Chapter 19 LAKE KASUMIGAURA

1. Outline of Lake Kasumigaura

1.1 Lake Kasumigaura

Lake Kasumigaura is located about 60-90 km northeast of Tokyo (Fig.19-1). It is Japan's second largest natural fresh-water lake, and from ancient times it has bestowed countless benefits on the local inhabitants. In recent years, with the rapid growth of the Japanese economy and in line with policies to promote development within the prefecture, Lake Kasumigaura has come to be viewed as a precious water resource. The lake has become the focus of expectations for it to play a major role in the potential transformation of this flat basin area into a prosperous development region.

Lake Kasumigaura covers an area of approximately 220 square kilometers, and it is comprised of three water regions: Nishiura, Kitaura, and the Hitachi-Tone River (Fig.19-2). While 56 rivers including the Sakura, the Ono, and the Koise, flow into Lake Kasumigaura, the lake discharges into just one river, the Hitachi-Tone, which later joins with the Tone River.

Because Lake Kasumigaura used to be an inland sea, it lies a mere 16 centimeters above sea level, and with an average depth of 4 meters, the lake is extremely shallow in comparison with its size. Moreover, water remains in the lake for as long as about 200 days on average (Table 19-1). Because of all these characteristics, Lake Kasumigaura is unusually vulnerable to pollution. Kasumigaura became a freshwater lake around the year 1638, during the Edo Period (1600-1868).

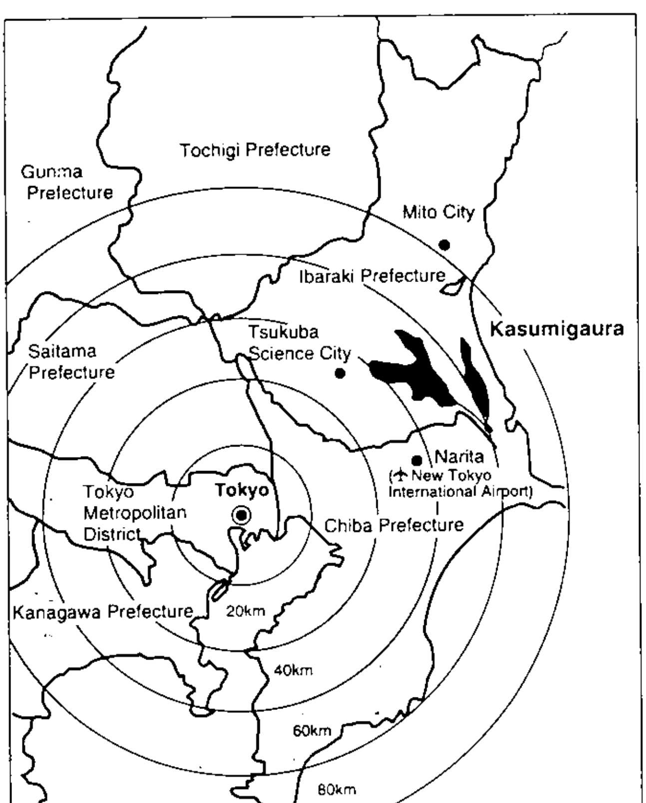


Fig.19-1 Kasumigaura Location Map

Fig.19-2 Region of Lake Kasumigaura

1.2 Kasumigaura Basin

The Kasumigaura drainage basin encompasses 45 cities, towns, and villages located in Ibaraki, Chiba, and Tochigi prefectures. The total basin area is approximately 2,200 square kilometers, equivalent to one-third the entire area of Ibaraki Prefecture. At present, about 950,000 people inhabit this basin, and urbanization is expected to progress further in this region. The basin is dominated by agriculture, which accounts for 37.2 percent of the overall land use (Fig.19-3). Urban areas account for 12.4 percent of the land use, and Tsuchiura City, Ishioka City, and Itako Town are among the well-developed areas within the basin. The development of industrial parks in Kashima Town and Kamisu Town and the construction of Tsukuba Science City are changing the characteristics of the regional land use.

Table 19-1 Outline of Lake Kasumigaura

Category	Item	Unit	Kasumigaura
Lake	Origin	—	Inland Sea-Lake
	Maximum Depth	m	7
	Average Depth	m	4
	Area	km^2	220
	Circumference	km	252
	Capacity	billion m^3	approx. 9
	Average Water Replacement Period	days	approx. 200
	Height Above Sea Level	m	0.16
Basin	Area	km^2	2,157
	Number of Cities, Towns, and Villages	—	45
	Number of Cities, Towns, and Villages Nearby the Lake	—	23
	Population	1,000 persons	93
	Average Annual Rainfall	mm	1,350
	Average Annual Discharge	billion m^2	approx. 1.2

Urban Areas	Rice Fields	Other Fields and Orchards	Mountains, Etc.	Lake
12.4	21.2	16.0	40.1	10.3

Note: Figures for fiscal year 1992.

Fig.19-3 Land Use in the Kasumigaura Basin

Table 19-2 Majio Industries in the Kasumigaura Basin

Manufacturing	• Industrial Shipments—¥2,407 billion (accounting for approximately one-fifth of the prefectural total, number 9 nationwide)
Agriculture	• Rice Cultivation Area—48,000 hectares (accounting for approximately one-half of the prefectural total, number 5 nationwide) • Lotus Root Cultivation Area—1,700 hectares (accounting for virtually all of the prefectural total, number 1 nationwide) • Region for the Provision of Perishable Foods to the Greater Tokyo Metropolitan Area
Livestock Industry	• Number of Pigs—330,000 (accounting for approximately 50 percent of the prefectural total, number 3 nationwide) • Number of Beef Cattle—20,000 (accounting for approximately 40 percent of the prefectural total, number 17 nationwide) • Number of Dairy Cattle—30,000 (accounting for approximately 60 percent of the prefectural total, number 8 nationwide) • Number of Chickens for Egg Production—6.17 million (accounting for approximately 60 percent of the prefectural total, number 3 nationwide)
Fisheries	• Freshwater Fish Harvest—5,214 tons (accounting for approximately 40 percent of the prefectural total, number 1 nationwide) • Carp Breeding Production—5,471 tons (accounting for virtually all of the prefectural total, number 1 nationwide)

The Kasumigaura basin is blessed with natural resources, which are being used for the prosperous operation of manufacturing, agriculture, livestock raising, and fisheries (Table 19-2). As for agriculture, the Suigo or lakeside area enjoys an unusually large scale in rice farming. The basin prides itself as the nation's largest production area for lotus root, and the third largest region for pig farming. There has also been a thriving fishing industry in the area for many years. The basin is number one in Japan in both fresh-water fishery catch and carp breeding. Furthermore, becase the Kasumigaura region is located just 60 kilometers from the greater Tokyo metropolitan area, many new production plants are being located here, and factory shipments are increasing.

