## 3 The present conditions and eutrophication measures in lakes in Japan

There are many designated lakes as well as other lakes in this country, but the closed nature (retention time), water depth, water temperature and catchment area load vary. Therefore, the eutrophication characteristics in lakes also vary as do opinions on the measures for tackling the problem. In this chapter, based on these points mentioned above, the present conditions of eutrophication in lakes in this country are described. For each lake, (1) the characteristics of catchment areas, (2) the water quality in lakes, the characteristics of biota, (3) the problems of the present situation and prospects for measures are described.

### 3-1 Lake Kasumigaura

#### 3-1-1 Characteristics of the catchment area/lake

Lake Kasumigaura is an inland sea-lake belonging to the Tonegawa River system that flows through the Kanto Plain, and the lake is situated on the left bank of the lower reaches of the Tonegawa River, a low-lying area in the southeast part of Ibaraki prefecture. The water area is about 220 km$^2$, so it has the second largest area after Lake Biwa in this country. Moreover, the pondage is about 850 million m$^3$, which is larger than the total pondage of the multipurpose dam that was constructed in the upper reaches of the Tonegawa River. About six thousand years ago, Lake Kasumigaura was part of the inlet connected to the present upper reaches of the Tonegawa River, Lake Inba and Lake Tega. Over the centuries, the mouth of the river became blocked by earth and sand that was carried from the upper reaches, and it is said that the lake more or less assumed its present shape about 1,500-2,000 years ago, becoming a freshwater lake around 1638 during the Edo period. Lake Kasumigaura is a very young lake when compared to Lake Biwa that was said to have formed about four millions years ago, and it is naturally sensitive to surrounding

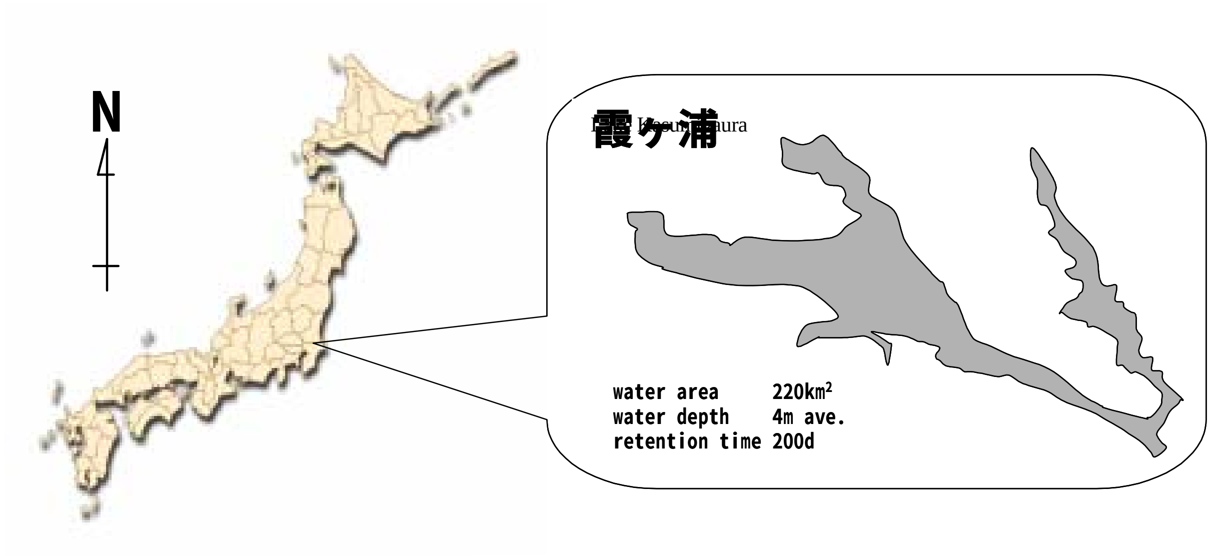


Fig 3-1-1 Overview of Lake Kasumigaura

environmental changes. In recent years, in particular, large-scale development projects and a lot of regional development works have taken place in areas where development is possible such as the flat metropolitan catchment areas. As the plentiful lake water is a valuable water resource, Lake Kasumigaura plays an important role and has various uses as a water source including an irrigation water supply, domestic water supply, industrial water supply and inland water fisheries as well as recreation places, such as yachting and fishing, together with the experience of a remarkable anthropogenesis. However, Lake Kasumigaura has the characteristic tendency to accelerate water pollution due to eutrophication from its natural conditions; for example, Lake Kasumigaura is very shallow, the average water depth is about 4 m (the maximum is 7 m), the retention time (about 200 days) is long and the catchment area is large when compared to the volume of lake water. Therefore, for large-scale development sufficient consideration must be given to the water quality and conservation of the ecosystem together with the adjustment of extensive interests.

**3-1-2 The present conditions of the lake**

Lake Kasumigaura, as shown in Figure 3-1-1, is a natural lake under the control of Ibaraki prefecture. The water area is 220 $km^{2,}$ the pondage is 850 million $m^{3,}$ the maximum water depth is 7 m, the average water depth is 4 m, the basin area is 2,135 $km^2$, the catchment area population is 964,000, the average retention time is 200 days and it fronts a total of 21 cities, towns and villages, such as Tsuchiura City. The population density per pondage of a million $m^3$ is 1,126 and the population density per basin area of 1 $km^2$ is 448. The water is used for the public water supply, irrigation water supply, industrial water supply, fisheries, fishing and boating. The level of the environmental standard under the Plan for the Preservation of Lakes and Marsh Water Quality is COD: 3 mg/*l*., T-N: 0.4 mg/*l*., T-P: 0.03 mg/*l*., but the water quality in 1996 was COD: 10 mg/*l*., T-N: 1.1 mg/*l*., T-P: 0.14 mg/*l*. in Nishiura, COD: 8.7 mg/*l*., T-N: 0.71 mg/*l*., T-P: 0.086 mg/*l*. in Kitaura and COD: 8.8 mg/*l*., T-N: 0.75 mg/*l*., T-P: 0.090 mg/*l*. in the Hitachitone River. This lake was previously used as a lake resort, but was closed in 1973 due to the acceleration of water pollution. It is one of the lakes in Japan in which a lot of research has been conductedfor many years on the water quality and the organisms of Lake Kasumigaura, but even this is by no means sufficient. Recently, research has been specially focused on the transition of water-bloom formative algae. In the past, outbreaks of water-bloom from mainly *Microcystis* and *Anabaena* had occurred every summer, but for the past several years, *Oscillatoria* and *Phormidium* that emerge throughout the year have become dominant. The reason for this transition has not been made clear, but it is indicated that the changes in the quality of the inflow load from the catchment area might affect the transition.

**3-1-3 The present situation of measures**

The Conservation of Lakes and Marsh Water Quality Measures Project includes the enlightenment project for purification in Kasumigaura, the domestic drainage canal purification measures promotion project, the water-bloom disposal measures project, the river environmental improvement project, the Lake Kasumigaura_catchment area paddy fields self-purifying function improvement emergency measures project, the environmental preservation livestock establishment guidance project and the Lake Kasumigaura and Kitaura purification measures project. Furthermore, Tsuchiura Biopark was established at Tsuchiura Port, and this park functions as a place for both water purification and connecting the residents and the waterside. "The 6th International Conference on the Conservation and Management of Lakes - Kasumigaura '95" was held in October 1995 with an attendance of 8,200 participants from 75 foreign countries, under the theme of "Harmonizing Human Life with Lakes - Towards the Sustainable Use of Lakes and Reservoirs." There, residents, researchers, companies and administrators met together for discussion and presentation of the results of their research. This was a landmark international conference as there was an intense exchange of opinions among the participants. Through the discussions at this conference, the present conditions and problems of lakes around the world were made clear, and people related to the preservation of lake environments became aware of the importance of cooperation and the necessity for international cooperation. "The declaration of Kasumigaura," action guideline for the 21st century, was adopted, and it became a great opportunity for heightening interest in the environmental issues of lakes in Japan. In addition, since April 2001, an independent administrative agency, the National Institute for Environmental Studies Bioecoengineering Research Facility, has been established at Kasumigaura lakeside, and its function as a place for the international and scholarly transmission of information is greatly expected.

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### 3-2 Lake Biwa

#### 3-2-1 Characteristics of the catchment area / lake

Lake Biwa with its long history of about five million years is a natural treasury of over 1,000 species of aquatic organisms. The water is used not only for water sources including the public water supply, industrial water supply and the irrigation water supply of about 14 million people in areas such as Keihanshin, but also for resort places including a swimming area and a place for the marine products industry. Furthermore, it was designated as a registered wetlands under the "Ramsar Convention (Convention on Wetlands of International Importance Especially as a Waterfowl Habitat) " in June 1993, and its significance as a habitat for a variety of organisms was recognized once again. Lake Biwa is one of the lakes known as an "ancient lake," in which stream dwellers evolved originally, and its ecological system was fixed by its endemic species throughout its long history. In fact, endemic species of fish, such as crucian carp (*Carassius auratus grandoculis*), *Gnathopogon caerulescens* and the Lake Biwa catfish, which evolved in the unique environment of the lake, exist in Lake Biwa. Thirteen species out of 53 species of fish living in Lake Biwa are endemic species, and a dozen or so species of endemic shellfish, called *Semisulcospira,* can also be found. Climatically and geographically, Lake Biwa is a great natural puddle. Climatically, the southern part of Lake Biwa adopts the Pacific coast climate and has a lot of rain both in the rainy season and the typhoon season. On the other hand, the northern part of Lake Biwa adopts the Japan Sea coast climate and has a lot of snow in winter. Therefore, this area has heavy rainfall throughout the year on average, besides being surrounded by mountains, in which the water is constantly flowing from over 400 rivers and watercourses, and then out into the Seta River only. This specialty leads to its value as a natural puddle of Lake Biwa.

