Approaches by the Ibaraki Prefectural Government to Improve Water Quality in Lake Kasumigaura

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Abstract

Lake Kasumigaura is the second largest lake in Japan around which is a major agricultural production area and about one million people are living and working. It is also Ibaraki Prefecture's natural symbol.

However, effluent load from households, industries, livestock and agricultural lands flow into rivers around Lake Kasumigaura and this is one of the main reasons of eutrophication.

The Chemical Oxygen Demand level of the lake has recorded beyond 8mg/l in recent 5 years, and this condition should be improved immediately to revitalize Lake Kasumigaura.

The aim of this paper is to show the characteristics of Kasumigaura and the various measures the Ibaraki Prefectural Government has taken to improve water quality. It also mentions future plans for lake conservation to be conducted by the Ibaraki Prefectural Government.

Key words

conservation, Lake Kasumigaura, local government, policy

1 History and Data of Lake Kasumigaura

Lake Kasumigaura, the second largest lake in Japan, consists of three water surfaces, which are Lake Nishiura, Lake Kitaura, and the Hitachi-tone River. The total water surface area of Lake Kasumigaura is 219.9 km^2, where Lake Nishiura is the largest with a surface area of 171.5 km^2, followed by Lake Kitaura's 36.2 km^2, and the Hitachi-tone River's 12.2 km^2. The location of Lake Kasumigaura is shown on Figure 1.

The three water surfaces were originally a coastal inlet (Kaisekiko). Since it formed a lake through the accumulation of earth and sand, it is extremely shallow. The maximum depth of the lake is no more than 7m and the average depth is 4m.

The catchment area of Lake Kasumigaura is 2,157 km^2, which is approximately 1/3 of the total area of Ibaraki Prefecture (6,093 km^2) and rain water and water from the rivers in the catchment area flow into the lake. This area is quite urbanized, with about 980,000 people living and working there.

The data of Lake Kasumigaura are compared with those of Lake Biwa, the largest lake in Japan, on Table 1.

2 The Land Use of the Catchment Area

The catchment area of Lake Kasumigaura is shown on Figure 2.

In 2005, 19.7% of the catchment area was used for rice paddies, 14.5% for farmland and orchards, 18.6% for woodlands, and 14.7% for urban land area. More data are on Table 2.

As the figure above shows, the main industry of the region is agriculture because the area is flat and fertile in addition to a mild climate and plentiful water.

Pig farming is also flourishing and about 293,000 pigs are bred in this area, which account for 45-50% of Ibaraki Prefecture's pig raising industry.

However, land for agriculture is getting smaller recently, while the urban land

area tends to become larger.

3 Changes in the Lake Water Quality

Chemical Oxygen Demand (COD) is a unit of measurement to describe Lake Kasumigaura's water quality. It denotes the amount of oxygen consumed when organic matter in the water is chemically decomposed by an oxidizer. It is a representative index used to describe how much lakes and marshes are polluted by organic matters.

The Japanese Basic Law for Environment defines COD as one of the standard units to measure water quality, and it have been recorded annually by taking the monthly averages of the results obtained from eight designated sites.

The changes of COD in Lake Kasumigaura are shown on Figure 3.

The COD of Lake Kasumigaura registered a level of 3-4mg/l until 1969. By the 1970s, the economy in Ibaraki Prefecture became bustling. At that time, the water quality of the Lake was hovering at a COD of 5mg/l. As Kashima Seacoast Industrial Area and southern Ibaraki, including Tsukuba Science City, became more and more developed, the COD level increased. In 1979 the three water bodies recorded a COD of 10mg/l, the worst in their history.

To tackle this problem, The Ibaraki Prefecture Ordinance to Prevent Eutrophication in Lake Kasumigaura was established in 1982.

Lake Kasumigaura is a eutrophic lake. The water quality of the lake has deteriorated because of the phytoplankton which had grown massively through the consumption of nitrogen and phosphate that flowed in and accumulated at the bottom of the lake. Hence, the ordinance focused on the idea of reducing the amount of nitrogen and phosphate in the wastewater. The ordinance included a ban on the use and sale of phosphorus detergent, and wastewater standards for factories.

Following the enforcement of the ordinance, the water quality of Lake

Kasumigaura improved little by little, and in 1991 it reached a COD level of 6.8mg/l.