2. The Use and Management of Lake Kasumigaura

2.1 Lake Kasumigaura and Human Life

The water resources of Lake Kasumigaura have long been used for diverse purposes. Historically, the abundant varieties of fish that inhabit the lake served as the foundation for the development of the region's fresh-water fishing industry (Fig.19-4). At its peak around 1975, the annual fish harvest from Lake Kasumigaura reached approximately 17,000 tons, but the harvest has been declining ever since. Traditionally, the main varieties were Wakasagi (pond smelt), Shirauo (whitebait), and Shijimi (corbicula). In recent years, the havest of Haze (goby), Ebi (prawn), and Isazaami (shrimp) have been increasing. Since around 1955, carp have also been raised inside fish pens.

The area also has a long history of water transportation. Especially since the mouth of the Tone River was moved to the east in the early Edo period, Lake Kasumigaura was a key route for the transportation of rice and other goods from the northeastern region to the city of Edo (the old name for Tokyo). During the Meiji period (1868-1912), regular steamboat liner services were also widely used.

The waters of Lake Kasumigaura have long been used for agriculture, but the extensive use began from the Taisho period (1912-1926), as pumps and other modern irrigation equipment became widespread. The primary application is rice farming, accounting for 80 percent of the total agricultural use.

The waters were first used for municipal supply (household use) in 1955. The waters have been used for manufacturing since 1965, with the construction of the Kashima Coastal Industrial Region.

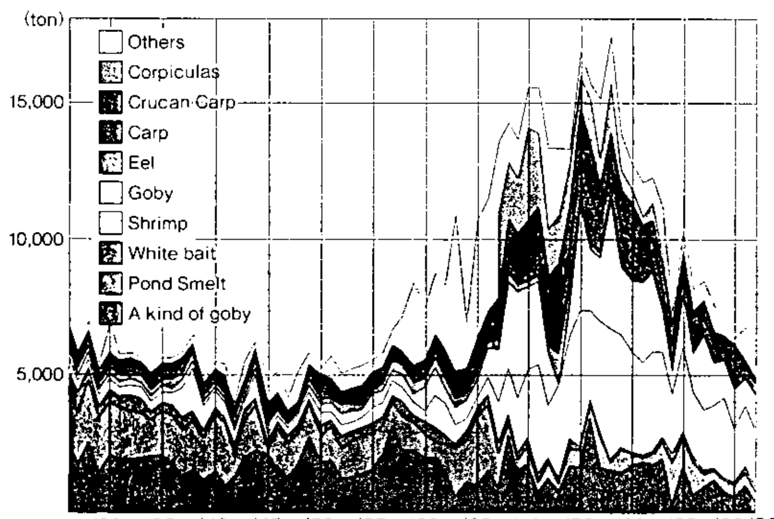


Fig.19-4 Changes in the Total Yield in Lake Kasumigaura

In the past, the lake provided several swimming areas for children including Ukishima, Tennozaki, and Ayumizaki.

2.2 Floods and Salt Damage

Moreover, in response to the domestic demand for increased foodstuff production from the Taisho period through to the Showa period(1926-1989), large-scale projects were implemented to open up new arable lands and to reclaim portions of the lake by drainage. As a result, the area of reclaimed land around Lake Kasumigaura reached about 2,700 hectares, expanding the area of fertile agricultural land. Kasumigaura became a key region for the provision of food to the Tokyo metropolitan area.

In this way, Lake Kasumigaura has provided countless blessings to the Japanese people. However, because the lake also functions as the retarding basin for the Tone River, the Kasumigaura basin has been subjects to frequent flood damage during heavy rainfalls and from the backflow of the Tone River. For this reason, diverse efforts have been made to limit this damage including the construction of embankments and the excavation of flood canals. Nevertheless, these flood-prevention works were insufficient. Serious floods occurred in 1938 and again in 1941 (Table 19-3).

Therefore, after the Second World War a radical improvement plan was drawn up and implemented. Efforts to dredge and greatly expand the width of the Hitachi-Tone began to substantially increase the carrying capacity of the river, and the physical interaction between Lake Kasumigaura and the Tone River were greatly improved. However, the intrusion of ocean water led to salt damage, so in May 1963 the Hitachi River Tidegate was constructed at the confluence of the Tone and Hitachi-Tone rivers to prevent flood damage from the back-flow of the Tone and to prevent salt damage during droughts.

2.3 Overall Development System for Lake Kasumigaura

These measures proved effective. The region is no longer subject to the type of massive flooding experienced in the past, and since 1975, when "fair current" procedures were instituted whereby the Hitachi River Tidegate is operated to prevent any mixed salt water in the Tone from backflowing into Lake Kasumigaura, there has been no salt damage.