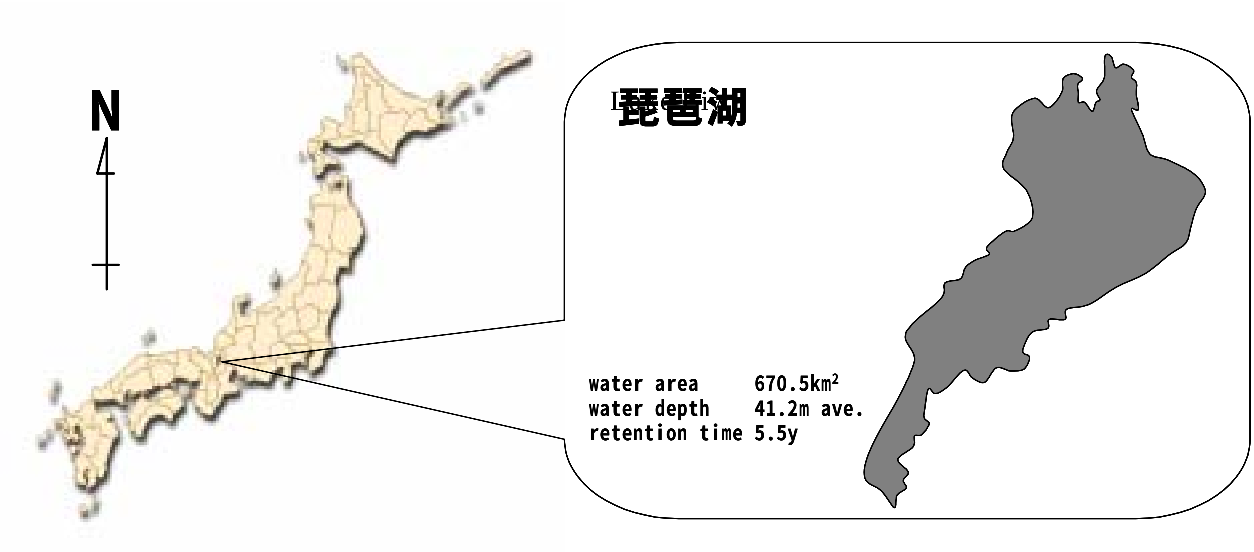


図3-2-1 琵琶湖の概要
Fig.3-2-1 Overview of Lake Biwa

**3-2-2 The present conditions of the lake**

Lake Biwa, as shown in Figure 3-2-1, is a natural lake under the control of Shiga prefecture, and the water area is 670.5 km$^2$, the pondage is 27,500 million m$^3$, the maximum water depth is 130.6 m, the average water depth is 41.2 m, the basin area is 3,174 km$^2$, the catchment area population is 1,219,000, the average retention time is 5.5 years and it fronts 21 cities and towns, such as Otsu City. The population density per pondage of a million m$^3$ is 44 and the population density per basin area of 1 km$^2$ is 381. The water is used as a public water supply, irrigation water supply, industrial water supply, for fisheries, bathing, fishing, sightseeing, boating and natural environment protection. The level of the environmental standard under the Plan for the Preservation of Lakes and Marsh Water Quality is COD: 1 mg/*l*., T-N: 0.2 mg/*l*., T-P: 0.01 mg/*l*., but the water quality in the year of 1996 was COD: 2.5 mg/*l*., T-N: 0.34 mg/*l*., T-P: 0.007 mg/*l*. in the Northern Lake, and COD: 3.0 mg/*l*., T-N: 0.42 mg/*l*., T-P: 0.018 mg/*l*. in the Southern Lake. Freshwater red tide and algal-bloom start to bloom every summer, and create difficulties for water use and deterioration of the landscape. Since the 1960s, water pollution has been accelerated mainly in the Southern Lake with the increase of industrial effluent and household wastewater flowing into Lake Biwa. The pollution finally spread over the whole of Lake Biwa, with eutrophication being remarkable in the 1970s. There was a particular outbreak of freshwater red tide caused by *Uroglena americana* in Lake Biwa in 1977 for the first time, and an outbreak of algal-bloom on the west coast of the Southern Lake in 1983. Since then, there have been outbreaks of, freshwater red tide almost every year except in 1986, 1997 and 1998, and algal-bloom outbreaks except in 1984. Mass multiplication of picoplankton that is classified as the blue-green algae *Synechococcus* was also observed over the whole of Lake Biwa in 1989. Looking at the transition of COD, which is a typical parameter of organic pollution in lakes, it temporarily showed a tendency to decrease in the early 1980s in Lake Biwa, but since then it has shown a tendency to increase gradually. The COD of the Northern Lake is 2-3 times higher than the level of the environmental standard and the COD of the Southern Lake is 3-4 times higher than the level of the environmental standard, so both levels drastically exceed the level of the environmental standard every year.

**3-2-3 The present situation of measures**

Lake Biwa has a large inflow pollution load amount derived from area sources among the designated lakes. In Lake Biwa, the inflow pollution load amount has decreased by the implementation of measures under the Lake Law, but the water quality has not yet been improved. The reasons for this include the following: (1) the retention time is long (about 5 years), and the change of the inflow load amount does not immediately reflect changes of the water quality, (2) the load amount estimated by the area sources including agricultural land might very likely be underestimated, (3) the increase of nitrogen and the phosphorus effluent load amount due to the changes from a pit latrine to a septic tank, (4) based on the calculation of the load amount, it is assumed that the residential pollutant load per unit production has not changed, but there is in fact the possibility of an increase, (5) the load amount from the bottom sludge is not decreased immediately, so a time lag is observed. However, if measures had not been taken, the inflow load amount would clearly have been increased. In 1995 when the measures were taken, the load amount of COD: 20%, T-N: 20% and T-P: 31% was reduced.

The Conservation of Lakes and Marsh Water Quality Measures includes the water quality conservation facilities improvement project, the joint treatment plant installation project, the small-scale wastewater facilities in agricultural villages improvement project, the waterweed harvesting project, the Southern Lake Water quality Improvement measures project, the enforcement of ordinance to reed community preservation, the enforcement of ordinance to household wastewater measures promotion and the Northern Lake organic pollution measures. To preserve reeds at the lakeshore, especially in Shiga, the “Ordinance to Preserve the Reed Community in Lake Biwa in Shiga Prefecture” was adopted in 1992, and projects that protect the community at the lakeshore under the specification of reed community preservation areas and raise reed communities are being conducted. Taking into consideration that the wetlands are designated under the Ramsar Convention, the water purification ability of botanical reeds is not sufficient to merit evaluation, but the role of the reed field as a cradle of organisms is very important. Furthermore, the 1st World Lakes Conference was held here in 1982, and the 9th World Lakes Conference under the slogan of “Building Partnerships between Citizens and Local Governments for Sustainable Lake Management” was held at Lake Biwa in November 2001.

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## 3-3 Lake Suwa

### 3-3-1 Characteristics of the catchment area / lake

Lake Suwa is located in the middle of Nagano Prefecture, and its water area is the largest in the prefecture. Moreover, the lake is typical of the eutrophic lakes in Japan.　Lake Suwa is situated at an altitude of 759 m above sea level, and located away from large cities, but it is known that eutrophication is accelerated earlier in inland highland lakes.　This is a very shallow lake and the present water area is 13.3 km$^2$, the maximum water depth is up to 6.5 m, the average water depth is about 4 m, but the thickness of the lake bottom cumulus deposit is over 200 m and it consists of earth and sand carried from the surroundings through rivers, the carcasses of organisms and diatom organic ooze produced in the lake.　There is a lot of earth and sand flowing into the cumulus deposit from outside of the lake, because major mountains surrounding the lake are volcanoes including Yatsugatake.　It is supposed from the muddiness of influent rivers during rainfall that earth and sand presently flow out of agricultural land at the foot of mountains on a plateau, and a lot of earth and sand flow into Lake Suwa.　The lakeshore line is less irregular due to artificial repairs, and its extension length is about 16 km.　The total influent rivers into the lake are considered to