However, the COD level has recorded beyond 8mg/l in recent 5 years. The reason being considered is that the white turbidity phenomenon disappeared around 2006 and the degree of transparency has been improved in Lake Nishiura, and phytoplankton has increased rapidly in water containing a high concentration of nitrogen and phosphorous.

4 Amount of Inflowing Pollutant Load to Lake Kasumigaura

Figure 2 shows the amount of effluent load for the three water bodies in 2010.

The total COD load per day for Lake Nishiura, Lake Kitaura, and the Hitachi-tone River in 2010 was 26.7 tons. The effluent load was broken down in the following way: 24% from household wastewater, 18% from livestock wastewater, 12% from rice paddies and farmlands, and 19% from urban land areas.

The total nitrogen load per day for the three water bodies was 14.1 tons, where 33% of the total amount was from livestock waste, and 17% was from rice paddies and farmlands.

The total phosphorus load per day flowing to the three water bodies was 0.67 tons, and a half of the total amount was from livestock waste.

5 For Revitalizing Lake Kasumigaura

The pollution of Lake Kasumigaura peaked in 1979, but since then, measures which were taken have gradually ameliorated this condition.

Since 1985, 5 Basic Plans for the Conservation of Lake Kasumigaura were drafted. The most recent of these plans (5^{th} version) was made to reduce effluent load to Lake Kasumigaura, and set a target COD level of 7.0 mg/l, which should have been accomplished by 2010. During the term of the 5^{th} plan, the Ordinance to

Water Conservation in Lake Kasumigaura was reformed in 2007 and a local environmental tax was introduced in 2008 to ensure the accomplishment of the target.

The result of the plans was that COD inflow load per day in 2010 was estimated to be 26.7 tons, while that of 1979 was 45 tons. The project for the prevention of eutrophication succeeded in reducing the load by 18 tons in 20 years for a 40% of reduction.

However, since 2006 the water quality has deteriorated as the COD level climbed to 8.2mg/l in 2006, 8.8mg/l in 2007, and 9.5mg/l in 2009. The COD level fell to 8.7mg/l in 2010, but we still have to make more of an effort to prevent further water deterioration.

The 6th version of the plan is now being made to reduce more effluent load for Lake Kasumigaura than that reduced under the 5th plan.

The basic policies which are being considered are shown below:

(1) Household Wastewater Management

Approximately 30% of households in the catchment area have not disposed of wastewater properly. Improving this condition is one of the most important aims of the new Basic Plan.

In 2008 the local environmental tax was introduced to conserve forests and lakes. With its revenue, Ibaraki Prefectural Government has made a grant to encourage connection to sewage systems or introduction of high-quality septic tanks.

(2) Livestock Waste Management

As Figure 4 shows, 1/3 of the total nitrogen load for the three water bodies is from livestock wastes.

Livestock wastes have been fermented and used as compost, but new ways of using livestock wastes are to be encouraged (e.g. use as biomass fuel) to reduce the use in agricultural fields.

In addition, distribution of compost outside the catchment area is to be promoted.

(3) Agricultural Measures

Acknowledgement of eco-friendly farmers is to be promoted to reduce the use of chemical fertilizer and agricultural chemicals.

Introduction of a new irrigation system is to be promoted in the paddy fields, with which agricultural wastewater is recycled as irrigation water and naturally purified before flowing into the river.

(4) Lake Purification Measures

Dredging the bottom of Lake Nishiura will be completed by the Ministry of Land, Infrastructure, Transport and Tourism, which is in charge of the Lake Kasumigaura itself. They will also construct wetlands at the mouth of inflowing rivers to Lake Kitaura.

Ibaraki Prefecture is to take measures to improve the natural purifying function of inflowing rivers.

Carp farming used to be very popular at Lake Kasumigaura, and pollution load from carp feeding caused a deterioration of the lake. All of the farming was abolished when carp herpes disease occurred in 2003, but it started again as the disease calmed down in 2009. Supervision will be given by the Ibaraki Prefectural Government for proper feeding.

(5) Industrial Wastewater Management

The Ibaraki Prefectural Government reformed the Ordinance to Water Conservation in Lake Kasumigaura in 2007, and introduced strict standards on the wastewater discharged from small factories and project sites. These standards will be strictly enforced.

(6) Raising Environmental Consciousness of Citizens

To achieve a 'swimmable' Kasumigaura requires not only the leadership of national, prefectural and other local governments, but also the cooperation of the residents and the industries around Kasumigaura.