In this way, since the Hitachi River Tidegate came into operation, there have been increasing calls for stopping the "dead" discharge of water (that is the discharge of water not being used for any specific purpose) from Lake Kasumigaura at this tidegate, and for

Table 19-3 Major Floods

Water Level & Total Rainfall / Date	Water Level	Average Rainfall in the Basin	Reference
June-July 1938	Y.P. + 3.34 m	600 mm (7 days)	Typhoon
July 1941	Y.P. + 2.90 m	315 mm (4 days)	Typhoon #8
Sept. 1947	Y.P. + 1.96 m	179 mm (5 days)	Typhoon #9 (Catherine)
July 1950	Y.P. + 2.34 m	248 mm (10 days)	Typhoon #17
Sept. 1958	Y.P. + 2.30 m	246 mm (5 days)	Typhoon #22 Kano River
June-July 1961	Y.P. + 1.96 m	300 mm (7 days)	Rain Front
Sept. 1971	Y.P. + 1.91 m	312 mm (9 days)	Typhoon #23 & #25
Aug. 1977	Y.P. + 1.84 m	212 mm (7 days)	Rain Front, Tropical Low Pressure
Sept. 1982	Y.P. + 1.80 m	175 mm (3 days)	Typhoon #18
June-July 1985	Y.P. + 1.89 m	115 mm (2 days)	Typhoon #6
Aug. 1986	Y.P. + 2.05 m	238 mm (2 days)	Typhoon #10
Sept. 1991	Y.P. + 2.31 m	198 mm (2 days)	Typhoon #18
Oct. 1991	Y.P. + 2.50 m	279 mm (9 days)	Typhoon #21

(Figures for 1961 and earlier measured at the Inoue Water Level Monitoring Station; figures from 1971 and later measured at the Dejima Water Level Monitoring Station).

the efficient use of this "dead" water. The background to these demands includes the opening of the Kashima Coastal Industrial Region in line with the rapid growth of the Japanese economy and regional development policies within Ibaraki Prefecture, the decision to construct Tukuba Science City, and the expansion of the periphery of the greater Tokyo metropolitan area. While supporting the development of the Kasumigaura region, Lake Kasumigaura is also being used to supply the long-term and wide-ranging water needs of the greater Tokyo metropolitan area, which continues to grow. From 1968, a national development project has been conducted at Lake Kasumigaura (Fig.19-5) in accordance with the Water Resources Development Promotion Low, and as part of the Basic Plan for the Development of Water Resources (Tone River Water System).

There are no mountainous areas or large rivers in the region nearby Lake Kasumigaura, and the annual rainfall is relatively small for Japan (1,350 mm versus a national average of 1,780 mm). The subterranean water is limited, and the quality is not very good. On the other hand, Lake Kasumigaura is useful for water regulation because it is located in a downstream lowland, and the lake is also beneficial in that it provides extremely good geographical features to limit the "dead" discharge of water, including the Tone River. Thus, the region increasingly relies upon Lake Kasumigaura for the stable supply of good quality water resources.

The goals of the national development project are to prevent flooding in the basin area through the construction of embankments along the shoreline with a crown height of Y.P.+3.0m (flood-control works), and to utilize the water capacity of 278 million cubic meters that lies between a water level of Y.P. ± 0.0m to Y.P.+1.3m to develop a supply capacity of 42.92 cubic meters per second for irrigation and city water (water-utilization works). The total project costs are ¥286.4 billion, and the project term runs from 1968 through 1995 (Fig.19-6).

2.4 Water Utilization at Kasumigaura

Aside from this national development project, the Kasumigaura Waterworks Project is also designed to secure the water resources at lake Kasumigaura. This project will provide two

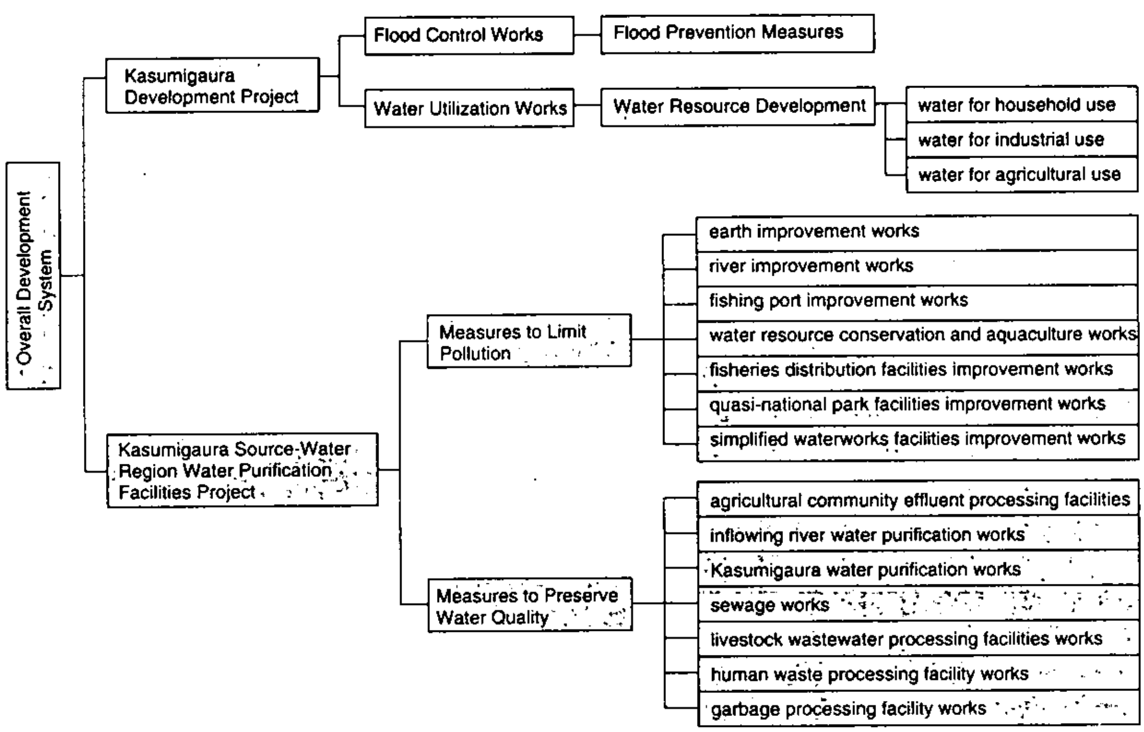
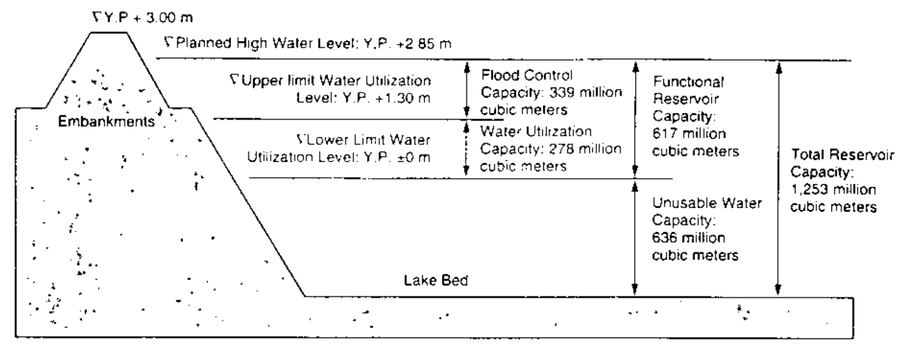