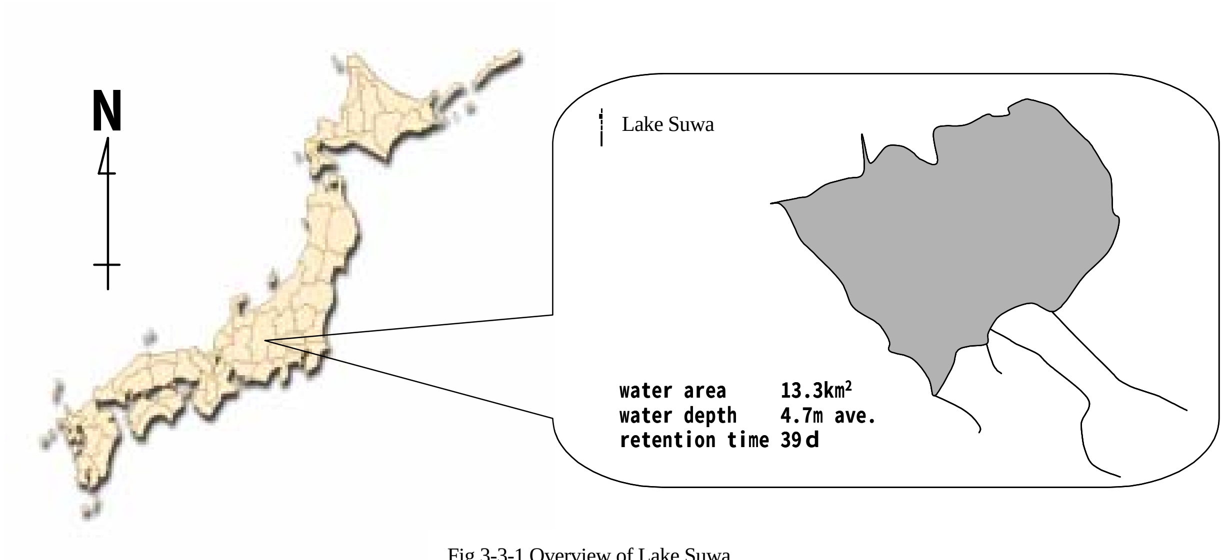


Fig 3-3-1 Overview of Lake Suwa
図 3-3-1　諏訪湖の概要

number 31, but many of them are irrigation canals and small canals, and the main influent rivers are the Yokokawa River, the Togawa River, the Kakumagawa River, the Kamikawa River, the Miyagawa River and the Shinkawa River. The only effluent river to flow out of the west part of the lake is the Tenryu River, which flows into the Pacific Ocean in Shizuoka through Inatani.

### 3-3-2 The present conditions of the lake

Lake Suwa, as shown in Figure 3-3-1, is a natural lake under the control of Nagano prefecture, and the water area is 13.3 km$^2$, the pondage is 62.9 million m$^3$, the maximum water depth is 7.2 m, the average water depth is 4.7 m, the basin area is 531.8 $km^2$, the catchment area population is 182,000, the average retention time is 39 days and it is located in Suwa City. The population density per pondage of a million $m^3$ is 2,905 and the population density per basin area of 1 $km^2$ is 344. The water is used for the irrigation water supply, fisheries, fishing and boating. The level of the environmental standard under the Plan for the Preservation of Lakes and Marsh Water Quality is COD: 3 mg/*l*., T-N: 0.6mg/*l*., T-P: 0.05 mg/*l*., but the water quality in 1996 was COD: 11 mg/*l*., T-N: 1.0 mg/*l*., T-P: 0.094 mg/*l*. Algal-bloom outbreaks occur every summer and cause deterioration of the landscape and difficulties in water use. Scientifically, for three years from 1985 to 1987, a large-scale isolated water mass (mesocosm) experiment was conducted to determine whether any chain reactions occur in organisms and the environment when artificial changes are inflicted on the ecosystem in each water mass. Then, an analysis and examination were purposely conducted to investigate the mechanism of maintenance and changes in ecosystem stability.

### 3-3-3 The present situation of measures

The Preservation of Lakes and Marsh Water Quality Measures Project includes river-basin sewerage works, joint treatment plant maintenance (outside the area of the sewage system plan), bottom sludge dredging (for example, off Hama in Okaya City, off Shimosuwa Town and off Takashima in Suwa City) and the removal of suspended solids and waterweed (in cooperation with related cities, towns and villages, and various lobbies). Several mistakes can be observed in the original Lake Suwa purification plan. One of them is the dredging plan, adopted as one of the main plans. One reason for the plan is secondary pollution caused by aquatic plants; as a result of the pollution, the removal of aquatic plants along the shore was done effectively. However, it is clear that this action caused significant changes in the environment of Lake Suwa not only its water quality but also its biota. Fortunately, nationally and worldwide, the importance of coastal areas and the restoration of lakes as an ecosystem has become recognized, and the restoration plan for coastal areas can be progressed in Lake Suwa. Preservation of lakes is important not only for the water quality of the environment of organisms that inhabit lakes, but also for preservation of the shape of Lake Suwa itself, and its preservation as an ecosystem is possible only after the two are combined. The restoration still has to be progressed with trial and error, but it is expected that the experiments in Lake Suwa will be applied as one of the case studies.

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## 3-4 Lake Mikatagoko

### 3-4-1 Characteristics of the catchment area/lake

Lake Mikatagoko, in the southern part of Fukui Prefecture, is a lake community consisting of five lakes, Hyuga, Kugushi, Suigetsu, Suga and Mikata, and each lake has a close relationship hydraulically, because each lake is connected mutually by the Hyuga channel, the Hayase River, the Urami River, Saga Zuido, Seto and the Horikiri River, and eventually, to the ocean. Lake Mikatagoko originated from a pooling lake on a fault basin submerged by diastrophism about one million years ago, and it is said that Hyuga, Suigetsu, Suga and Mikata used to be freshwater lakes, respectively. On the other hand, it is said that Kugushi is a lake formed by closure with a bar. After that, to

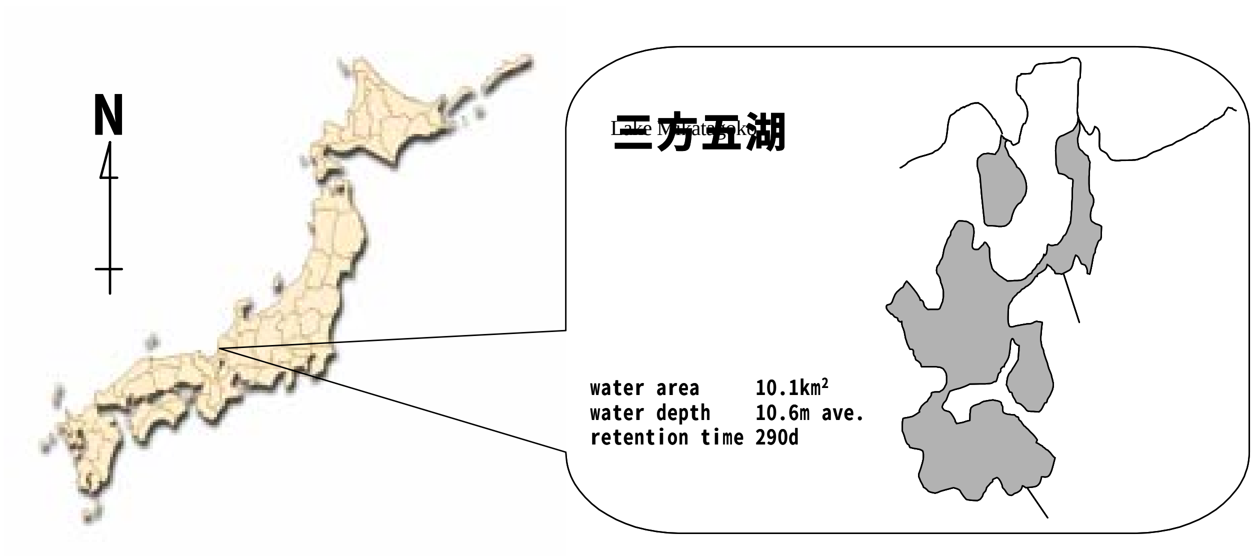


Fig 3-4-1 Overview of Lake Mikatagoko
図 3-4-1 三方五湖の概要

prevent overflowing by flood, the Hyuga channel and the Urami River were excavated in 1630 and in 1655 respectively, and Saga Zuido was dug and widened from 1933 to 1936, after which a large amount of seawater flowed into Lake Suigetsu. However, Saga Zuido was closed in 1978. At present, Hyuga is a saltwater lake that opens onto Wakasa Bay. Kugushi, Suigetsu and Suga are brackish-water lakes, and moreover Suigetsu is a partly circular lake with a halocline around a water depth of 10 m, and Suga is a sub-lake basin of Suigetsu. Mikata is a freshwater lake that has the role of the sedimentation of the earth, sand and pollutants from inflowing rivers. The main river that flows into Lake Mikatagoko is the Nanamegawa River that flows into Lake Mikata, but there are some others, such as agricultural effluent canals and the Ubanishi River that flows into the Bessho River, the Kannon River and the Kugushi River.

