

A Way to Comprehensively Harness the Water Pollution in Taihu Lake: Sludge-dredging Work for Environmental Purposes*

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Abstract: *The eutrophication of Lake Taihu is becoming more serious day by day and more urgent to be comprehensively harnessed. The lake sludge is considered as a important polluting factor. To control the internal pollution source of Lake Taihu and restore its water ecological environment, this paper put forward an idea of the dredging for environmental purposes. It was on the basis of the research on the sludge storage and physical/chemical characteristics. The technical keys are sludge-dredging depth, time, method and sludge treatment. The requirements and scheme for the environmental dredging work in Lake Taihu were also analyzed in detail.*

Keywords: *Lake Taihu, sludge and nutrient storage*

1. Introduction

Lake Taihu, located in south of the Changjiang delta, is one of the five famous largest freshwater lakes in China, with an area of 2 338 km² and a mean depth of 2 m. For the last decade, the economic development and lake resource utilization have made a mighty advance, however the water pollution control lagged behind. At present the water environmental pollution in the basin, such as water quality and eutrophication of lakes and river nets, becomes a more and more serious problem. Of which the eutrophication of Lake Taihu is most critical one. How to control and hardness the eutrophication of Lake Taihu have being seriously taken with the nation and local organizations. Some measures have been put forward, in which sludge-dredging work will be taken as one of the most important engineering programs.

2. Storage of the sludge and distributions of nutrients in the superficial sediment

2.1 Storage of the sludge

On the basis of the surveying data collected among 1992-1996, about twenty-nine percent area

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of the whole lake is covered with more than 0.1 m sludge, whose distribution is mainly in the lake bays and along the littoral. The limnological mud area, deep more than 1.0, makes up 12 percent of that. The total storage of the sludge in the lake is evaluated to be $6.91 \times 10^8 \text{ m}^3$.

2.2 Distribution of the main nutrients in the superficial sediment

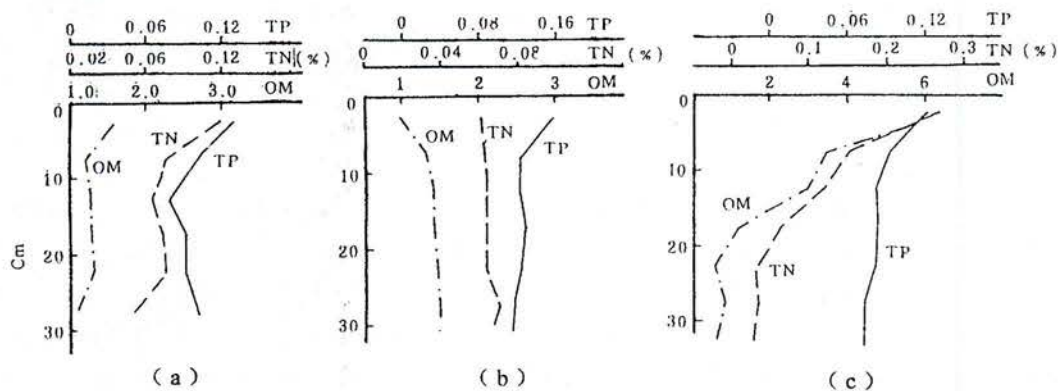
According to the analysis of the superficial sediment, TN contents of total nitrogen (TN), total phosphorous (TP) and organic matter (OM) of the whole lake are 0.022-0.45%, 0.039-0.237% and 0.31-9.04%, respectively. Wulihu Bay, Meiliang Bay

Tab. 1 The main nutrient contents of the superficial sediments in Lake Taihu (%)

lake district	OM	TN	TP
East Taihu Bay	4.180	0.206	0.124
Wulihu Bay	3.117	0.196	0.230
Meiliang Bay	1.347	0.092	0.153
main lake area	0.802	0.057	0.117
whole lake	2.098	0.124	0.149

Note: taking mean value during 1990-1995

and East Taihu Bay hold higher contents of TN, TP and OM, seeing Table 1. Moreover, a great difference is in the vertical distributions of the nutrients. There are three principal types of content variation with depth. The first type is that the content increases with depth, the second result turns out contrary to the first, and the third type goes high-low-high content change from surface to bottom in the sediment (Fig. 1).



a—Meiliang Bay b—Xiaomeikou c—Dongtaihu Bay

Fig. 1 The vertical distribution of the main nutrients in the sludge in different lake districts

Lake Taihu with a long history, has a sedimentary of $0.41 \text{ mm} \cdot \text{a}^{-1}$ (Sun Shunca, *et al.*) and accumulated a great quality of sediment, including the nutrients. Fig. 2 and Fig. 3 show that in the near years humankind activity is of importance to the nutrient contents in the superficial sludge. The contents have been rapidly risen since 1980. TN has increased by 120%, TP 12.7% and OM 90.5%. However, only -3.0%, 25% and 100.7% correspondingly increased in twenty years (1960-1980).

