Relationship of Soil Erosion and Pollution in the Chaohu Lake Basin

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Abstract: The Chaohu Lake is one of the five famous largest freshwater lakes in China. But it is polluted by rapid increasing of many kinds of pollutants as industry, agriculture and domestic. In this study, I put attention to the study of the relationship of soil erosion and sediment delivered into the lake. Soil and water conservation methods for pollution control are suggested.

1 The background of the chaohu lake

The Chaohu Lake basin lies in the middle of Anhui province, 117°16′ 54″ —117°51′ 46″ E, 31°43′ 28″ —31°25′ 28″ N, between the Yangtze River and Huaihe River, with the area of 9,130 km^2 (913,000 ha) (See Fig.1). The lake basin covers 11 cities and towns. The Chaohu Lake is one of the five most famous largest freshwater lakes in China, which belongs to the typical geological fault constructional lake. There are seven main rivers flowing into the lake. The yearly average runoff from the Chaohu Lake basin is about 5,330 million m^3 (about 580 mm). The lake flows into the Yangtze River through the Yuxi River, which is 60 km.

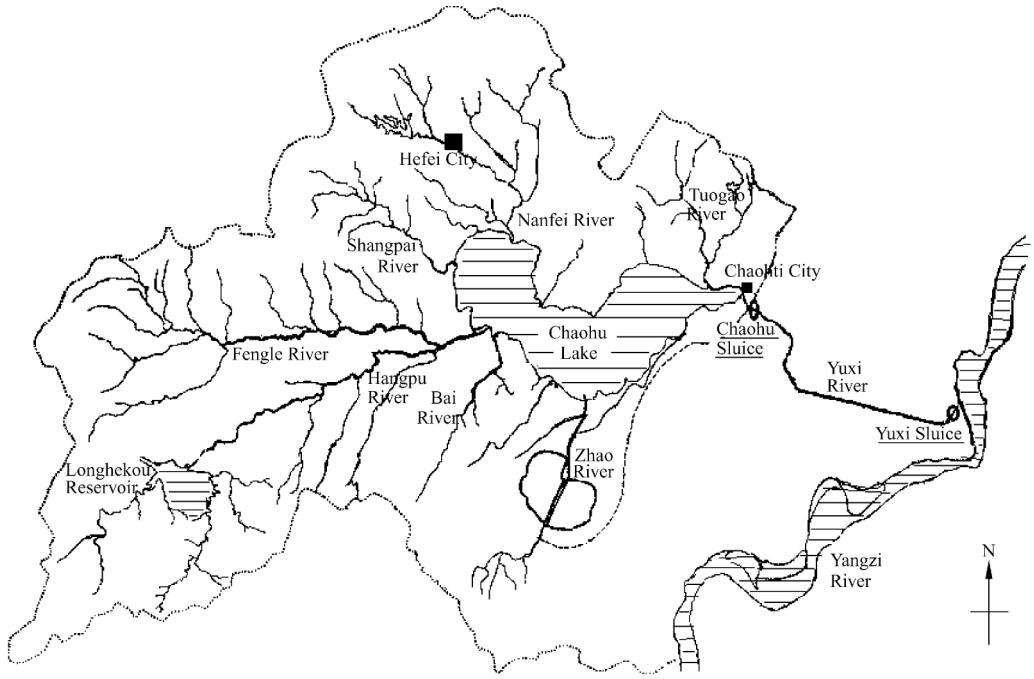


Fig. 1 Map of the Chaohu Lake Basin

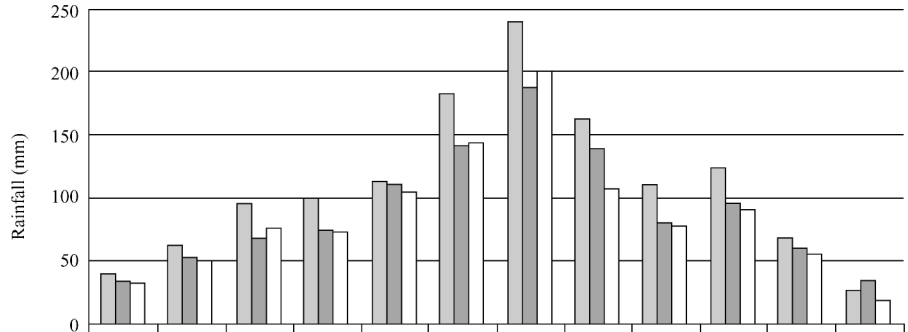
In order to control the flood and drought in the lake basin, the Chaohu Sluice and the Yuxi Sluice were built in respectively 1952 and 1968, which made the Chaohu Lake change from a natural (inflow and outflow) lake into a man-controlled and half-sealed lake (Xiang Lei, 1997). The normal retained water level is 8.0 m and the water surface area will then be 780 km^2. If the water level above 10 m, the flood control methods will be practised (Table 1). When the dry season, the Chaohu Sluice will be open for irrigating the downstream fields.