### 3-4-2 The present situation of the lake

Lake Mikatagoko, as shown in Figure 3-4-1, is under the control of Fukui prefecture, and the outline of the lake community that forms Lake Mikatagoko is as follows: For Lake Hyuga, the water area is 0.9 km$^2$, the average water depth is 14.3 m, the lake capacity is 12.87 million m$^3$ and the basin area is 2.2 km$^2$; for Lake Kugushi, the water area is 1.4 km$^2$, the average water depth is 1.8 m, the lake capacity is 2.52 million m$^3$ and the basin area is 15.8 km$^2$; for Lake Suigetsu, the water area is 4.3 km$^2$, the average water depth is 14.3 m, the lake capacity is 74.36 million m$^3$ and the basin area is 4.3 km$^2$; and for Lake Mikata, the water area is 3.6 km$^2$, the average water depth is 1.3 m, the lake capacity is 4.68 million m$^3$ and the basin area is 60.3 km$^2$. In Lake Mikatagoko taken as a whole, the water area is 10.1 km$^2$, the maximum water depth is 33.7 m, the average water depth is 10.6 m, the lake capacity is 107 million m$^3$, the basin area is 84.2 km$^2$, the catchment area population is 11,300 and the average retention time is 290 days. The lake lies between the two towns of Mikata and Mihama, and the water quality in 1996 was COD: 5.0 mg/*l*., T-N: 0.64 mg/*l*. and T-P: 0.056 mg/*l*. Algal-bloom outbreaks occur from June to September every year and cause deterioration of the landscape and difficulties in water use.　Component species of algal-bloom outbreaks in Lake Mikatagoko are known to belong to the following four species: genus *Microcystis*, genus *Anabaena*, genus *Oscillatoria* and genus *Aphanizomenon*.

### 3-4-3 The present situation of measures

The environmental standard of Lake Mikatagoko except for Hyuga was designated as type B in February 1977, because the water pollution due to eutrophication was accelerated (Lake Hyuga was designated as type A). Moreover, for the four lakes, the environmental standard related to nitrogen and phosphorus was designated as type IV in October 1987.　At the designation, for Lake Mikata the temporary targeted value with the type designation was set at 0.61 mg/*l*., because it was not expected to achieve the type IV water quality of nitrogen quickly, so "An attempt will be made to achieve the temporary target step by step and the environmental standard as early as possible."　The temporary target will be reconsidered every 5 years, so the water quality of the present state was set as the standard in 1992; taking into consideration that enforcement of the measures for conservation of the water quality was planned, the water quality estimation for the future (in 1997) was made, then reconsideration of the temporary target was examined.　However, the proportion of the pollutant loads except for residential and industrial loads is high, and measures for the sewerage system are underway, so it was estimated that achieving the temporary target in 1997 would be difficult.　Therefore, it was decided that the conventional temporary targeted value would remain unchanged, and the total measures for the achievement are continuing to progress.　Measures for Water Quality to achieve the temporary target of the "Preservation of Lakes and Marsh Water Quality Comprehensive Measures Promotion Conference," organized in the $17^{th}$ section of the prefectural office, were established, and various measures are being conducted as the keys to "source control," "measures for inflowing canals," "measures for inlakes" and "measures for lakesides."　The Preservation of Lakes and Marsh Water Quality Measure Project includes a public sewerage improvement project (Mihama public sewerage: disposal population 7,560, the scheduled year of completion is 2020; Mikata special environment public sewerage: disposal population 4,550, the scheduled year of completion is 2016), an agricultural comprehensive improvement project, a rural community sewerage project (disposal population 1,020, the scheduled year of completion is 1999), an agricultural-recycled lake measures establishment promotion project (enlightenment on the prevention of fertilizing-outflow, the spread of fertilizing-planting machinery, the installment of a floating reef for aquatic plants) and a rivers purification project (dredging of Mikata).

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## 3-5 Lake Kojima

### 3-5-1 Characteristics of the catchment area/lake

Lake Kojima, located about 8 km south from the center of the Okayama city area, is an artificial lake that became a freshwater lake when the river mouth of Kojima bay was closed by the Ministry of Agriculture, Forestry and Fisheries. This measure was taken to prevent drought damage and salt water damage to agricultural products raised on reclaimed land that had prospered from the Edo era until 1963, and to reinforce the draining of reclaimed land and secure the safety of the reclaimed embankment. The construction work on the closed embankment began in

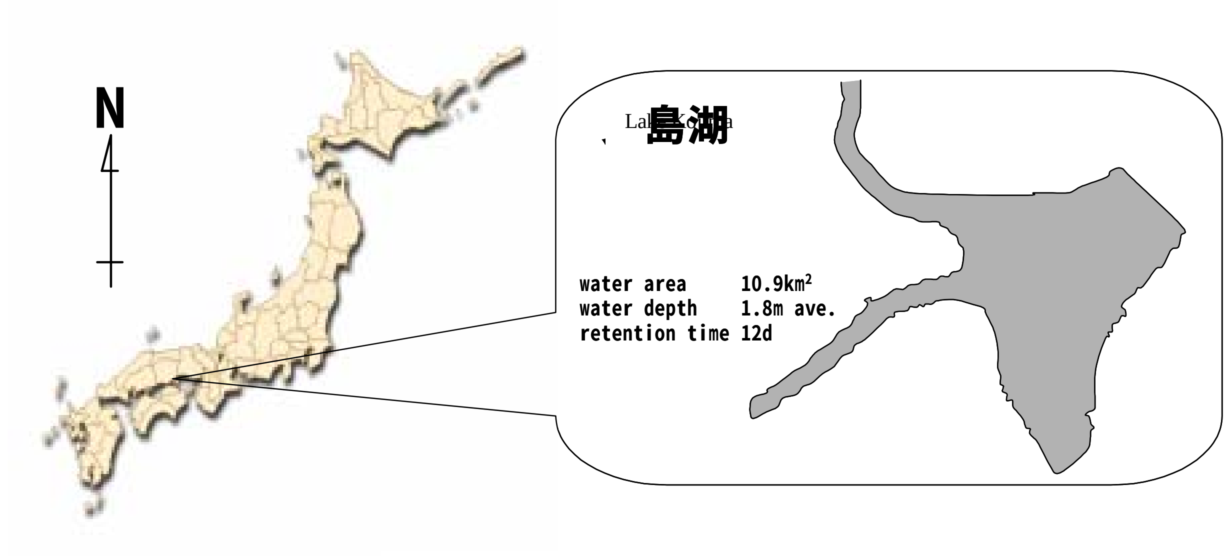


Fig.3-5-1 Overview of Lake Kojima
図 3-5-1 児島湖の概要

February 1951, the construction of the tide block was conducted in 1956, the embankment was constructed in 1959 and then the entire work of the embankment extending for 1,558 m was completed in March 1962. The water level is controlled by opening and closing the center sluice consisting of 6 gates and a distance of 24 m. When the standard water level of 80 cm in an irrigation period and 50 cm in a non-irrigation period is exceeded, control is exerted by discharging into Kojima bay at low tide. The Sasagase River and the Kurashiki River flow into Lake Kojima through both the city areas of Okayama and Kurashiki and its surrounding fields. Especially, the Kurashiki River flows into Lake Kojima through the fields of estuarial areas. As for the characteristics of Lake Kojima, it is entirely shallow except near the sluice and part of Kohoku, and the lake belongs to a shallow water lake. It has a small water area, many people, about one third of the prefectural population, live in the catchment area, the pollutant load ratio charges of 33,700 persons/million $m^3$ lake water and 3,070 ha/million $m^3$ lake water are the third highest next to Lake Tega and Lake Inba, and the lake becomes polluted easily. Moreover, the annual average retention time is as short as about 12 days.

### 3-5-2 The present conditions of the lake

Lake Kojima, as shown in Figure 3-5-1, is an artificial lake under the control of Okayama prefecture, and the water area is 10.9 $km^2$, the pondage is 26.1 million $m^3$, the maximum water depth is 9.0 m, the average water depth is 1.8 m, the basin area is 543.6 $km^2$, the catchment area population is 624,000, the average retention time is 12 days and it fronts eight cities, towns and villages, such as Okayama city, Kurashiki city, Tamano city, Sojya city, Nadasaki town, Hayashima town, Yamate village and Kaya town. The population density per pondage of a million $m^3$ is 23,895 and the population density per catchment area of 1 $km^2$ is 1,146. The water is used for an irrigation water supply and fisheries. The level of the environmental standard under the Plan for the Preservation of Lakes and Marsh Water Quality is COD: 5 mg/*l*., T-N: 1 mg/*l*., T-P: 0. 1 mg/*l*., but the water quality in 1996 was COD: 10 mg/*l*., T-N: 1.8 mg/*l*., T-P: 0.21 mg/*l*. Looking at the COD effluent amount to the catchment area by different sources, household wastewater with the urbanization accounts for 51.6%, then mountain forest, fields and live-stock account for 31.4%, plant effluent and business establishment effluent account for 17.0%, and T-N and T-P are shown as having almost the same effluent ratio as the COD by different sources. Being influenced by the source, the water quality has changed by about double the level of the environmental standard of 5 mg/*l*. of COD, the conformable rate of the environmental standard is 0% and the conditions of water pollution are extremely bad, so much so that it became the fifth worst lake in Japan in 1997. By adopting the environmental standard type V, T-N 1 mg/*l*. and T-P 0.1 mg/*l*., both T-N and T-P are changed by about double the level of the environmental standard such as COD. Lake Kojima became a closed water area in which water exchange is poor because of the closure of Kojima bay, and the concentration of nutrient salts, such as nitrogen and phosphorus is high. Thus, typical eutrophication is caused by a marked increase in the production of aquatic organisms, such as plankton, aquatic plants, benthos, fish/crustaceans due to the abundant growth of algal-bloom, freshwater red tide, Water Hyacinth and water lettuce. Freshwater red tide caused by *Euglena sanguinea* started to bloom in irrigation canals in the catchment area from 1994, indicating in particular that organic pollution was extremely accelerated, and the acceleration of eutrophication is suggested to have occurred throughout the entire catchment area with the algal-bloom caused by *Microcystis aeruginosa* and *Anabaena spiroides* in Lake Kojima.