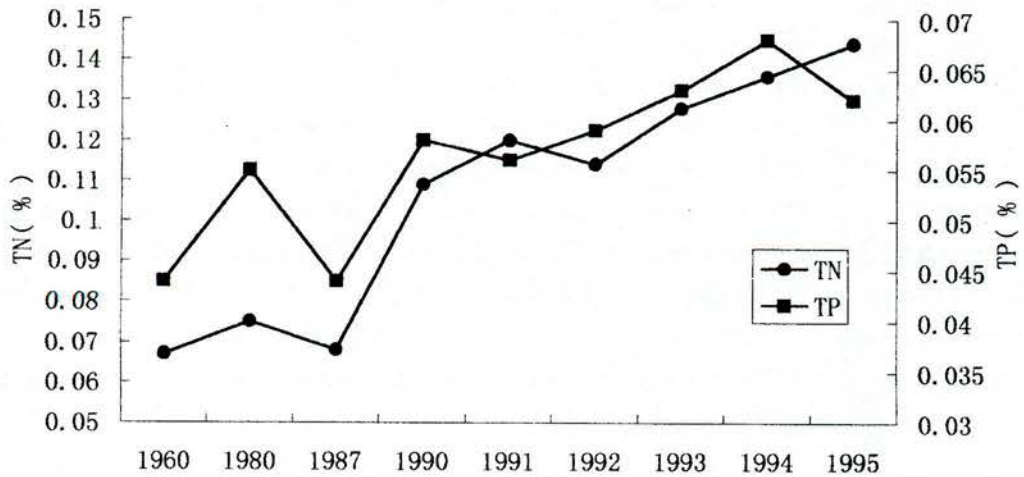


Fig. 2 The historical variation of TN and TP contents in the sludge of Lake Taihu

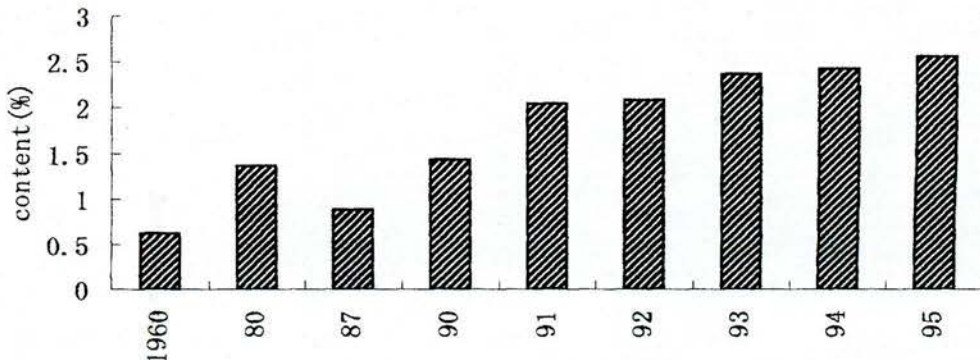


Fig. 3 The historical variation of OM content in the sludge of Lake Taihu

3. The tendency of nutrient accumulation in the superficial sludge

3.1 The historical variations of the nutrient contents

The nutrients that come from a various kinds of resources can undergo a series of physical, chemical and biological reactions. They are adsorbed on some suspended solids and partly deposited downward. Although the process is very unstable because of hydrodynamic resuspension, the sedimentary occurs at all the time.

3.2 Analysis of effect of the mankind activity on the sludge

Lake sludge is the important component part in the lake ecosystem and one of the central link of the nutrient circulation within the lake. The sedimentary of lake sludge not only directly re-

flects the polluted situation, but also influence the lake water quality and eutrophic level by means of nutrient release from the sludge to the overlying water, which is also the specific ecosystem characteristics of the shallow lake.

C/N Ratio in lake sludge is one of the most main indexes that indirectly reflect the organic pollution level of the lake. Table 2 shows the ratio of C/N in the different lakes of Lake Taihu among 1990-1995. It can be seen from the table that the ratio of the each bay is basically rising year by year. Of which those of bays that are near to the cities or towns are distinctly greater, such as Wulihu Bay. Also, excessive nitrogen and phosphorus in a lake mostly come from the rivers, atmosphere and lake littoral. The town residents and farmlands are main resources of nitrogen and phosphorus in Lake Taihu (Yuan Jingxiu, *et al.* 1993). That TN and TP contents in the sludge have sharply gone up since 1980 demonstrates effect of the human activity on the accumulation of the nutrients in the sludge of Lake Taihu.