Fig.19-5 Overall Development System for Lake Kasumigaura

underground tunnels to transport 650 million cubic meters of water per year. One of the tunnels will connect the downstream region of the Naka River with Lake Kasumigaura (approximately 42.9 km), and the other will connect the downstream region of the Tone River with the lake (approximately 2.6 km). To improve the water quality of Lake Kasumigaura and the Sakura River (the Naka River water system), and toward the stable supply of water that is already being acquired from the Naka and Tone rivers, the Kasumigaura Waterworks Project will develop 12.7 cubic meters per second of new water supply for urban use from Lake Kasumigaura and the Naka River. The total project costs are projected at ¥190.0 billion, and the project term is from 1976 to the year 2000 (Fig.19-7).

At present, a total of 109.84 cubic meters per second of water is being utilized from Lake Kasumigaura for household, industrial, and agricultural use (Table 19-4). The volume of water usage will continue to grow along with changes in lifestyles, the growth of population



Note: Y.P. ±0 m = T.P. (mean tide level of Tokyo Bay) −0.84 m

Fig.19-6 Lake Kasumigaura Capacity Distribution

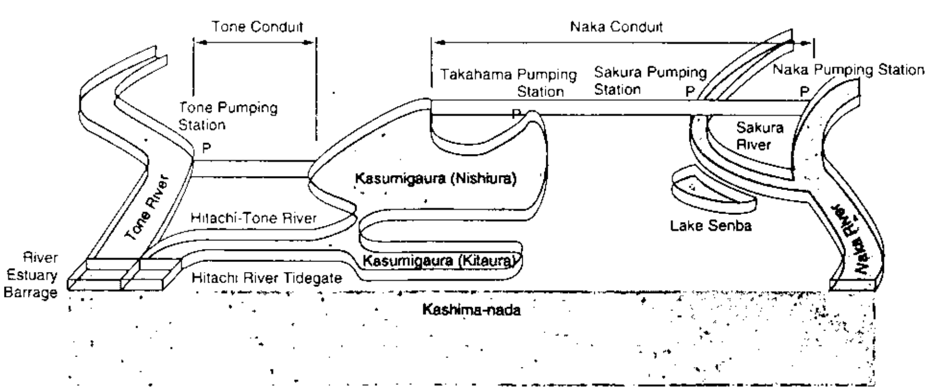


Fig.19-7 Structural Diagram of the Kasumigaura Waterworks Project

Table 19-4 Current Water Use Conditions at Kasumigaura

Item	Maximum Water Use	Reference
Agricultural Water	94.44	Irrigation area of approximately 50,891 hectares
Household Use	2.98	Wide-ranging utilization in the western and southern parts of the prefecture, Kashima water main, etc.
Industrial Use	11.45	Kashima Coastal Industrial Region and wide-ranging industrial use in western part of the prefecture.
Miscellaneous	0.97	
Total	109.84	

(compiled from data provided by the Ministry of Construction Kasumigaura Works Office) Unit: m³/sec within the basin, the improvement of agricultural land and industrial parks, and other factors. As a water resource that is highly resistant to drought, Lake Kasumigaura is absolutely indispensable for the further development of Ibaraki Prefecture.

3.Water Quality of Lake kasumigaura

3.1 Water Quality of Lake Kasumigaura

Originally, Kasumigaura water quality was a COD on the order of 4-5 mg per liter, and the water clarity was not particularly high. Nevertheless, this did not represent an obstacle to the water use. However, from around 1965 as various activities in the Kasumigaura basin began to flourish and water use expanded, the quality of Kasumigaure's water began to change along with growing concern about the water quality (Fig.19-8).

Examining the water quality at Lake Kasumigaura in terms of COD, the level was approximately 6-8 mg per liter from around 1965 through around 1975. In 1978 and 1979, the COD exceeded 10 mg per liter. Thereafter, however, the COD gradually decreased. Following the enforcement of the Ordinance to Prevent Eutrophication, in 1983 the COD level dropped to around 8-9 mg per liter, from 1988 it fell to 7-8 mg per liter, and in 1991 the level was 6.8 mg per liter, falling below 7 mg per liter for the first time in 14 years. Thereafter, the COD level began to increase once again, registering 7.4 mg per liter in 1992, 8.2 mg per liter in 1993, and 8.5 mg per liter in 1994. The present level is about 8-9 mg per liter.

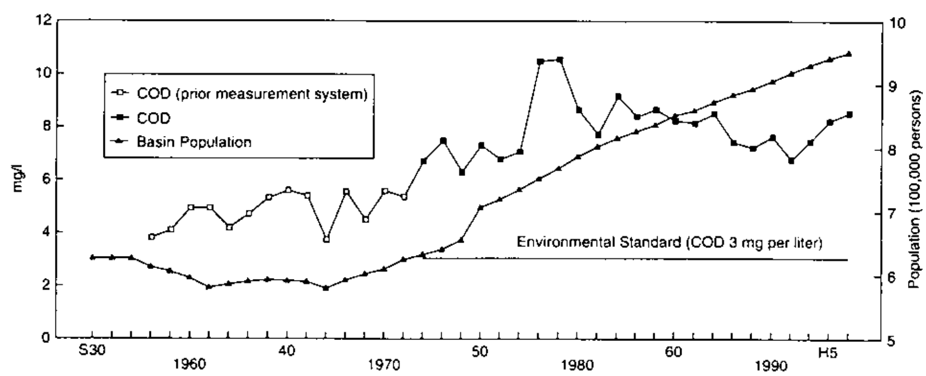


Fig.19-8 Water Quality at Lake Kasumigaura

3.2 Damage from Water Utilization

Then, from the early 1970's, algal bloom (a growth of algae near the surface) became conspicuous, and the COD exceeded 6 mg per liter. At the same time, condensation obstructions, filtration stoppages, and other impediments to treatment began to occur at water purification plants using the lake's waters. Water users began to complain of strange odors. Particularly in the summer of 1973, when the areas suffered from unusual drought, there was a major outbreak of algae bloom. In addition to interfering with water purification, the odor from decomposing algae was offensive, and damages were suffered as a large number of cultured carp died from oxygen depletion.