### 3-5-3 The present situation of measures

For the water purification measures, the lake was designated as a designated lake based on the “Special Measures Act for the Preservation of Lakes and Marsh Water Quality” in December 1985, after which the “Plan for the Preservation of Lakes and Marsh Water Quality for Lake Kojima” was established in January 1987. Various measures of Water Quality Conservation were then promoted all together within the prefecture, related cities, towns and villages, and the residents in the catchment area. Recently, the “Ordinance for Lake Kojima environmental protection” was established in March 1991 to promote general measures for environmental preservation, which were not only for Water Quality Conservation, but also for nature conservation, landscape measures and environmental considerations. Then, the ordinance was enforced in September 1991. Furthermore, the second plan for the conservation of the water quality was formulated in March 1992, and it was decided to reconsider the plan every five years after that. Currently, the third plan for the conservation of water quality is underway. However, the water quality is around 10 mg/*l*. of COD, and it remains stable. It has been evaluated that the deterioration of the water quality could be prevented based on the plan for the conservation of the water quality, but that the targeted value of 8.8 mg/*l*. under the plan for the conservation of the water quality could not be achieved. The Conservation of Lake Water Quality

Measures Project includes improvement of the sewage system/rural community sewerage, an installation assistance project of a joint treatment plant, a household wastewater treatment facilities installation project, a waste disposal facilities improvement project, an animal waste disposal facilities improvement project, an artificial formation of tideland/reed field, the development of vegetation revetment, the installation of water purification facilities, a governmental comprehensive farmlands disaster prevention project, the Lake Kojima catchment area environmental preservation measures promotion conference, the Lake Kojima catchment area water quality conservation Foundation and the Lake Kojima catchment area environmental preservation monthly publication event.

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## 3-6 Lake Nojiri

### 3-6-1 Characteristics of the catchment area/lake

Lake Nojiri is located in the Joshinetsu highland national park, and has been used as a summer resort for a long time. The lake is said to have originated from the eruption or volcanic activity of Mt. Kurohime.

### 3-6-2 The present conditions of the lake

Lake Nojiri, as shown in Figure 3-6-1, is a natural lake under the control of Nagano prefecture, and the water area is 4.56 km$^2$, the pondage is 9.6 million m$^3$, the maximum water depth is 38.5 m, the average water depth is 21.0 m, the basin area is 185.3 km$^2$, the catchment area population is 2,500, the average retention time is 738 days and it is located in Shinano town in Kamiminochigun. The population density per pondage of a million m$^3$ is 26 and the population density per catchment area of 1 km$^2$ is 13. The water is used for the public water supply, irrigation water supply, power generation water supply, fisheries and sightseeing. The water quality is said to be better than average,

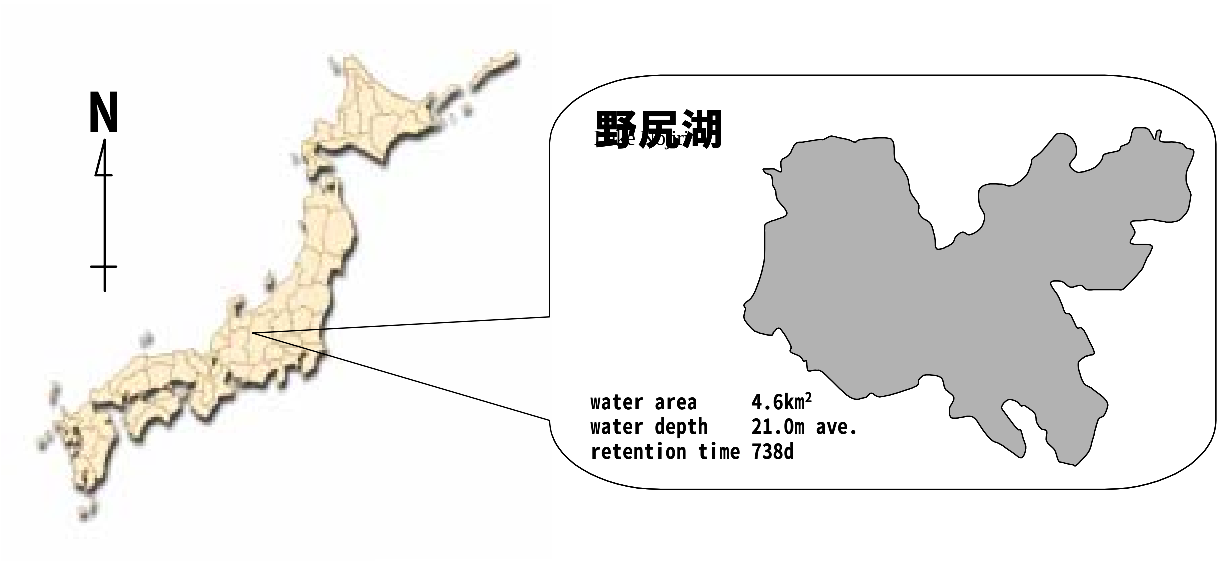


図 3-6-1 野尻湖の概要

Fig 3-6-1 Overview of Lake Nojiri

but freshwater red tide bloomed in 1988, and the development of eutrophication has been a concern ever since then. Therefore, the lake was designated by the Special Measures Act for the Preservation of Lakes and Marsh Water Quality in 1994, and comprehensive purification measures are being enforced. The level of the environmental standard under the Plan for the Preservation of Lakes and Marsh Water Quality is COD: 1 mg/*l*., T-P: 0.005 mg/*l*., but the water quality in 1996 was COD: 2.1 mg/*l*., T-P: 0.005 mg/*l*.

**3-6-3 The present situation of measures**

Conservation of the Lake Water Quality Measures Project includes public sewerage maintenance (partly started in 1995), rural community wastewater treatment facilities improvement (Kokai area, partly started in 1994), water purification by reed field (conducted at inflowing rivers), a joint treatment plant/clarification tank installation project (Shinano town, outside the sewerage system area, installation assistance) and the dissemination of environmentally-conserved agriculture (the dissemination of paddy field stripe fertilizing-planting machinery, appropriate control of the paddy field surface water).

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**3-7 Lake Tega**

**3-7-1 Characteristics of the catchment area/lake**

Lake Tega is located in the northwestern part of Chiba prefecture and belongs to the Tone River system. It is an important water source for the irrigation water supply and an inland water fisheries facility, but the water quality of COD, the parameter of organic pollution, has been at the worst level of all lakes in Japan since 1974 due to the progression of pollution. The current Lake Tega is a small shallow lake, and the water area is 650 ha, the water capacity is 5.6 million $m^3$ and the average water depth is 0.86 m, but many citizens visit its water side for relaxation on weekends, and more than 8.4 hundred thousand people have visited the Lake Tega public water square, “Mizunoyakata” established in 1991, over the past eight years. Furthermore, currently 22 parties belong to the “Joint association of the beautiful Lake Tega appreciation society,” established by resident organizations in the Lake Tega catchment area in 1995. Lake Tega is polluted, but is one of the small number of tasteful lakes remaining in the suburbs of the Tokyo metropolitan area. Restoring Lake Tega to its former glory will lead to the reclamation of hometowns that have been lost over the past few years. Lake Tega plays an important role as a symbol of the community in this area.