Therefore, it is important that every single person living in the catchment area is aware of the necessity of cleaning Lake Kasumigaura and education of children at an early age is particularly essential for improving water quality in the Lake. Lake Experience School has been held for elementary and lower secondary school students, in which they cruise on the lake and experience the examination of water quality.

(7) Research Base on Lake Kasumigaura

The Ibaraki Prefecture established the Kasumigaura Environmental Science Center in 2005 as a comprehensive base to coordinate efforts for creating and preserving an environment where man and nature coexist.

The establishment of the Center was first proposed during the 6th World Lake Conference, held in the Kasumigaura area in 1995.

The center aims to effectively manage and conserve water quality of the rivers, lakes, and marshes within Ibaraki Prefecture, including Kasumigaura, through partnerships between the citizens, researchers, corporations and government. These partnerships include research, technical development, environmental education, community activities and information exchange.

6 Conclusion

Lake Kasumigaura not only supports the industrial and agricultural development of the prefecture, but it is also Ibaraki Prefecture's natural symbol, and it is the earnest wish of the citizens of Ibaraki that the water of the Lake be purified.

For these reasons, the national, prefectural and other local governments, as well as the residents of the basin, continue to work together to put forth the maximum effort to improve the quality of the lake's water.

Reference

Tomiyama M. (1994) *Lake Kasumigaura: the origin, the past, present and future of the lake*. Ibaraki Shinbunsya, Ibaraki

Table 1 Lake Kasumigaura Data

Class/ Item	Unit	Lake Kasumigaura (Three Water Surfaces)	Lake Biwa
Origin		Coastal Inlet	Fault Lake
Greatest Depth	m	7	103
Average Depth	m	4	41
Water Surface of the Lake	km^2	220	670
Shoreline of the Lake	km	252	235
Capacity of the Lake	m^3(in billions)	0.9	27.8
Size of Catchment Area	km^2	2,157	3,844
Population of the Catchment area(2005)	in millions	0.98	1.28

Table 2 The Land Use of the Catchment Area(2005)

Rice Paddies	Farmlands /Orchards	Woodlands	Urban Land Area	Lake Surface	Others
19.7%	14.5%	18.6%	14.7%	10.2%	22.3%

