

Planning Objectives and Thinking for Taihu Lake Water Pollution Prevention*

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Abstract: *According to the social and natural conditions of Taihu Lake Basin, the planning objectives and some ideas for water pollution prevention in Taihu Lake and its surrounding river-lake system are proposed.*

Keywords: *Water pollution prevention plan, Taihu Lake*

1. General conditions of Taihu Basin

Taihu Basin is located in southern part of Yangtze Delta, eastern longitudinal $119^{\circ}11'$ - $121^{\circ}53'$, and northern latitude $30^{\circ}28'$ - $32^{\circ}15'$. It faces Yangtze River on the north, reaches Hangzhou Bay on the south, and neighbors with East China Sea on the east and is bounded on the west by Tianmu Mountain Range and Maoshan Mountain Range and Qiantang River and Shiyang River. It covers a total area of $36\,500\text{ km}^2$ with a population of $35\,500\,000$. The basin is under Jiangsu Province, Zhejiang Province and Shanghai Municipality, including 7 large and medium-sized cities such as Shanghai, Hangzhou, Suzhou, Wuxi, Changzhou, Yixi, Huzhou and 33 counties (cities at county level). It is one of the most developed areas with the fastest economic and social development in China and plays a significant role in our country's social and economic development. Total annual average water quantity of Taihu Lake is 16.2 billion m^3 but per person water quantity is only 456 m^3 , much lower than average per person water quantity of whole county. Additionally, rainfall distributes in time and space uneven. As Taihu Basin reaches Yangtze River on the north, so it provides favorable condition to make full use of Yangtze River flowing water. At present there are 19 large and medium-sized reservoirs in Taihu Basin with a total storage capacity of 1.25 billion m^3 , which plays important role in flood control for the Basin. There are more than 60 inlets along Yangtze River, which have formed as a major water diversion passage. Taihu Basin has a developed river network system with unique regulation and storage functions for plain.

As rapid development of basin economy and exploitation and use of basin resources, the prevention of water pollution is correspondingly backward. Presently, water environment pollution within the basin is increasingly worse, water pollution of river network more severe as well as

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eutrophication of Taihu Lake, so water pollution appears more and more severe on the whole and even becomes the same dangerous problem as flood disaster. Shortage of water in type of water quality becomes more and more obvious in Taihu Basin, hinders the rapid and continuous development for social economy and threatens people's health. Therefore, comprehensively harnessing water pollution in the basin is of great urgency.

2. Existing situation of water pollution

2.1. River water quality of river network rapidly falling

Water of most rivers within the river network is poorer than Class III surface water, mainly under organic pollution. As indicated by a comprehensive analysis of water quality of cross-sections within the basin in 1995 (including 5 indexes: DO, COD_{Mn}, NH⁻-N, NO⁻-N, TP), water body of more than half (58%) of river channels in the whole basin is in Class V or poorer than Class V. Most of inflow and outflow river channels around Taihu Lake have lost function as water source. While water quality of river channels of those provinces and municipality is worsened, which causes water quality conflicts between provinces and municipalities, water pollution accidents sometimes take place in the basin, so it has threatened people's health and industrial and agricultural production.

2.2. Lake eutrophication

Excessive nutrients, great algae reproduction and severe eutrophication take place in the Lake. Monitoring and comprehensive evaluation (including DO, COD_{Mn}, BOD TP as 4 indexes) of Taihu Lake water quality in 1995 shows that there is no water as Class II in Taihu Lake over a whole year, Class IV or poorer than Class IV covers 77 % of total area of the lake. Average concentration of TN of Taihu Lake is 2.3 mg·l⁻¹, 2.6 times that of 1980's; average concentration of TP is 0.06 mg·l⁻¹, 3 times that of 1980's. The lake body has reached middle eutrophication level. As algae greatly reproduction in part of the lake that causes algae blooming and damages domestic water. For instance, Wuxi Water Plant stopped production in July, 1990 as algae blooming in Taihu Lake which caused direct economic loss 130 million RMB yuan.

2.3. Urban residents' drinking water source facing threatening

Since river channel water quality worsened in the basin, the water lost drinking value finally and inlet of water plants have to be moved again and again. For instance, as water quality of Huangpu River worsened, the inlet of water plant moved to Linjiang River 46 km from Wusongkou in 1987. But urban river stretch sewage flowing upstream, water quality of Linjiang River became worse too. Now Shanghai municipality invest 1 billion RMB yuan to take water at Songpu Bridge (73.2 km from Wusongkou) at upstream of Huangpu River. If water quality continues to be worsened, water quality at Songpu Bridge can no longer meet required criterion, thus Shanghai cannot take water from Huangpu River, then will have to take from Yangtze River. How

many billion RMB yuan will be needed?