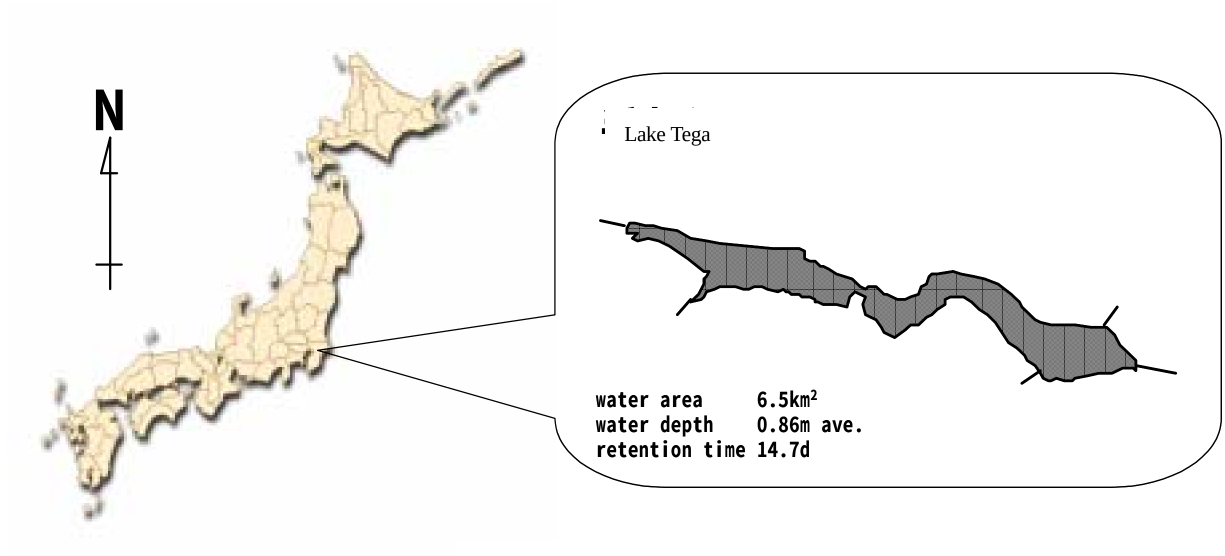


Fig.3-7-1 Overview of Lake Tega
図3-7-1 手賀沼の概要

**3-7-2 The present conditions of the lake**

Lake Tega, as shown in Figure 3-7-1, is a natural lake under the control of Chiba prefecture, and the water area is 6.5 $km^2$, the pondage is 5.6 million $m^3$, the maximum water depth is 3.8 m, the average water depth is 0.86 m, the basin area is 150.2 $km^2$, the catchment area population is 465,000, the average retention time is 13.9 days and it fronts 2 cities and 3 towns, such as Kashiwa city, Abiko city, Shonan town, Shiroi town and Inzai town. The population density per pondage of a million $m^3$ is 83,036 and the population density per catchment area of 1 $km^2$ is 3,096. The water is used for an irrigation water supply, fisheries, fishing and boating. The water area was once 12 $km^2$, but it was reduced to 6.5 $km^2$ as a result of the reclamation project conducted from 1954 to 1968. The level of the environmental standard under the Plan for the Preservation of Lakes and Marsh Water Quality is COD: 5 mg/*l*., T-N: 1 mg/*l*., T-P: 0.1 mg/*l*., but the water quality in 1996 was COD: 24 mg/*l*., T-N: 4.5 mg/*l*., T-P:0. 49 mg/*l*. Algal-bloom caused mainly by *Microcystis aeruginosa* and *Anabaena affinis* starts to bloom from June to October every year, and it has a harmful influence on the recreational function through deterioration of the landscape.

### 3-7-3 The present situation of measures

Lake Tega is a lake that has a high residential load ratio among the designated lakes. In spite of the decrease of the inflow load amount through measures taken in Lake Tega as well as in Lake Biwa, the effect is not reflected in the water quality. The reasons may include the following: (1) The retention time is short and the lake is influenced by the water quality of inflowing rivers. However, a change in the water quality of inflowing rivers has not been observed, so the decrease in the load amount is caused by the decrease in the water amount of inflowing rivers; (2) The nutrient load from the bottom sludge is heavy. In Lake Tega, the water quality of the influent has to be considered, and the introduction of purifying water is necessary as a purification measure. Moreover, there are actually no effective measures for the nutrient load from the bottom sludge, so the development of technologies is expected.

A lot of purification measures, such as residential wastewater measures, industrial wastewater measures, direct purification measures for river / lake and area sources measures have been enforced in Lake Tega. It can be said that sewerage system development has been the most effective among these measures, but the water purification effect has not actually been immediately apparent because as the sewerage system user population increases, the population in the catchment area also increases at the same time. In Chiba prefecture, in an attempt to drastically improve the water quality in Lake Tega, new measures that have been added to the purification measures in the Plan for the Preservation of Lakes and Marsh Water Quality have been examined. On examination, it is difficult to recover the water quality in Lake Tega to the environmental standard (COD: 5 mg/ *l*) for the moment, so COD: 10 mg/ *l* that was the water quality before the drastic deterioration around 1970 was established as a provisional target. The Lake Tega river basin sewerage plan was set on eight cities and towns in the catchment area in 1972, and treatment was started in part of the areas in 1981. Treated wastewater is discharged directly into the Tone River, so the effluent load amount of the sewerage system user population to Lake Tega becomes zero, and the purification effect is high. Furthermore, the Kitachiba water conveyance project is a project that supplies a city water supply from the Tone River to the Edo River and conducts a purification water supply into Lake Tega up to 10 $m^3$/s. Its construction was started in 1974 and it finally reached the final stage of real water conduction in 2000. Examination of the water conduction began in March 1999. The test result shows that if a water conveyance of 5-10 $m^3$/s is conducted for 5-10 days continuously, it will be expected to achieve COD: 10 mg/*l*. Thus, this project has quite good prospects, although the water conveyance of the purification water supply is conditional and it includes uncertain factors because continuous water conveyance is impossible. Moreover, measures have been taken to establish purification facilities for the river water as the principal objective to remove the phosphorus that causes the bloom of phytoplankton. The result obtained is that a one third reduction of the current phosphorus inflow load amount is required to achieve the estimated COD: 10 mg/*l*. Taking the progress of the sewerage system in the future and the beginning of Kitachiba water conveyance into consideration, the decision was made to construct facilities with a total of 35,000 $m^3$/day in four areas of sewerage system underdevelopment in the upstream catchment area of the Obori River and the Otsu River, and the construction of the first facilities began in 1999.

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## 3-8 Lake Naka-umi/Lake Shinji

### 3-8-1 Characteristics of the catchment area / lake

Lake Naka-umi and Lake Shinji, situated at the foot of the mountains in the Shimane peninsula and the mountains region of Chugoku, are located in part of the river mouth of the Hii River, the source of which is the mountains region of Chugoku, and which is a brackish-water lake passing through the Sakai channel into the Sea of Japan (Miho bay). Independently, the water area of each lake constitutes the fifth and the seventh largest area, respectively in Japan, but the joined area connected by 7 km of the Ohashi River exceeds the largest brackish-water lake, Lake Saroma (the water area is 151.9 km$^2$) in the country.  Similar to ancient mythology stated in "The description of the natural

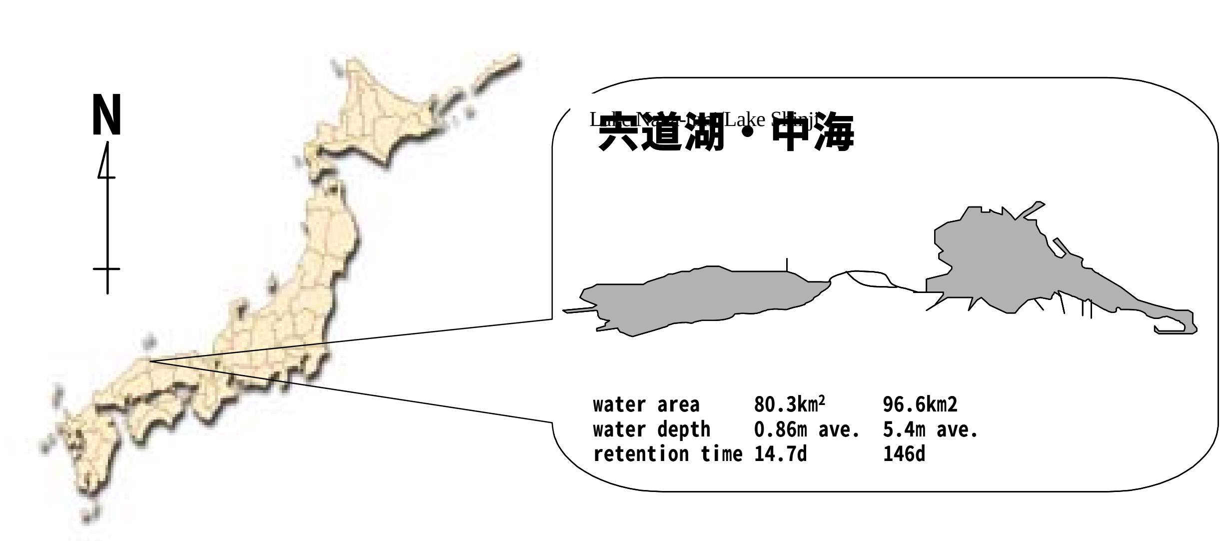


Fig 3-8-1 Overview of Lake Naka-umi/Lake Shinji

図3-8-1 中海・宍道湖の概要

features of Izumo," a project called "Kunihiki of Showa" was started.  This was the "Governmental Lake Naka-umi Land Reform Project," which was related to the desalination and reclamation of Lake Shinji and Lake Naka-umi that began in 1963.  Arguments about the project still continue over the reclamation of the Honjo building construction area, which is the last area that has been planned for reclamation for over forty years.  In addition, it has become well known as an aquaculture base for corbicula, which are shipped to the whole country.