4.Measures to Improve Water Quality

4.1 Environmental Standards

To prevent this pollution at Lake Kasumigaura, the government set desirable water quality standards as administrative targets in the environmental standards concerning water pollution. Because the waters from Lake Kasumigaure are used as a resource for household water, the lake was classified as a "Class A" lake in 1972, and the rivers that flow into Lake Kasumigaura were designated as "Class A" rivers in 1972 and 1973.

Also in 1985, nitrogen and phosphorus standards were added to the Environmental Standards, and in 1986 Kasumigaura was designated as a "Class 3" lake.

4.2 Local Effluent Standards More Stringent than the National Uniform Standards

To achieve these Environmental Standards, first of all, in accordance with the national Law for Prevention of Water Pollution and the Ibaraki Prefectural Pollution Prevention Ordinance, the regulations governing industrial and business effluent were strengthened. In Ibaraki Prefecture, regulations were passed applying the strictest standards in the nation (the highest effluent standards) to prevent the pollution of Lake Kasumigaura (Table 19-5).

Moreover, in 1975 Kasumigaura was designated as a source-water region under the Special Measures Act for Source-Water Regions, and the Plan for Water Purification Facilities in Kasumigaura's Source-Water Regions was enacted in 1976. Under this plan, various works have been promoted for the preservation of water quality including the improvement of treatment plants for sewage and human waste, the improved processing of livestock waste, and dredging works, etc.

In addition, citizens' movements to improve water quality have included the use of powdered soap and non-phosphate detergent, and a large-scale citizens' plan to clean up Lake Kasumigaura is being implemented.

4.3 Ibaraki Prefectural Ordinance for the Prevention of the Eutrophication

Nevertheless, despite these diverse improvement activities, population growth, expansion of industrial activities, and changes in lifestyle have resulted in a worsening of the water quality at Lake Kasumigaura. In 1978 and 1979, the COD exceeded 10 mg per liter.

The cause of this water pollution lies in the massive growth of phytoplankton because of the influx of nitrogen, phosphates, and other nutritive salts; that is, in the process known as eutrophication. Therefore, based on a report issued by the prefectural water quality council, in 1981 regulations were enacted to prevent the eutrophication of Lake Kasumigaura. (These represented the second such regulations in all of Japan, following regulations enacted for Lake Biwa). These regulations forbid the use of phosphate and other synthetic household detergents, and place limitations on the levels of nitrogen and phosphorus in industrial effluent (Table 19-6). Ibaraki Prefecture has been ahead of the national government in eutrophication prevention efforts.

4.4 Special Measures Act for the Preservation of Lakes and Marsh Water Quality

From the mid-1980s, water pollution in lakes and marshes became a common national problem, so legal measures were upgraded at the national level. The Special Measures Act for the Preservation of Lakes and Marsh Water Quality was enacted in 1984. This law designated certain lakes and marshes in particular need of pollution countermeasures. Under this law, a Plan for the Preservation of Lakes and Marsh Water Quality was prepared, covering sewage and other works to preserve water quality as well as industrial effluent regulations. In accordance with this plan, the preservation of lake and marsh water quality is moving forward in a systematic and comprehensive manner.

Kasumigaura became a designated lake under the Special Measures Act in 1985, and

Table 19-5 Uniform and More Stringent Standards for Wastewater

Wastewater standards based on the Water Pollution Control Law and strict standards for Lake Kasumigaura

Harmful substances items concerning water quality	Water Pollution Control Law uniform wastewater standards (by the Prime Minister's Office)	Ordinance for Prevention of Pollution by the Ibaraki Prefectural Government strict wastewater standards for Lake Kasumigaura	
		new	conventional
cadmium and its compounds	0.1mg/l	0.01mg/l	0.1mg/l
cyanogen compounds	1mg/l	under the detectable level	1mg/l
organic phosphorus compounds	1mg/l	under the detectable level	1mg/l
lead and its compounds	0.1mg/l	0.1mg/l	
chrome hexad compounds	0.5mg/l	0.05mg/l	0.5mg/l
arsenic and its compounds	0.1mg/l	0.05mg/l	
mercury and its compounds including alkyl mercury	0.005mg/l	0.0005mg/l	0.005mg/l
alkylmercury compounds	under the detectable level.	under the detectable level	under the detectable level
PCB	0.003mg/l	under the detectable level	0.003mg/l
trichloroethylene	0.3mg/l		
tetrachloroethylene	0.1mg/l		
dichloromethane	0.2mg/l		
tetrachlorocarbon	0.02mg/l		
1,2-dichloroethane	0.04mg/l		
1,1-dichloroethylene	0.2mg/l		
cis-1,2-dichloroethylene	0.4mg/l		
1,1,1-trichloroethane	3mg/l		
1,1,2-trichloroethane	0.06mg/l		
1,3-dichloropropene	0.02mg/l		
Thiram	0.06mg/l		
Simazine	0.03mg/l		
thiophene carboxylic acid	0.2mg/l		
benzene	0.1mg/l		
selenium	0.1mg/l		