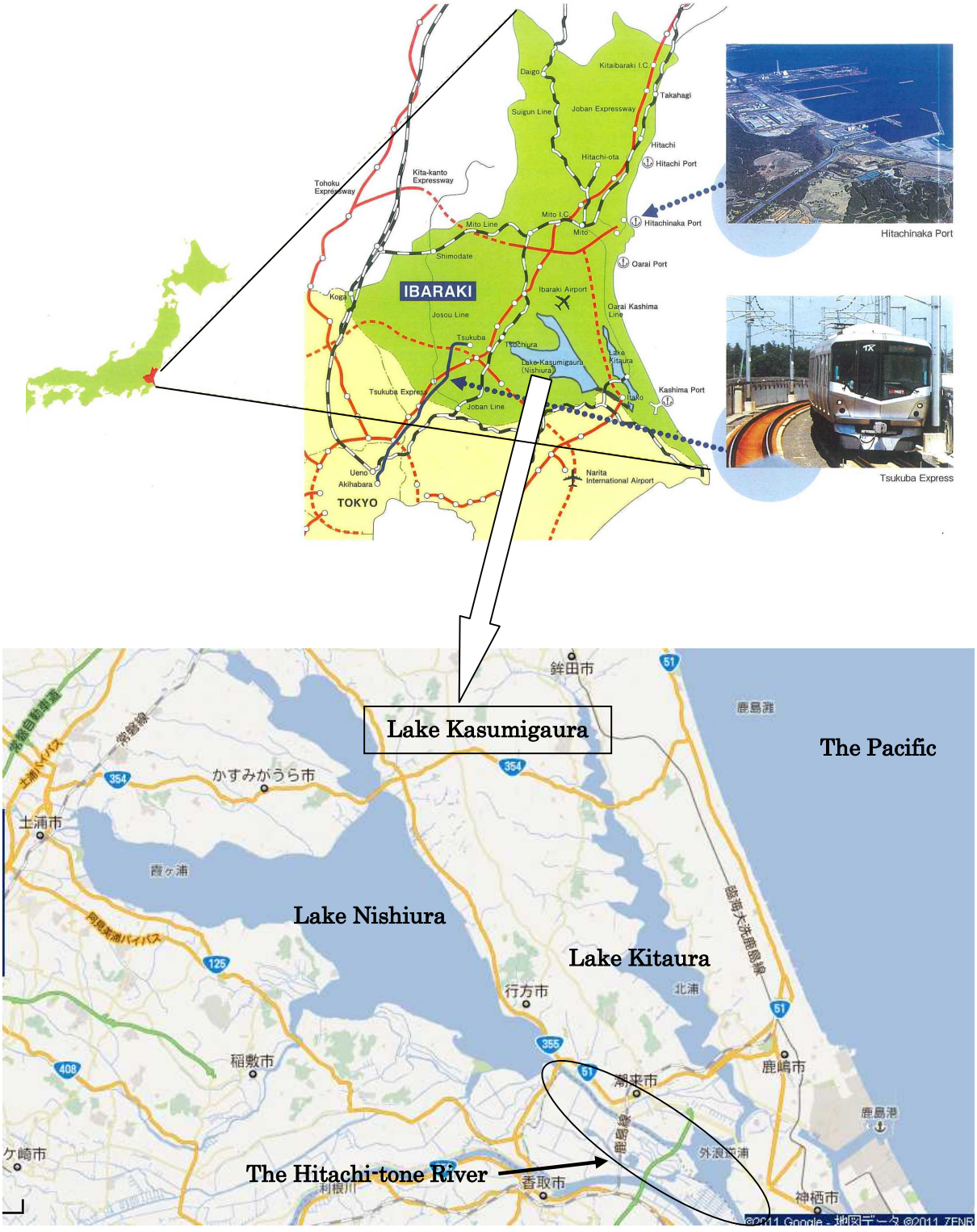


Figure 1 Location of Lake Kasumigaura

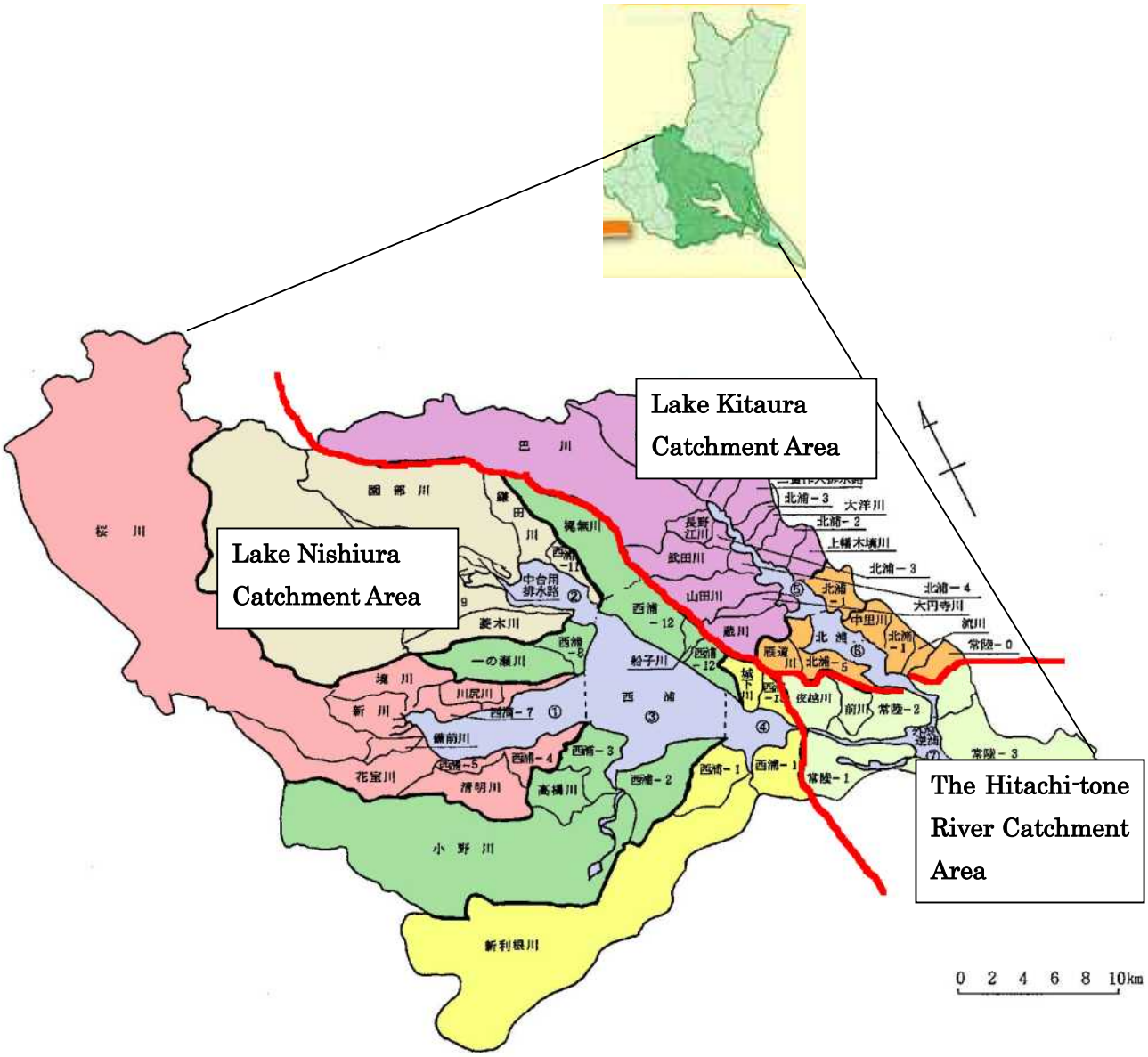
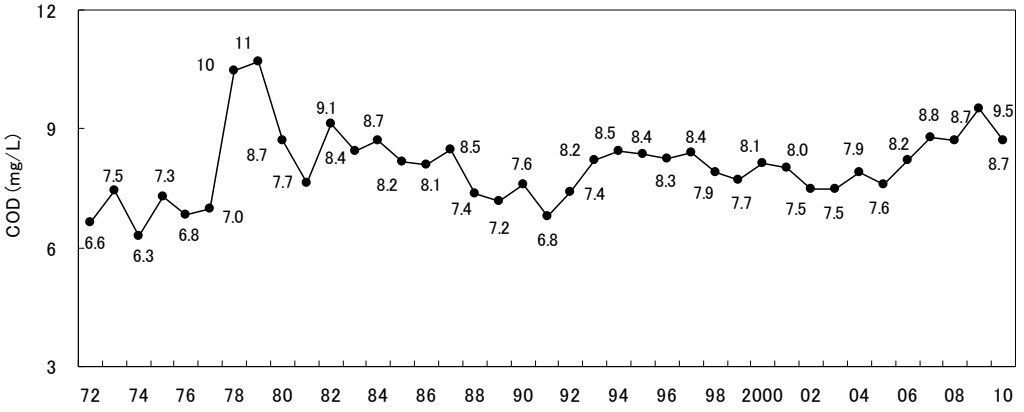