**3-8-2 The present situation of lake**

Lake Naka-umi, as shown in Figure 3-8-1, is a natural lake under the control of Tottori and Shimane prefectures, and the water area is 86.2 $km^2$, the pondage is 521 million $m^3$, the maximum water depth is 8.4 m, the average water depth is 5.4 m, the basin area is 590.1 $km^2$, the catchment area population is 161,200, the average retention time is 146 days and it fronts 4 cities and 3 towns, such as Yonago city, Sakaiminato city, Matsue city, Yasugi city, Mihonoseki town, Higashi-Izumo town and Yatsuka town.  The population density per pondage of a million $m^3$ is 300 and the population density per catchment area of 1 $km^2$ is 265.  The water is used for fisheries, an industrial water supply, sightseeing and fishing.  With the development of socio-economical activities, the water quality environmental standard has not been secured since 1973, and the level of the environmental standard under the Plan for the Preservation of Lakes and Marsh Water Quality is COD: 3 mg/*l*., T-N: 0.4 mg/*l*., T-P: 0.03 mg/*l*., but the water quality in 1996 was COD: 7.5 mg/*l*., T-N: 1.0 mg/*l*., T-P: 0.1 mg/*l*. On the other hand, Lake Shinji is a natural lake under the control of Shimane prefecture, and the water area is 80.3 $km^2$, the pondage is 366 million $m^3$, the maximum water depth is 6.4 m, the average water depth is 4.5 m, the basin area is 1289.1 $km^2$, the catchment area population is 271,800, the average retention time is 110 days and it fronts 2 cities and 3 towns, such as Matsue city, Hirata city, Tamayu town, Shinji town and Hiigawa town.  The population density per pondage of a million $m^3$ is 743 and the population density per catchment area of 1 $km^2$ is 211.  The water is used for fisheries, an industrial water supply, sightseeing and fishing.  With the development of socio-economical activities, the water quality environmental standard has not been secured since 1973, and the level of the environmental standard under the Plan for the Preservation of Lakes and Marsh Water Quality is COD: 3 mg/*l*., T-N: 0.4 mg/*l*., T-P: 0.03 mg/*l*., but the water quality in 1996 was COD: 4.7 mg/*l*., T-N: 0.56 mg/*l*., T-P: 0.053 mg/*l*.

**3-8-3 The present situation of measures**

Lake Naka-umi was designated by the Special Measures Act for the Preservation of Lakes and Marsh Water Quality in 1988, and based on the measures, the Plan for the Preservation of Lakes and Marsh Water Quality was settled in1989. This was followed by the second plan, which was settled in 1994, after which measures for the Conservation of the Water Quality were planned for its comprehensive and systematic promotion.  The outline of the main measures for the Plan for the Preservation of Lakes and Marsh Water Quality includes sewerage system development (the increase of the dissemination rate: from 27% to 35%, used together with 4 cities and 2 towns, and conduit construction in 1 town and 1 village), small-scale wastewater facilities in agricultural villages (used together with 10 areas, the construction of a conduit and water treatment plant in 6 areas), purification measures for inflowing rivers (an environmental lake shore development project, river bed dredging, the former Kamo River purification water supply introduction project), direct purification of lakes (bottom sludge dredging, cover sand, artificial formation of seaweed beds), the spread of small-sized joint treatment plants (734 plants for 3 cities, 2 towns and 1 village), Measures for Miscellaneous Household Effluent (assistance to the community residents' enlightenment project, attaining 100% installation rate of fine strainer), agricultural area measures (the spread of fertilizing-planting machinery), measures related to the live-stock industry (appropriate treatment of excrement by composting facilities installation) and factory business establishment of wastewater measures (technical service and financing related to the prevention of pollution). Lake Shinji was designated by the Special Measures Act for the Preservation of Lakes and Marsh Water Quality in 1988, and based on the measures, the Plan for the Preservation of Lakes and Marsh Water Quality was settled in 1989. This was followed by the second plan, which was settled in1994, after which measures for the conservation of water quality were planned for its comprehensive and systematic promotion. The outline of the main measures for the Plan for the Preservation of Lakes and Marsh Water Quality includes sewerage system development (the increase of the dissemination rate: from 26% to 42%, used together with 2 cities and 4 towns, and conduit construction in 4 towns), small-scale wastewater facilities in agricultural villages (used together in 20 areas, the construction of a conduit and water treatment plant in 20 areas), a household wastewater polluted water channel direct purification project (conducted at 4 places in 2 cities), river improvement works projects (pseudo-natural bank development, river bed dredging, water weed removal), a small-sized joint treatment and purification plant improvement project (1,518 plants for 3 cities and 9 towns), the promotion of the Measures for Miscellaneous Household Effluent (assistance to the community residents' enlightenment project, attaining 100% installation rates of fine strainer), an environmental preservation agriculture promotion project (the spread of fertilizing-planting machinery), live-stock management environmental preservation comprehensive measures guidance (composting facilities installation) and factory business establishment of wastewater measures (technical service and financing related to the prevention of pollution).

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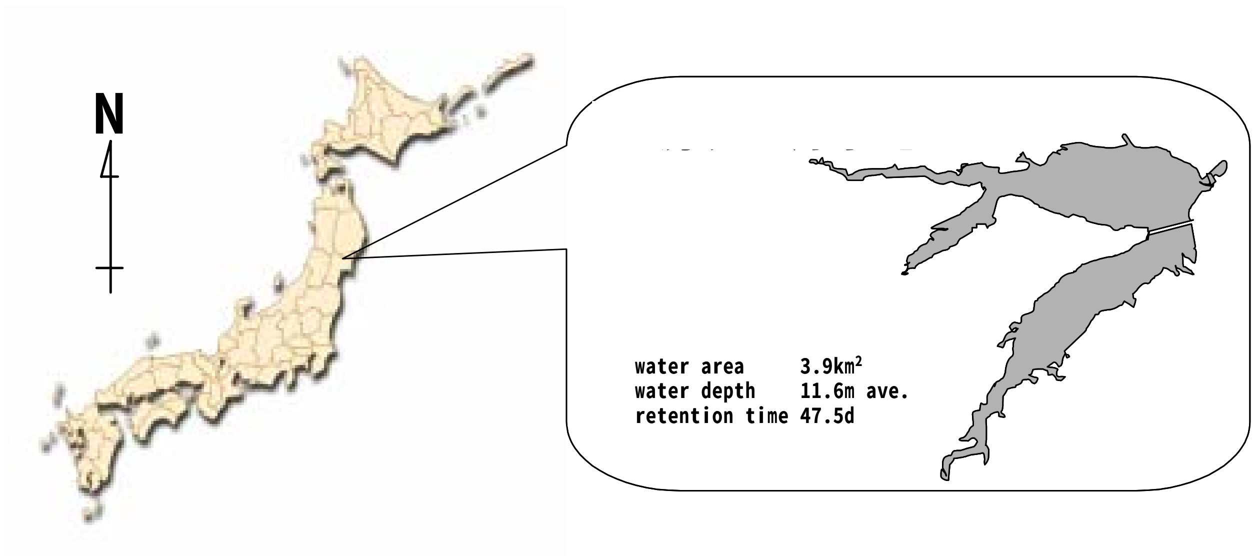
### 3-9 Kamafusa Damu-ko (Reservoir)

#### 3-9-1 Characteristics of the catchment area / lake

Kamafusa Damu-ko (Reservoir) is a dammed lake that was constructed on the Goishi River, a branch of the Natori River System; the water source is the Miyagi and Yamagata prefecture borders, and it is located in Kawasaki-cho, 25 km southwest of Sendai. The construction was completed in 1970 for flood measures due to the action of successive typhoons after the war and for the purpose of water use. The dam takes the form of a linear gravity concrete dam, with a height of 45.5 m and a crest length of 177 m. The geology of the dam site belongs to green tuff areas consisting of tuff and sandstone, but fossil seashells can be found on the lake shore, and an underground lignite mine is present. Kamafusa Damu-ko (Reservoir) is a multi-purpose reservoir, and used for flood-control as well as irrigation water for water use, a domestic water supply, an industrial water supply and a power generation water supply. The domestic water supply is especially supplied to 3 cities and 3 towns including Sendai City, after purification of the source water taken in directly from Kamafusa Damu-ko (Reservoir) at the Moniwa water purification plant. The amount is up to two hundred thousand liters a day. Furthermore, the Goishi River, a lower reach of the dam, is connected to the Natori River, and 44,000 $m^3$ of water is taken from a river channel at the Tomita water purification plant in the lower reaches of the Natori River. Up to 9,684$m^3$/s of irrigation water is used, industrial water up to a hundred thousand a day is used in a land industrial zone in Sendai, and in addition, 1,200 kW of electric power is generated with the maximum water use of 6.0 $m^3$/s. On the other hand, the areas around Kamafusa Damu-ko (Reservoir) play an important role as recreation spots. The peaks of Zao seen from a distance provide fine views, and there is a famous waterfall, Akino-otaki and many hot springs nearby. Furthermore, it is famous as a relaxation spot for citizens, for activities such as pond smelt fishing and outdoor sites. Michinoku-mori National Lakeside Park was opened as the tenth state park by the Ministry of Construction in 1980. It has become a large water park, which includes a vast flower garden, a variety of fountains and cascades, a public square that is a replica of one from the Jomon period, a forest for relaxation, a nature trail and a square for games and water. These were established in the 76-ha site, and recently, zones of culture and water have also been added. There are plans to expand the site to about 300 ha, including a campsite over the next few years.