Conditions and substances affecting living environment			
hydrogen-ion concentration (pH)	5.8-8.6 (5.0-9.0 of seas)	5.8-8.6	5.8-8.6
biochemical oxygen demand (BOD)	160mg/l (day average 120mg/l)	15(10)mg/l	25(20)mg/l
chemical oxygen demand (COD)	160mg/l (day average 120mg/l)	15(10)mg/l	25(20)mg/l
suspended solids (SS)	200mg/l (day average 150mg/l)	20(15)mg/l	40(30)mg/l
extracted n-hexane substances (mineral oil)	5mg/l	3mg/l	3mg/l
extracted n-hexane substances (plant and animal fats and oils)	30mg/l	5mg/l	5mg/l
phenols	5mg/l	0.1mg/l	1mg/l
copper	3mg/l	1mg/l	3mg/l
zinc	5mg/l	1mg/l	5mg/l
soluble iron	10mg/l	1mg/l	10mg/l
soluble manganese	10mg/l	1mg/l	1mg/l
chrome	2mg/l	0.1mg/l	1mg/l
fluorine	15mg/l	0.8mg/l	8mg/l
coliform groups	day average 3,000/cm^3	day average 3,000/cm^3	day average 3,000/cm^3
nitrogen content	120mg/l (day average 60mg/l)	(See next page)	
phosphorus content	16mg/l (day average 8mg/l)	(See next page)	

Note: These wastewater standards are applied to factories and plants which discharge the following amounts of water:

1. The standards for harmful substances are applied to all factories and plants regardless of the amount of water discharged.
2. The standards for conditions and substances affecting living environment are applied to all existing factories and plants discharging 50m^3/day or more (or both harmful substances and 30m^3/day or more of wastewater and newly built factories and plants discharging 20m^3/day or more.

Table 19-6 Strict Standards for Nitrogen and Phosphorus in Wastewater

Strict standards for nitrogen and phosphorus in wastewater by the Ordinance to Prevent Eutrophication of Lake Kasumigaura

(unit: mg/l)

Class		average amount of water discharged a day	for building new facilities		for existing facilities	
			nitrogen	phosphorus	nitrogen	phosphorus
manufacturing industry	food factories	$20m^3$ or more but less than $50m^3$	20	2	25	4
		$50m^3$ or more but less than $500m^3$	15	1.5	20	3
		$500m^3$ or more	10	1	15	2
	metal factories	$20m^3$ or more but less than $50m^3$	20	2	30	3
		$50m^3$ or more but less than $500m^3$	15	1	20	2
		$500m^3$ or more	10	0.5	15	1
	other kind of manufacturing industry	$20m^3$ or more but less than $50m^3$	12	1	15	1.5
		$50m^3$ or more but less than $500m^3$	10	0.5	12	1.2
		$500m^3$ or more	8	0.5	10	1
other industries	livestock farms	$20m^3$ or more but less than $50m^3$	25	3	50	5
		$50m^3$ or more but less than $500m^3$	15	2	40	5
		$500m^3$ or more	10	1	30	3
	final plants for treating sewage	$20m^3$ or more but less than $100,000m^3$	20	1	20	1
		$100,000m^3$ or more	15	0.5	15	0.5
	plants for treating human wastes (excluding septic tanks)	$20m^3$ or more	10	1	20	2
	septic tanks	$20m^3$ or more	15	2	20	4
	other plants	$20m^3$ or more but less than $50m^3$	20	3	30	4
		$50m^3$ or more but less than $500m^3$	15	2	25	4
		$500m^3$ or more	10	1	20	3

Note: These standards are not meanwhile applied to factories or plants with which only septic tanks are installed.

Ibaraki, Tochigi, and Chiba prefectures prepared a water quality preservation plan in 1987. This plan specified a water quality COD target, and clarified the necessary policies and works to achieve this goal.

4.5 Measures for Maintaining Water Quality

The present water quality preservation plan and basic plan are both based on the third-phase plan of 1997, and all types of measures are being comprehensively pushed forward. The various measures are summarized in Fig.19-9, and the main items are outlined below.

The causes of pollution are summarized in Fig.19-10. Some 42 percent of the pollution may be attributed to household effluent, and the sewage works that serve as the pillar of the countermeasures for this pollution have been improved by both the prefecture and the local municipalities. High-level processing of nitrogen and phosphorus is also being conducted for the water treatment. As of the end of 1995, the population served by the water treatment facilities was 398,300 people, and the coverage ratio was 42 percent.

To address pollution from agricultural water use, an Outline of Guidance in Agricultural Methods has been prepared to prevent the influx of fertilizer runoff from rice paddies and vegetable fields. The primary points of this Outline are appropriate levels of fertilizer use, appropriate water management, and constructive soil buildup.

Similarly, an Outline of Guidance in Stock Raising has been prepared to address the livestock waste issue. The basic premise of this outline is that livestock waste should be returned to the soil, and the outline includes guidance on appropriate handling of animal waste and is designed to promote the stabilization of the livestock business.

