

# Strategies of the Pollution Control and Ecological Restoration in Taihu Lake Aquatic Ecosystem\*

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**Abstract:** *Taihu Lake is a multiple-function fresh water lake situated in the delta of Yangtze River. Nowadays, the serious pollution mainly created by industry and residents' life has made the water quality of the lake decline continuously. Eutrophication is the main characteristic of the water pollution. The water pollution not only affect the several functions of the lake, but also cause the changes of the aquatic biological community.*

*The pollution control strategies to be adopted include the treatment of the industrial waste water and residents' life sewage, as well as the agricultural non-point polluting source. Ecological engineering is the useful measure for diminishing the nutrition salts in water. On the basis of pollution control, the ecological restoration methods include the transplanting of the emerged and floating anchored aquatic plants at first and the restoration of the submerged plants in the next.*

**Keywords:** *Pollution control, ecological restoration, Taihu Lake*

## 1. Introduction

As the third largest fresh water lake in China, Taihu Lake is situated in the south of the Yangtze River delta, with an area of more than 2 000 km<sup>2</sup>, and mean water depth of about 1.89 m. Taihu Lake is a typical shallow lake, and the water exchange is rather quick. The catchment of lake area covers 36 500 km<sup>2</sup>, which includes Jiangsu, Zhejiang, Shanghai and a little part of Anhui Province.

Because of the advantageous geographical position and natural environment, the catchment of Taihu Lake is one of the most advanced areas in China, with dense city and town groups inside. The local economy was keeping a very high developing speed in the past two decades. Economic development, adding to the population increase, has caused the serious pollution. At the early time of 1980's, the pollution of Taihu Lake had been noted, and from that time on, the water quality maintain the continuous decrease tendency from the origin II-class to present III- to IV-class. The pollution of Taihu water body had the characteristic of eutrophication. Large amount of N and P from domestic wastewater and factory flow into the lake and cause the overgrowth of the

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phytoplankton algae, which worsen the quality of water and make the aquatic macrophytes, especially the submerged plants, disappear gradually in some places, and at the same time, the fishes and bottom-dwelling animals are seriously affected for the lack of food and oxygen resource. As a multiple-function lake, the water body pollution of Taihu adversely influence on fishery, shipping, tour, life and industrial production.

From the period of "the Sixth Five-year Plan" to now, the relevant administrative management authorities and scientific research units had carried out many investigation and research works. Among them, Jiangsu Province Institute of Environmental Science had ever participated in some research projects about Taihu Lake pollution control and made some preliminary investigations on the aquatic macrophytes. On the basis of the research results, we will discuss the strategies of the pollution control and ecological restoration in Taihu Lake aquatic ecosystem in this paper.

## 2. The situations of Taihu Water Pollution

From the early time of 1980's, the water quality of Taihu Lake shows the continuous declining trends, which changed one class only in a period of more than a decade.

The ever-increasing sewage and waste water inflow is the main cause of pollution in Taihu. According to the present investigation and statistics data, the amount of the main pollutants of N, P, COD<sub>Cr</sub> loading into Taihu Lake are 40 000 t·a<sup>-1</sup>, 3,000 t·a<sup>-1</sup> and 230 000 t·a<sup>-1</sup>, separately, but they were 28 000 t·a<sup>-1</sup>, 2 000 t·a<sup>-1</sup>, and 49 000 t·a<sup>-1</sup>, separately in 1988. It proves that the amount of the main pollutants increase in one or two-fold in a period of only 7-8 years. Among them, the amount of COD increase 5-fold, it should be paid more attention.

It is found that N in Taihu Lake comes mainly from the domestic wastewater and the agricultural system, and the wide-used P-containing detergent of household cause the density of P in the waterbody of lake to increase. The large-scale increase of COD is related with the organic matter discharge of factories, domestic wastewater and agricultural system.

We can also find that the eutrophication of Taihu Lake has the spatial characteristic as well as the temporal one, namely the eutropic area in Taihu enlarged continuously in the past several years. According to the investigation results, the eutrophication area in Taihu Lake only took up 1/5 of total area in 1980, the proportion reach 2/5 in 1987, and the eutrophication degree had further development in 1990's. However, the areas of meso-eutrophication declined from 4/5 to 3/5. The eutrophic parts are mainly located in Wuli Lake, Meiliang Lake, Zhushan Lake and some parts near the west coast area.

The investigations on the water environment of Suzhou, Wuxi, Changzhou, Zhenjiang and Southern Jiangsu Canal show that the inflow rivers are the main paths respectively carrying 90 %, 82 % and 92 % of total COD, N and P into the lake. The analyses on the pollutants discharge shows that the industrial wastes, life sewage and the agricultural non-point polluting source occupy the relative large proportion respectively (Tab.1).

One of the other reasons to be considered for lake eutrophication is the trophic substance input from the bait food of the intensive fish-cultivation. Since 1980's, the artificial intensive fish-

cultivation methods had been widely adopted in Taihu Lake and get the obvious economic profit, but the fish bait input, for the purpose of improving the yield of fish, has become one of the main causes of lake eutrophication as shown in Tab. 1.