2.4 Excessive drawing of groundwater

As water quality of surface water becomes worse, people actively search for second water source groundwater. While excessive taking ground water causes very severe deformation of ground surface in Taihu Basin. The unrecoverable deformation brings about many serious results, so the water conservation projects for which our county had invested large amount of funds will lost original flood control function.

3. Water pollution planning objectives for Taihu Basin

Since Taihu Basin is a united whole, so planning made by some regions and departments cannot take full account of problems in view of whole, more often, the planning can only represents local and department interest, therefore, it is necessary to prepare a water pollution prevention planning for whole basin.

Based on the principal policy issued by the state for harnessing water pollution of Taihu Basin: "objectives higher than that for Huihe Basin, requirements stricter than that for Huihe Basin, efforts greater than that for Huihe Basin", we have produced specific control objectives for water pollution prevention.

3.1 Objectives for present stage (before the year 2000)

3.1.1 All industrial and intensive aauacultural pollution sources within the basin shall meet certain drainage criterion by 1998. Water in Taihu Lake is to be improved to be between Class III and Class IV.

3.1.2. All rivers as urban water supply source shall be Class III and mixed river stretches be Class IV. Interprovincial and boundary rivers (sections) generally are controlled to be between Class III and Class IV by 1997 and to be Class III by the year 2000.

3.2 Water quality objectives for the year 2000

3.2.1 Taihu Lake: to return beautiful appearance clear water to Taihu Lake, water quality of central lake area and eastern Taihu Lake reaches Class II of bank area to reach Class III (water quality evaluation includes TP, TN nutrients) to effectively control eutrophication trend.

3.2.2 Water quality of Wangyu River to be Class III and of Taipu River to be Class II.

3.2.3 Water quality of major water sources in Pudong system, Hang-Jia-Hu water system to be Class III.

3.2.4 Water quality of Grand Canal protective stretch to be Class III Class IV, mixing stretch class IV and self-clearing stretch Class III.

3.2.5 Other lakes: water quality of Yangcheng Lake, Dingshan Lake to be class II and of Gehu Lake and Caohu Lake Class III.

3.2.6 Water quality of inflow rivers to Taihu Lake not to be poorer than Class III.

3.2.7 Water quality objectives for interprovincial rivers Water quality of interprovincial rivers is

no poorer than Class III.

3.3 Water quality objectives for the year 2010:

Water quality of main lakes will be Class II, except Canal Class III – Class IV, of other river channels Class II.

Water body of provincial boundary in Taihu Basin includes Taihu Lake, Dingshanhu Lake and other main inflow and outflow river channels, Wangyu River, Taipu River and other main river channels running across provincial (municipal) boundary. Taihu is either boundary water body of Jiangsu Province and Zhejiang Province or the most important water body of whole basin as well as base of basin ecological system. The supervision and harnessing work must combine closely with inflow and outflow rivers around the lake. Wangyu River and Taipu River are river channels for basin diversion and water supply and will produce significant influence on water environment of the basin.

To carry out the 18th Clause of “Water Pollution Prevention Laws of the People’s Republic of China”, Taihu Basin Water Resources Protection Bureau has been implementing monitoring for water environment quality of provincial boundary water body in Taihu Basin. The bureau held an emergency monitoring plan work meeting of Taihu Basin, participated in by water conservancy and environment protection departments of two provinces and one municipality and 41 monitoring cross-sections were determined, Monitoring may fully reflect water environment quality of provincial boundary water body in Taihu Basin and provides a scientific base for the purpose of solving boundary water quality conflicts and decision making for water conservancy works.

Interprovincial rivers are shown as follows:

There are Liuhe River (from Liuhe river mouth of Taichang to joint of Yantietang), Yantietang (from southern suburb of Taichang to Weigang of Jiadin), Wusongjiang (from Lujia of Kunshan to Huangdu of Minghang), Yuandang of Dingshanhu Lake ; (between Kunshan and Qingpu), Jiisui-gang (from Zhouzhuang of Kunshan to Shangta of Qingpu) between Jiangsu Province and Shanghai.

There are Hongqitang (from Youchegang of Jiashan to Sanjiaodu of Songjiang) and Shanghai-tang (from Pinhu South Bridge to Zhujin of Jinshan) between Zhejiang Province and Shanghai. Except for Taihu Lake, there are Lanxitang (from Wuzheng of Tongxiang to Pingwang of Wujiang) , Dietang (from Dongqian of Huzhou to Pingwang of Wujiang) , Houshihe River (from Shengzhe of Wujiang to Wangjiangjin of Jiaxin) in Jiangsu and Zhejiang provinces; and there is Taipu River (from Pingwang to Liantang of Qinpu) running across Suzhou City, Zhejiang Province and Shanghai.