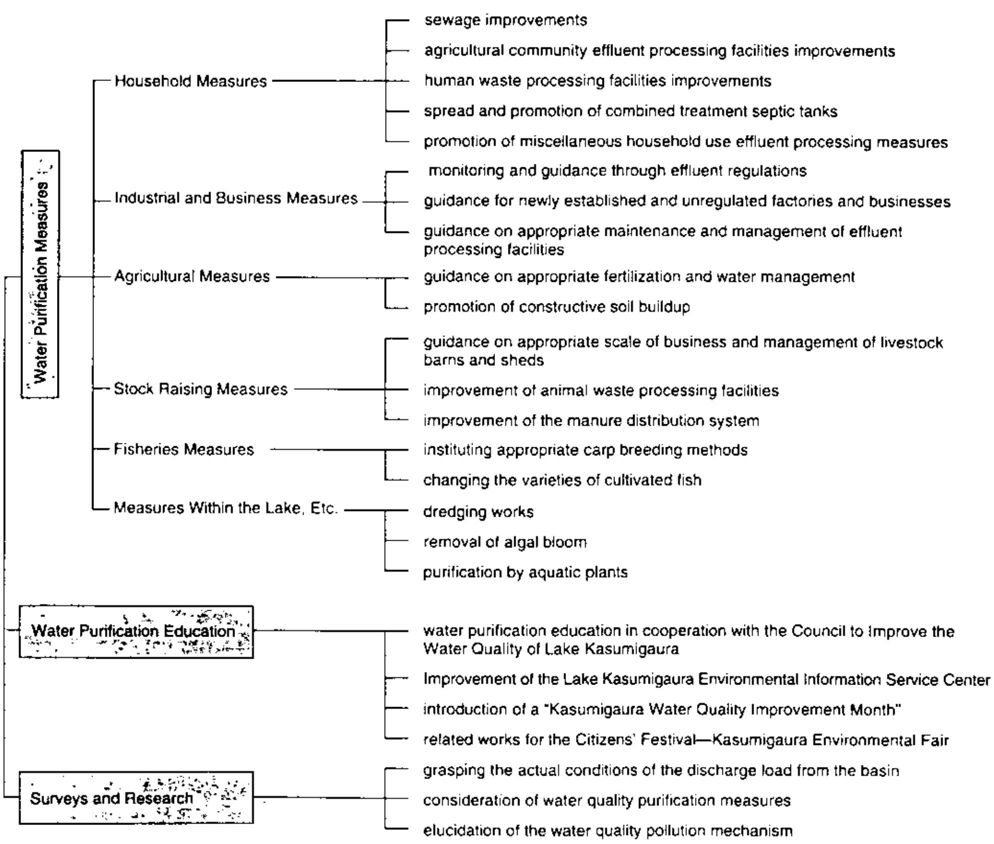


Fig.19-9 Water Purification Policy System

Moreover, an Outline of Guidance in Fish Cultivation was designed to minimize the nitrogen and phosphorus load on the lake from the raising of carp inside fish pens. This outline provides comprehensive guidance on appropriate measures for carp breeding, and on changing the varieties of fish for this type of aqua-culture.

Also, large-scale dredging operations are taking place to remove the accumulated silt on the bed of Lake Kasumigaura (Fig.19-11). Specifically, a target of approximately 7.22 million cubic meters of silt is scheduled to be dredged by the year 2000.

Aquatic plants also play a major role in the purification of the water and the health of the lake's ecosystem. Accordingly, in order to restore the aquatic flora that was reduced by the construction of embankments and the land reclamation works at the lake, (Fig.19-12) efforts are being made to construct natural diversity type shore protection works, floating fields of ditch reeds *(Phragmites communis)*, etc.

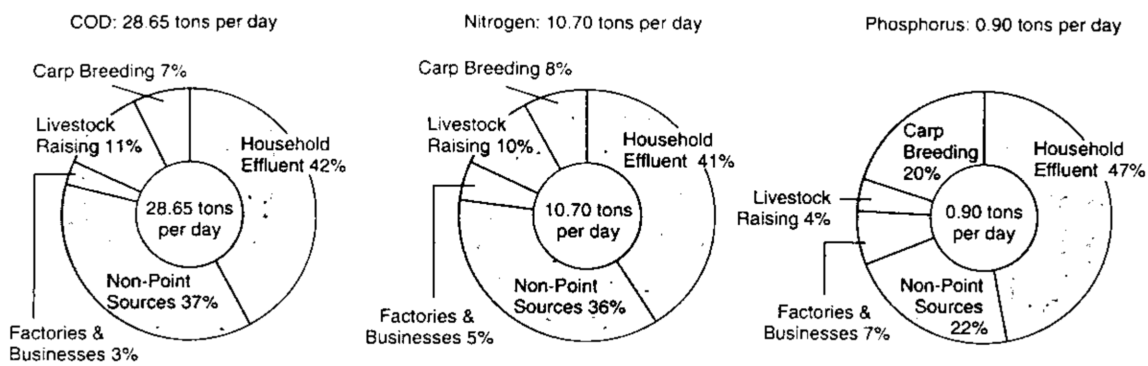


Fig.19-10 COD,Nitrogen, and Phosphorus Influx Load

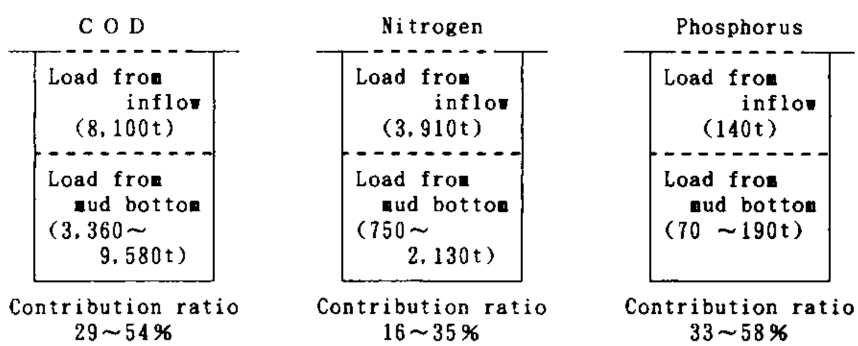


Fig.19-11 Load from Mud Bottom of Lake

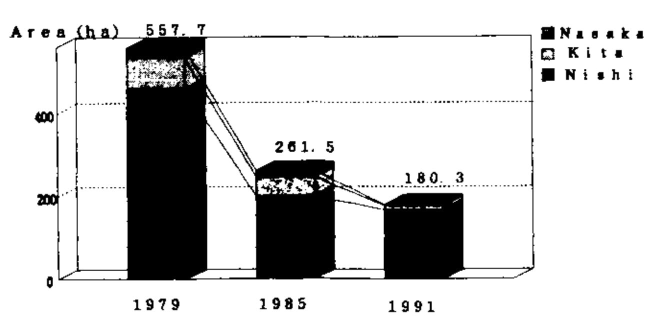


Fig.19-12 Reduction of the Emerging Plant Community

5. Issues for Water Quality Management

As the water quality has been declining since 1991, there are now serious concerns about the future water quality. Nevertheless, the type of rapid pollution seen from 1965 has not occurred, considering the increase in the basin's population, the change in lifestyles, and the development of industrial activities, the fact that the decline in water quality levels has not been more severe may be attributed to the effectiveness of the policies that have been enacted. Of course, the target water quality and water quality levels stated in the water quality preservation plan have not been achieved, and the current water quality levels are not satisfactory. Further efforts to improve the water quality are unquestionably necessary.