4. Significance and feasibility of the sludge-dredging work in Lake Taihu for environmental purpose

Tab.2 Annual mean ratio of C/N in the different area of Lake Taihu between 1990-1995

Year	Wulihu Bay	Meilianghu Bay	Gonghu Bay	Zhushanhu Bay
1990	8.08	7.61	7.57	6.13
1991	8.95	8.38	7.75	8.09
1992	10.02	8.01	8.67	8.53
1993	7.42	10.19	7.36	9.56
1994	10.63	6.48	9.03	7.50
1995	11.43	11.13	10.00	9.52
Mean	9.42	8.63	8.40	8.22

Engineering dredging is mainly a physical work, which is in accordance with the project aim that concludes sludge-dredging geometric size, such as dredging depth, bottom level and cubic meter of earth. The arm of environmental dredging, however, is removal of rich nutrients, dormant algae and remains of aquatic animal and plant in superficial sludge. Environmental dredging is involved to sedimentary environment, hydrodynamics condition and biological effect, and must consider the influence on natural and social environments. So it belongs to the category of ecological engineering. The engineering economic benefit will be thought over in the environmental dredging work. It should be first performed in the region whose effect is important on the national economic and social developments. In the north of Taihu region, the industry and agriculture develop very well, and tourism and communications do either. It is urgent to seek effective way to control the water pollution of Lake Taihu so as to keep sustainable development in the region and input/output balance. It is of very significance to the water resource of cities and towns and tourism spots. Wuxi City preliminary performed dredging in Meiyuan and Mashan water-works, removing 3 million m³.

4. 2 Feasibility of the environmental sludge-dredging in Lake Taihu

4.2.1 Sludge-dredging depth and special requirements

The nutrients and organic matter mainly gather in about 7-25 cm of the sludge in Lake Taihu. In consideration of uneven of micro-region in the sludge, the dredging depth is suitably recommended to be 30-40 cm.

On the interface of water-sediment, there is semi-suspend colloid matter about 10cm deep, which contains rich nutrients. Because of their special form, the dredging technique and equipment are particularly required. In which closure and pumping are key technological requirements. Other wise the dredging effect will be not so good. With regard to this point there have gotten two lessons resulted from the dredging work of Lake Xihu and Lake Xuanwuhu, China.

4.2.2 Sludge-dredging time

During early winter and last spring, Lake Taihu is in its low-water stage, with gentle breeze and slow water exchange. In this time the superficial sediment principally keep instant. Moreover, the remains of phytoplankton and zooplankton deposit in the bottom because of death. The alive algae are in dormant or non-active state as a result of low temperature and tiny sunshine. So it is best period to practice sludge-dredging work. Low water-stage is advantageous to mechanizing project.

4.2.3 Method of the sludge-dredging

In consideration of ecological protection and property of surface sediment, it is suit to practice methods of mechanizing dredging in lake subregion and adsorbing the sludge plot by plot to avoid producing great disturbance and forming the secondary pollution. Now some institutions try to study dredging equipment in order to attain the best combination of feasible technique and practicable facilities. A transregional company is suggested to found in order to raise standard of mechanization work and efficiency of sludge-dredging.

4.2.4 The focal points of dredging

It is not capable of and necessary to perform the sludge-dredging on the whole lake because of limit funds of the national and local finance. The focal points of dredging will be put on Wuli Bay and Meiliang Bay, which are the drinking-water resources and major scenery districts. The dredging scope is first limited within 100-200m, taking the water intake and scenic spots as the center. The work is by year by practiced according to actual demand and financial situation

4.2.5 Treatment of the dredged sludge

Generally, the sludge that the fertility is rich and does not contain poisonous matter can be used for the fertilizers of farm, vegetable lands and orchards. And that contains poisonous matter will be moved and buried. One can make use of the dredged sludge by means of waste utilization prin-

ciple.

The environmental dredging engineering in Lake Taihu is one important countermeasure that controls water pollution of the lake and enforces sustainable development of regional economics. Each relative province and city should support this engineering on their own initiative and actively take part in it. The internal source harness of the lake pollution will be gradually realized.

References

- Sun, S. *et al.* 1987. The bottom configuration and recent deposition of the Taihu Lake, *Memoirs of Nanjing Institute of Geography, Academia Sinica*, No.4. Science Press, Beijing, pp.1-15.
- Yuan, J., and Huang, Y. P. 1993. Preliminary study of pollutant load in the rivers around Taihu Lake, *Oceanologia et Limnologia Sinica*, 24: 486-493.