Function classification of main lakes in Taihu Basin and water quality protection objectives are shown in Tab. 1, of main rivers in Tab. II.

4. Thinking of comprehensive water pollution prevention for Taihu Basin

Water pollution harnessing for Taihu Basin focus on lakes and rivers used as. Water source of

urban water supply, key spots are Taihu Lake (as water source of urban water supply for Suzhou, Wuxi etc.) and Dinshanhu Lake (as water source of Shanghai water supply).

Tab. 1 Function classification & water quality protection objectives for major lakes of Taihu Basin

N o.	Name of lake, reservoir	Section	Area (km ²)	Storage Capacity(10 ⁸ m ³)	Major functions	Existing water quality*	Function Category*	Objectives* for Year 2000	Year 2010
1	Taihu	Central, Eastern	1 500	44.28	A,B,C,D	II	II	II	II
2		Bank	750		C,E,G,H	III	III	III	
3		Meiliang	130		C,E,F,H	IV	III	III	
4	Gehu		146.9	1.565	C,E,G	IV	III	III	
5	Yang-cunhu		119.0	1.726	C,E,G	IV	Es- II Ws-III	II	
6	Dinshanhu		63.7	1.06	C,E,F	IV	Sh- II	II	
7	Caohu		88.9	0.861	C,E,G	III-IV	III	III	

* According to State Standard (GB3838-88); Existing water quality in 1993

A-regulation; B-storage; C-drinking; D-fishing; E-breeding; F-tourism; G-agriculture; H-industry; Es-eastern; Ws-western; Sh-Shanghai

Harnessing should focus on major pollution source, i.e. severe pollution industrial enterprises. Major professions with pollution problem are chemical industry, paper-making, food processing, textile and printing and dyeing, mine, metallurgy, pharmacy and wine-making industry. Pollution is mainly organic pollution, Jiangsu Province is a key area. Jiangsu Province is mostly damaged by water pollution and under great impact. Therefore, the province must strengthen harnessing pollution. Wuxi city and Xishan city should be listed in key cities for pollution harnessing. According to analysis of lake body pollution, eutrophication in Meilianghu Lake of Wuxi city is very severe, water quality of inflow river (Liangxi River, Zhinangang) is very poor, which menaces urban water supply source. So they should be among the list of urgent harnessing areas. Presently, township enterprises have been rapidly booming in the basin, sewage drained by them is constantly increasing while harnessing work is done less and poor. Therefore the situation case should catch attention of leaders at different levels.

Policy for Taihu Basin comprehensive harnessing includes Five Harnessing for Both, i.e. "harnessing for both appearance and basis, harnessing for both lakes and rivers, harnessing for both two kinds of pollution sources (spot and area), harnessing for both region and basin, harnessing for both upstream and downstream"

Harnessing water pollution for the basin should take account of the basin as a whole to implement control of total pollutes quantity completely, then divide the whole into several parts, such as water systems, regions, factories and mines. Each part should carry out harnessing in the consideration of whole basin and all parts should unite to conduct harnessing work.

Tab. 2 Function classification & water quality protection objectives for major rivers of Taihu Basin

No	Water system	River	Stretch	Main drainage city & town	Major functions	Existing water quality*	Function Category*	Objectives* for	
								Year 2000	Year 2010
1	Tiaoxi	East	Shan-daqiankou	Huzhou	C,G	II	III	II	II
2		West	Zhitanpu-Xiaomeikou	Fanjiaocun, Huzhou	C,G	III	III	II	II
3	Nanxi	North	Nandu-Xiju	Nandu	G,H,I	III	IV	III	III
4	Huangpu	Huangpu	Dinfeng-Minhang	Songjiang, Minghang	C,G, H,I	II-IV	II-III	III	II
5			Minghang-Longhu	Wujing, Gangkou	G,H,I	III-IV	III-IV	III	II
6	Taipu	Taipu	Total length	Pingwang, Lili,Luxu	A,B, C,I	II	II	II	II
7	Wangyu	Wangyu	Total length	Changshou	A,B,I	IV	A-II B-III	A-II B-III	II
8	Grand canal	Danyang	Danyang-Xinzha	Danyang, Benniu	G,H,I	IV	III	III	III
9		Changshou	Xinzha-urban	Changzhou	G,H,I	>V	IV	III	III
10			Urban-Qishuyan	Changzhou, Qishuyan	G,I	>V	IV	IV	IV
11			Qishuyan-Roshe	Roshe	G,I	>V	IV	IV	III
12		Wuxi	Roshe-urban	Wuxi	G,H,I	>V	IV	IV	III
13			Urban-Wangzhuang	Wuxi	G,I	>V	IV	IV	IV
14			Wangzhung-Fengqiao	Wuxian, Fengqiao	G,H,I	V	IV	IV	III
15		Suzhou	Fengqiao-urban	Suzhou	G,H,I	V	IV	IV	III
16			Urban-Wujiang	Suzhou, Wujiang	G,H,I	IV	III	IV	IV
17			Wujiang-Pingwang	Pingwang	G,H,I	II	III	III	III
18		Jiaxin	Pingwang-Shuangqiao	Pingwang	G,H,I	II	III	III	III
19			Shuangqiao-urban	Jiaxin	G,H,I	IV	IV	IV	IV
20			Urban-Honghe	Jiaxin	G,H,I	IV	III	III	III
21		Hangzhou	Honghe-Tangqi	Tangqi	G,H,I	>V	IV	IV	III
22	Tangqi-urban		Hangzhou, Tanfqi	G,H,I	>V	IV	IV	IV	