It is believed that two of the main reasons for the recent worsening of the water quality are: the varietal shift in the type of phytoplankton growing in the lake from the microcystis, which only appear in the summer season, to the oscillatoria, which bloom throughout the year (Fig.19-13) (Fig.19-14); and the nitrogen and phosphorus loads from the basin have not been decreasing despite the fact that the sewage works, the improvement of combined treatment septic tanks, and the other main works specified in the Plan for the Preservation of Lake and Marsh Water Quality have generally been implemented according to plan.

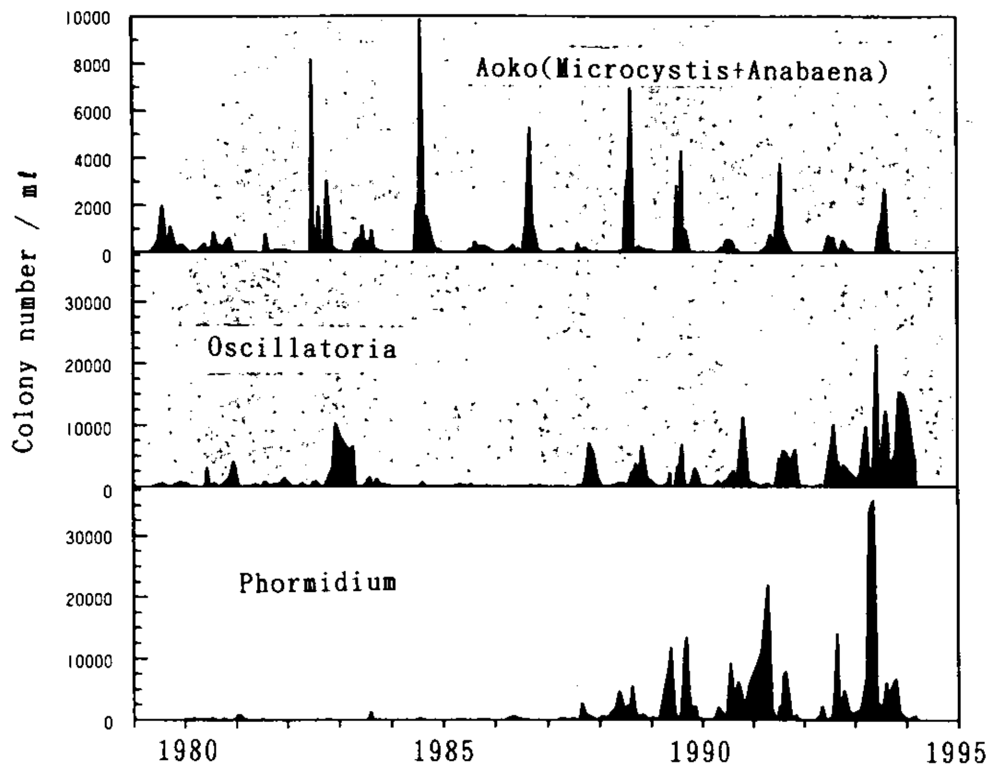


Fig.19-13 Varietal Shift in Type of Phytoplankton

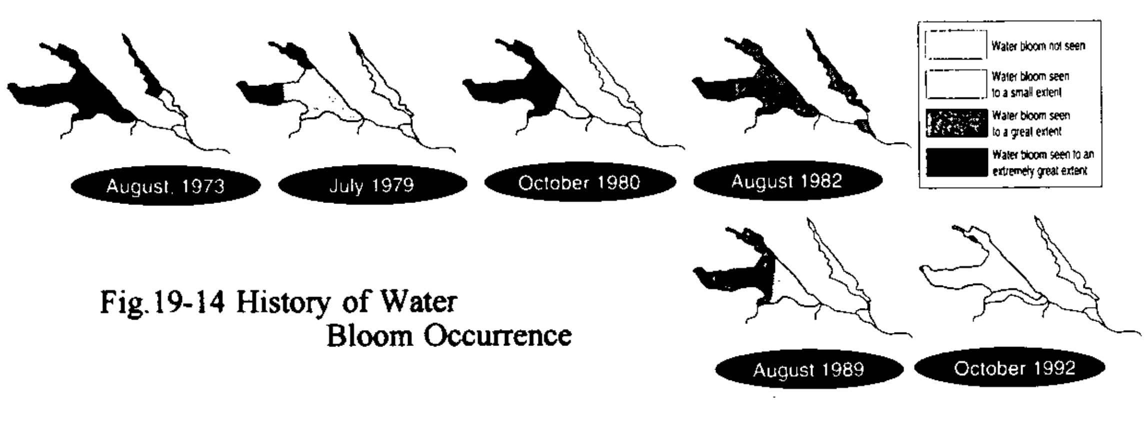


Fig.19-14 History of Water Bloom Occurrence

Therefore, while working to clarify the pollution mechanism including phytoplankton varietal shift and other phenomena, future efforts must include a quantitative and qualitative expansion of the sewage, agricultural community effluent facility, combined treatment septic tank improvement, and dredging works that have been implemented so far.

Moreover, new measures must be introduced and implemented to reduce the load from the household sector, which accounts for the largest share of the pollution factors. These should include promoting the development and spread of high-performance combined treatment septic tanks with a high capacity for the treatment of nitrogen and phosphorus; the transition to a water-conserving, cyclical lifestyle that generates a small environmental load; and the active utilization of gray water and rainwater.

Furthermore, efforts must also be made to address the pollution from non-point sources in urban and agricultural areas, which is the second largest cause of the water pollution following household use. Appropriate measures should include the active utilization of the natural purification functions of fallow rice fields, and other effective measures in line with the local land use.

While striving toward the creation of a good lake environment for fish habitation by actively utilizing the purification properties of aquatic plants, it will also be important to make every effort to improve the lake area environment with hydrophilic functions to contribute to the creation of a healthy ecosystem.

We must also consider new concepts for the management of the lake and the entire Kasumigaura basin including the rationalization of land use, total quantitative regulations taking the environmental capacity into account, and the creation of cyclical regional systems giving consideration to the ecosystem.

As it would be difficult to rapidly devise concrete measures to address many of these issues, it is important to create an institutional environment for the resolution of these problems and toward building a consensus to address these goals.

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