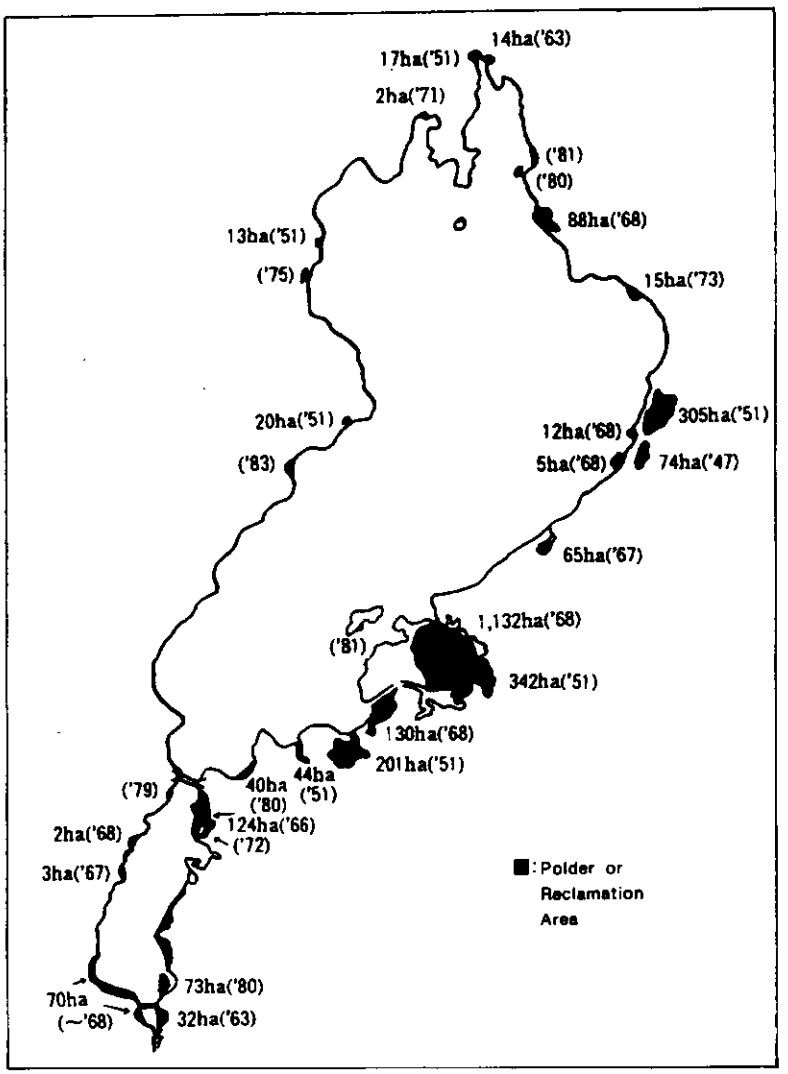


Fig.18-21 **Artificial Change of Lakeshore Line by Polder or Reclamation**

(Source:ref.1)

the environment and to obtain ideas on how to lead an environment-friendly life.

7. New Administrative Works for Conservation of the Lake Ecosystem

7.1 Ordinance Concerning Conservation of the Reed Beds of Lake Biwa in Shiga Prefecture

(Reed Beds Conservation Ordinance)

Reed beds at the lakeshore contributes to the shaping of Shiga's local scenery and to the conservation of the lake ecosystem (**Table 18-5**). The conservation of reed beds means not only the protection of Lake Biwa's nature and the lakeshore ecosystem but also the protection of lakeland culture. We must conserve, bring up and utilize the reed beds.

To meet the above objective, the Ordinance Concerning Conservation of the Reed Beds of Lake Biwa in Shiga Prefecture was promulgated on 30 March 1992 and came into effect from 1 July 1992.

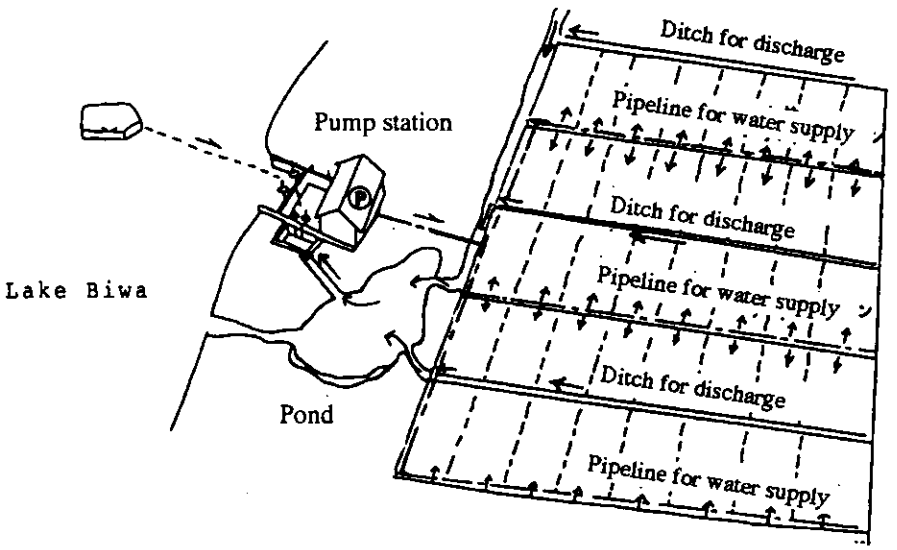


Fig.18-22 Recycling system of agricultural wastewater.

(Source:ref.10)

The Ordinance has three basic tenets: to conserve, nurture and properly utilize reeds (**Table 18-6**). It calls for the close cooperation of citizens, business people and administrators to conserve the reed beds on the lakeshore.

7.2 Conservation of Inner lakes

Around Lake Biwa there were many large and small lakes and marshes called "**inner lakes**" including "Dainaka-no-ko" with an area of 1,145 hectares. In the "inner lakes", aquatic plants grow thick forming spectacular sights and the wetland area may have water purification abilities. However, as these lakes were of low depth as shallow as about two meters, most of them were reclaimed after the Second World War to serve for an increased yield of food to cover a food shortage in the periods during and after World War II. Moreover, more than 300 hectares of Lake Biwa were reclaimed to meet the demand for area development and land for public use after the War. (**Fig.18-21**)

Recently section of agriculture administration in Shiga Prefecture is planning effective use of inner lakes for purifying the wastewater from paddy fields, especially in spring season. Discharge of silt from paddy field with rice planting works in spring is a problem in the prefecture. Outlook of measure using inner lakes for improving water quality is shown in **Fig.18-22.**

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Appendix-1 Outline of Lake Biwa Conprehensive Development Project