Figure 2 The Catchment Area of Lake Kasumigaura



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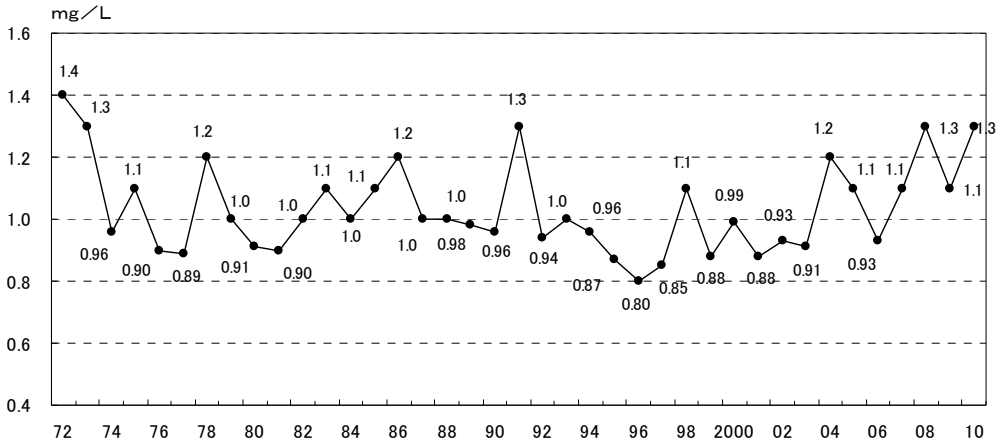