**3-9-2 The present conditions of the lake**

Kamafusa Damu-ko (Reservoir), as shown in Figure 3-9-1, is an artificial lake under the control of Miyagi prefecture, and the water area is 3.9 $km^2$, the pondage is 3.9 million $m^3$, the maximum water depth is 43.6 m, the average water depth is 11.6 m, the basin area is 191.4 $km^2$, the catchment area population is 8,900 and the average retention time is 47.5 days. The population density per pondage of a million $m^3$ is 46 and the population density per catchment area of 1 $km^2$ is 1.9. The level of the environmental standard under the Plan for the Preservation of Lakes and Marsh Water Quality is COD: 1 mg/*l*., T-P: 0.01 mg/*l*., but the water quality in 1996 was COD: 2.4 mg/*l*., T-P: 0.017 mg/*l*. By looking at the annual changes of the recent water quality, the average of *Kalium permanganicum* consumption is 4.3 mg/*l*., and it is especially high from summer to winter. This tendency did not change after the dam construction. $NO_3$-N is 0.58 mg/*l*. on average, while T-P is 0.015 mg/*l*. When the nutritional state of Kamafusa Damu-ko (Reservoir) is indicated by the modified Carlson index, the level is close to the level of the South Lake of Lake Biwa, and the result of a decision by Forsberg-Ryding shows Chl.a, the eutrophic state for transparency, the mesotrophic state for T-N and T-P. Furthermore, Kamafusa Damu-ko (Reservoir) is in the Tohoku district, and notorious as a dam lake that causes the problem of mold odor, which creates a bad smell in the domestic water supply not only in summer but also in winter. The mold odor of Kamafusa Damu-ko (Reservoir) was observed from the year following the dam construction, and 2-methyl-isoborneal produced by *Phormidium tenue* is considered to be a causative substance. Two air pumping pipes were installed by the Ministry of Construction in June 1984 as a measure against the mold odor, then more pipes were built in September 1984, in 1987 and 1989; 9 pipes are working at present. The population size of the mold odor producing algae, *P. tenue* has been drastically decreased and after the installation of the air pumping pipes, the mold smell is only observed periodically. Kamafusa Damu-ko (Reservoir) has been regarded as a successful case of water quality improvement with air pumping pipes all over the country. However, the occurrence of the mold odor has begun to be observed again since the winter of 1996, and the areas are suffering from mold odor problems throughout the year.

### 3-9-3 The present situation of measures

The Conservation of Lakes and Marsh Water Quality Measures Project includes sewerage system development projects (the increase of dissemination rate: from 49% to 58%, the administrative population in the designated area is 8,858, the population in the treatment area is 5,336), a joint treatment and purification plant installation promotion project (sharing the difference with a single type purification plant, 109 plants were installed), a miscellaneous wastewater simple purification plant installation promotion project (a subsidy for the area outside the sewerage system plan, 53 plants were installed), a stripe fertilizing machinery introduction project (regulated by the Law for paddy field fertilization, assistance with the purchase costs, 80 plants were introduced), aeration circulation with air pumping pipes, the installation of purification facilities between grits (water purification in the lakeside park), a live-stock environmental measures project (compulsory fermentation treatment facilities, compost facilities, human waste treatment facilities, maintenance of agricultural machines) and the establishment of the Kamafusa Dam Conservation of Water Quality Measures Promotion Council (started in 1989). For the removal of mold odor, powdered activated carbon is used at the Moniwa water purification plant and granular activated carbon is used at the Tomita water purification plant. Furthermore, the drastic change in the water level is considered to be one of the reasons for the mold odor, and the reduction of sedimentation in the Kamafusa Dam (Reservoir) is being attempted by the construction of sand stored dams in each of the inflowing rivers.

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**3-10 Isahaya Bay Balancing Reservoir**

**3-10-1 Characteristics of the catchment area / lake**

Isahaya Bay, located in the center of Nagasaki prefecture, has become well known through the "Isahaya Bay Reclamation Project."　"Blocking the tide" with a tide blocking dike in April 1997 was reported by the mass media; the scene of steel plates being dropped one after another was compared to a guillotine, chopping off the abundant organisms, which form the tideland ecosystem.　Differences between the high and low tides of the Ariake Sea incorporating Isahaya Bay reach 5-6 m and with the tideland being developed on the coast, the history of reclamation projects is old and dates back to before 1690.　The Isahaya Bay reclamation project mentioned above was started in 1989, and at first, its completion was planned for the year 2000, but completion has been postponed until the year 2006 due to various reasons.　Blocking the tide by a tide blocking dike was conducted in April 1997, and the construction of the tide blocking dike, with a total length of 7.05 km and a dike levee crown true height of 7.0 m, was almost completed in October 1998.　Because of that, the mouth of Isahaya Bay, all 3,550 ha, was closed and with the construction of the inside dike, a 1,840-ha dry area and 1,710-ha balancing reservoir were developed.

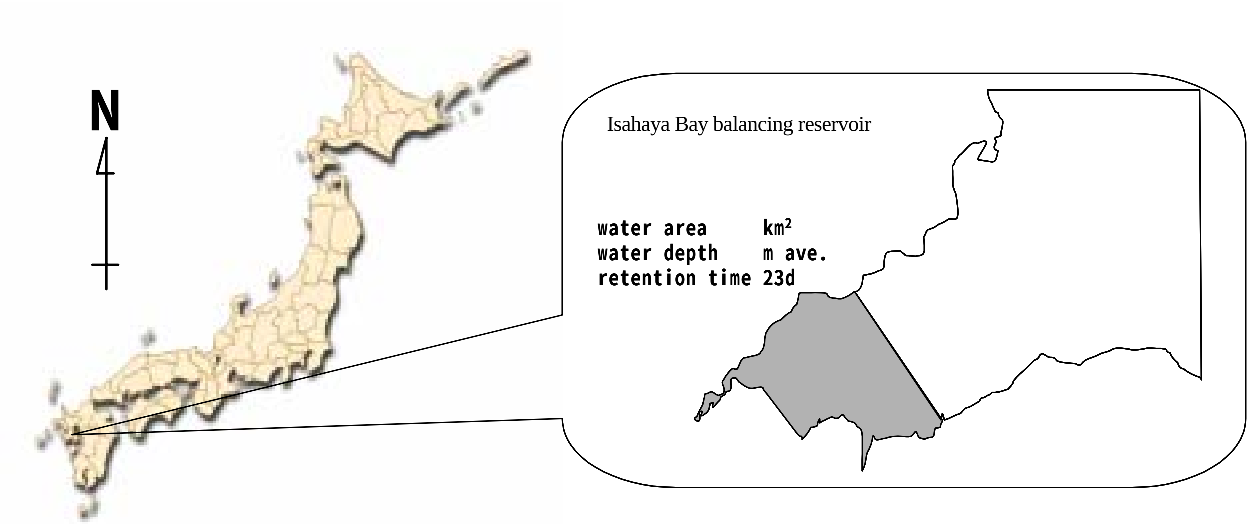


Fig 3-10-1 Overview of Isahaya Bay balancing reservoir

**3-10-2 The present conditions of lake**

, as shown in Figure 3-10-1, is under the control of Nagasaki prefecture, and the water area is 123.58 $km^2$, the river inflow level (the normal water level) is 249.3million $m^3$, the average retention time (in a normal water year) is 23 days and the rainfall on the surface of the lake is 64.78 million $m^3$.　Based on the results of water quality monitoring for one year from the closure of the mouth of Isahaya Bay, desalting of the water area closed by the flood-control dike has rapidly progressed because of the decrease in salt concentration; that is, a decrease from 17,000 mg$Cl^-$/*l*. before the closure to about 4,000 mg $Cl^-$/*l*. three months after the closure has been recognized.　Moreover, looking at the average values, especially for COD that indicates the conditions of organic matter pollution, T-N that indicates the nutrient salts concentration and the T-P rise from 1998, it can be seen that COD is increased from 3 mg/*l*. from before the closure to 6-8 mg/*l*., T-N is increased from 0.2 mg/*l*. from before the closure to 1.5-2.0 mg/*l*. and T-P is increased from 0.03 mg/*l*. from before the closure to 0.20 mg/*l*.

### 3-10-3 The present situation of measures

For measures for conservation of the water quality of the balancing reservoir, the water quality conservation targeted value is set on environmental assessment; COD: below 5 mg/*l*., T-N: below 1 mg/*l*. and T-P: below 0.1 mg/*l*. are set. The estimated pollutant load on the balancing reservoir as of March 2001 was COD: 3,104 kg/day, T-N: 1,556 kg/day, T-P: 182 kg/day, and for COD the residential load (33.1%) and that originated in the source area (37.3%), for T-N the live-stock load (17.9%) and that originated in the source area (38.7%) and for T-P the residential (25.3%) and live-stock load (38.5%) are high. That is, the percentage of the load of area sources from the catchment area is large in the Isahaya Bay balancing reservoir, indicating that the measures for area sources in the catchment area are important while the water quality conservation in the balancing reservoir is being progressed. The examination of putting pollutant reduction using charcoal to practical use is being conducted in Isahaya, and the maintenance of the sewerage water supply is being progressed at the same time. On the other hand, bottom sludge measures by dredging, water purification with aquatic plants and the removal of waterweeds are being considered as purification measures for the balancing reservoir. As a concrete example of lake purification, a water area purification boat that is a free running algal-bloom increase prevention device was introduced, and it plays an active role in combination with stream current generation and ultrasonic technology.

<Reference>

1) Japan Society on Water Environment, ed., *Water Environment in Japan vol.7 Kyushu/Okinawa Edition*, pp.221 （2000）.