**Tab. 1 The percentages of the pollutants discharge in Taihu Lake (%)**

	waste water	COD	TN	TP
Industrial waste water	33.44	57.39	33.03	12.01
Agricultural non-point life sewage	36.51	7.00	28.95	13.03
Total	78.07	94.02	82.84	87.23
Other*	21.93	5.98	17.16	12.77

\* "other" refers to the waste water discharge of the fishery, tour, lake surface precipitation, falling dust and shipping, etc..

The eutrophication of the water body of Taihu Lake almost completely change the aquatic biological community, including the dominant species, biological diversity, community components and structure. For example, eutrophic salts and organic matters make the phytoplankton algae overgrowth, such as *Cyanophyta*, *Bacillariophyta*, and *Cryptophyta*, and when they die and discompose, large amount of dissolved oxygen is consumed. This phenomenon could threaten the fishery because of the shortage of the dissolved oxygen in water. The dominance of the algae to the water body may influence on the aquatic macrophytes, especially the submerged plants, such as *Ceratophyllum demersum*, *Najas minor*, *Vallisneria gigantea*, *Potamogeton crispus*, and *Ottelia alismoides* etc., which are the dominant species in Taihu Lake originally. However, the emerged plants, the floating anchored plants and the floating plants are not or rarely affected by the overgrowing algae. For example, *Eichhornia crassipes*, *Nymphaea tetragona* and *Euryale ferox* usually grow well in the eutrophic waterbody. Because some of the aquatic macrophytes have the allelopathic effects or the advantages in competition with the algae, this property can be used to constrain the overgrowth of algae in eutrophication waterbody. The algae and macrophytes coexists in harmony through a long-term competition under the normal condition, but once the nutrition balance of the waterbody is destroyed, the origin aquatic biological community structure is also destroyed (Tab.2).

**Tab. 2 The comparisons before and after eutrophication in Taihu Lake**

	before eutrophication	After eutrophication
light transparent in water	good	Bad
Aquatic macrophytes	rich	Often reduce, some species disappear
Algae	normal	Overgrowth
Fishery and bottom-Dwelling animals	high biodiversity and productivity	Low biodiversity And productivity
Ecological balance	normal	Destroyed

The overgrowth of algae may cause the fish diversity simple, more seriously, may cause the bottom-dwelling animals die and disappear in some places. So, it may be vary harmful to the fishery production. Up to now, we cannot take good use of the algae and the methods for getting rid of the algae is not sufficient. The basic method for controlling the overgrowth of algae is to prevent the large-scale nutrition substances from putting into the lake as well as possible for the purpose of keep the balance of lake.

### **3. Strategies of pollution control and ecological restoration**

The pollution characteristics of Taihu Lake is that the waste water and sewage discharge of industrial enterprise and residents' life are the most important, and the eutrophication of the lake is the key problem. On the basis of our knowledge, the comprehensive pollution control programs are as follows:

**3.1** The management to the point polluting sources( industry and domestic )is planed to begin with the total amount control of pollutants discharge and respectively meeting the standards in each district. The concrete methods to be adopted include the building of the wastewater treatment plant and the remaking of the little rivers for the purpose of controlling the water pollution in them and diminishing the pollutants flowing into the lake. By estimation, the sewage from life occupies not more than 10% of total wastewater discharge, but its carrying N and P occupies 21.0% and 62.19% respectively. So, life sewage is the key problem of the lake eutrophication.

**3.2** The management to the non-point polluting source should be based on the development of the ecological agriculture. The aim is to reduce the amount of away-flowing N and P. It is necessary to take use of the advanced methods of fertilization, irrigation and insecticide use. If possible, it should be considered to build the green protection belts around the agricultural systems. However, all the programs to be carried out are meeting not only the technological problems, but also the administration ones. The corresponding laws and administrative acts should be drown up and executed.

**3.3** We should take steps to solve the water body eutrophication problems of Taihu Lake. At first, the most importance must be attached to the management of the water source-supply places especially in Wuli Lake and Meiliang Bay, which are now the seriously polluted parts in Taihu. There are some effective methods to be adopted, such as the ecological engineering, and the eco-physical engineering barrier, and so on. In the future, we should take measures to realize the pollutants loading control and adopt the comprehensive management programs.

**3.4** In order to shorten the water retention time and lessen the contradiction of water supply of Taihu Lake, it is necessary to improve the inflow water amount into the lake, namely to pump the water of the Yangtze River into Taihu Lake.

**3.5** To begin with the ecological restoration work in the places where the water quality is relatively good. The principles are:

- (1) To cultivate the emerged and floating anchored aquatic macrophytes in the shallow places. These species of plants show the features of adapting to the eutrophic water body and constraining the overgrowth of phytoplankton algae.
- (2) To cultivate the floating macrophytes in the relative deep places to control algae and absorb the nutrients in water.
- (3) To build the aquatic plant community, including the submerged plants and other ecological type species on the basis of the relative good water quality.
- (4) To carry out the scientific research works to understand the specific features and ecological threshold of each plant, and the allelopathy characteristics when they live together. The rebuilding of the aquatic plant community can assure the restoration of the ecological function of Taihu Lake, and improve the environmental capacity. In the process of work, it is necessary to prevent the predation of the plants by fish.
- (5) The ecological restoration of the rivers that flow into Taihu Lake should be a part of the whole restoration work.

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