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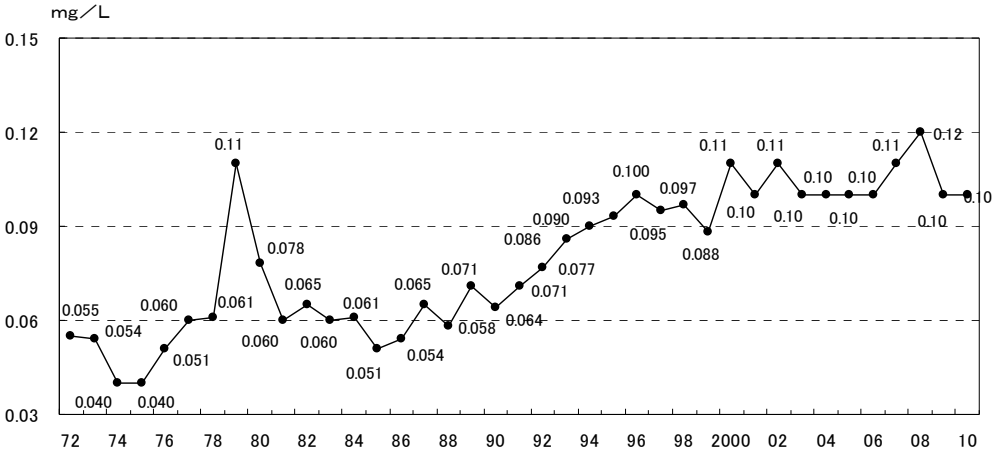

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Figure 3 Changes in the Water Quality of Lake Kasumigaura

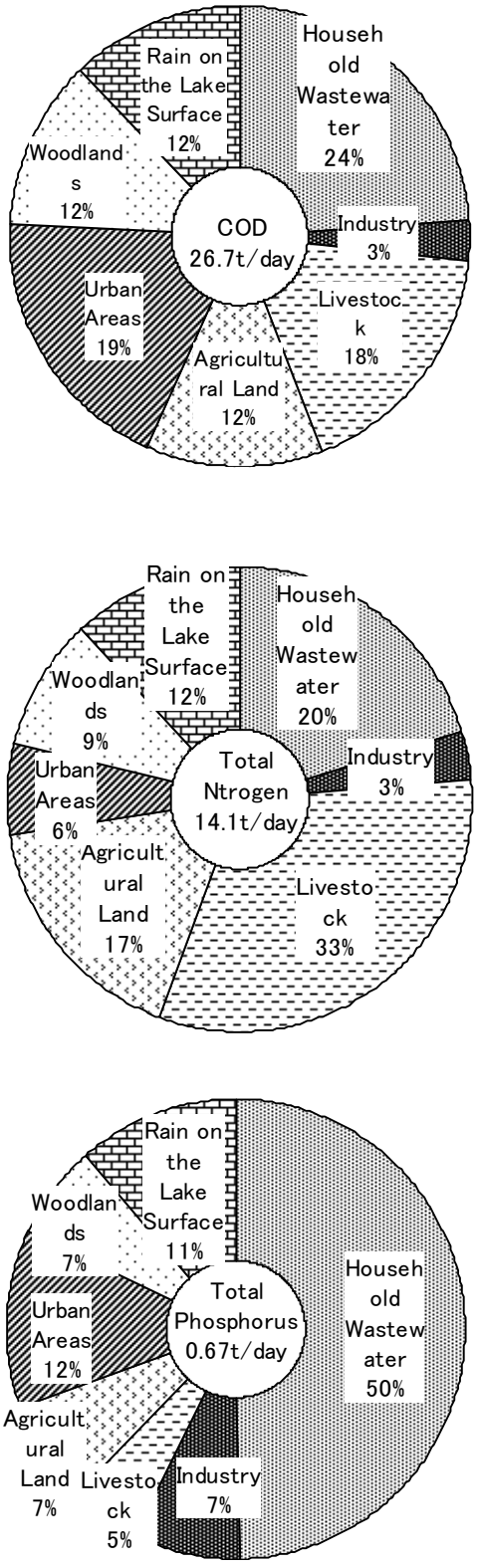

Figure 4 Amount of Effluent Pollutant Load to Lake Kasumigaura (2010)