* According to State Standard (GB3838-88); existing water quality in 1993

A-diversion; B-drainage; C-drinking; D-fishing; E-breeding; F-tourism; G-agriculture; H-industry; I-navigation

4.2 Control and harnessing pollution sources

4.2.1 Harnessing measures for industrial pollution sources

Major pollution enterprises must carry out harnessing in specified period. All key enterprises within the basin, big pollution drainage units in particular, must reach drainage criterion by the

end of 1998, To those professions with severe pollution and great difficulty to harness, for instance, small- sized paper-making plant with annual production of less than 5 000 ton, small-sized tannery with annual production of 100 000 pieces of leather, etc. they should be closed, stopped, combined or transferred before Sept. 30, 1997. Each profession and each enterprise should produce harnessing measures to strictly control new pollution source and stick on “Three Simultaneous” and evaluation system of environmental impact for engineering project.

4.2.2 Harnessing measures for domestic pollution source

Establishing urban sewage treatment plant, popularizing-application of non-P detergent. As urbanization of rural area and expansion of townships, it is expected to complete construction of drainage piping system, to implement collective sewage drainage and treatment in order to conform to criterion of sewage drainage.

4.2.3 Harnessing measures for agricultural pollution source

Reasonably applying chemical fertilizer, mainly to control application quantity of nitrogen fertilizer and pesticide and to make afforestation to prevent soil and water from loss.

4.2.4 Harnessing measures for livestock and poultry pollution source

Wastes emitted by livestock and poultry may be used as organic fertilizer which are to be controlled not to directly drain into water body, It is required to build oxydation pool in available places.

4.2.5 Pollution control for aquaculture

It is supposed to control scale of aquaculture in lake area by means of net enclosure, It is forbidden to breed fishes around the water source areas,

4.2.6 Harnessing pollution source of tourism and navigation

To control scale of tourist spots around the lake, ships and boats are not allowed to directly drain waste oil and water to the lake.

4.3 Harnessing for lake water body

Dredging shall be carried out for bed soil of lakes with heavy sedimentation to maintain Taihu River and Wangyu River as a clear water passage. It is expected to establish interprovincial water quality criterion, Taihu Basin Water Resources Protection Bureau is responsible for monitoring, supervision and administration of interprovincial water body.

4.4 Improving water environment by water conservancy works

Ten key water conservancy components within Taihu Basin do not only function for flood control and water logging drainage, but also can improve water environment. As a result, the environmental capacity of Taihu Lake and the river network is to be increased.

The requirements of environment improvement, water environment improvement by water distribution and strengthening self-clearing capacity of water body have been included in optimizing distribution measures on the basis of existing water conservancy components.

It is suggested that in some water systems and river channels water conservancy components

should be built in order to improve water environment, such as sluice gates built in Zhihugang and Wujinggang.

5. Administration of basin water environment

5.1 Establishing and perfecting monitoring and information systems for the water environment of Taihu Basin

Taihu Basin Water Environment Monitoring Center under the leadership of Taihu Basin Authority takes the responsibility of monitoring for provincial boundary river channel cross-sections. The environment protection department and water conservancy department of all regions undertake water quality monitoring of the regions, so that a monitoring system characterized by division and cooperation has been formed.

5.2 Identifying the status of Taihu Basin Water Resources Protection Bureau

Taihu Basin Water Resources Protection Bureau undertakes macro administrative work for basin water resources protection. Since water resource is a sort of flowing resource, basin should be managed in the way of unit but the administration must be supported by laws. The administration laws and regulations must conform to the basin's characteristics. Therefore, the legal status of basin water resources protection bureau must be identified.

5.3 Taihu Basin Water Pollution Prevention Leading Group

Taihu Basin Water Pollution Prevention Leading Group has been established, under the unified leadership of the leading group, two provinces and one municipality unit to harness water and pollution. With practical support of various departments of the state council and positive efforts of the people in the basin, the water pollution prevention objectives of Taihu Basin are bound to be realized.