Table 1 The relationships of water level, surface area and volume of the chaohu lake

Water level (m) *	6.0	7.0	8.0	9.0	10.0	11.0	12.0
Surface area (km^2)	560	703	755	770	774	776	778
Volume (10^6 m^3)	350	986	1,717	2,482	3,253	4,029	4,807

* Above the sea level

The climate in this area belongs to sub-tropical monsoon climates. The yearly average temperature is 15℃—16℃. The average temperatures in January and July are respectively 2℃ and 29℃. The frost-free period lasts 224 days to 252 days. The yearly average rainfall is 1,120 mm, the largest yearly average rainfall is 1,740 mm in 1991, about 3 times that of the smallest one which is 582 mm in 1978. The yearly rainfall distribution is uneven (See Fig.2): the rainfall from May to August is accounting for 54% of the total rainfall.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Longhekou	39.06	62.16	95	99.96	112.65	183.71	240.2	162.79	110.89	124.3	67.39	26.19
Hefei	32.77	51.85	68.24	73.67	111.26	141.46	188.35	138.88	79.19	94.84	59.19	35.09
Chaohu	32.31	50.36	75.79	73.06	104.49	143.62	201.12	107.02	77.09	91.04	54.49	17.98

Fig. 2 The yearly rainfall distribution

The Chaohu Lake basin is an abundance place and more like a brilliant pearl in Anhui province. The cultivated land is 448,000 ha that covers 50% of the total lake basin. The main crops are rice, corn, wheat, cotton and soybean. In 2000, the GNP of Chaohu Lake basin was 30.8 billion Yuan (3.8 billion US$) and the total crop yield was 2.5 million ton that account for 12% of the Anhui province (Anhui Statistic Bureau, 1997). The GNP per capita is 3,034 Yuan, which is higher than the average level of 2,521 Yuan per capita of the whole Anhui province.

2 Soil Erosion and sediment delivery

Sediment is the most visible pollutant originating from non-point sources. Sediment — especially its fine fraction — is primary pollutant carrier such as organic components, metals, ammonium ions, nitrogen, phosphates and other toxic materials. Soil erosion, transportation and deposition of sediment are natural processes that have been enhanced by human activities. According to the landforms, the Chaohu Lake basin can be divided into a up-hill area, a low-hill area, a hill-alluvial area and an alluvial area from west to east. The capping rocks all lay around the hill and low-hill area. The main surface rocks are quartz schistose, gneiss, sand rock, mixed granite rock, limestone, dolomite and shale. The soils in the basin are mainly clay, sub-clay and sub-sand. The contents of heavy metals is high in the basin soil. It's the background of erosion and sedimentation.

On the other hand, human activities enhanced soil erosion in recently decades. There have been two severe deforestations in the upper stream hill area from 1950s to 1970s, which was caused by the increasing need to create more agricultural land and the need of timber and fuel wood. Decrease of forest

resources and subsequent unreasonable land utilization caused severe “human-induced” erosion. Current erosion is taking place mostly in the forms of sheet and rill erosion in the Chaohu Lake basin, especially in the upper stream hill and low-hill area. For example, in order to built the Longhekou Reservoir (upstream, see Fig.1), which inundated 4,500 ha farmland and 44,000 local residents migrated, they cut forest and reclaimed about 14,000 ha (0.03 ha/person) land on the hill. The forest coverage decreased quickly from 60% to 27.8% and 2,500,000 ton/year of soil eroded away.

By the application of the Universal Soil Loss Equation (USLE) (Morgan, 1995) (A = R.K.LS.C.P) and satellite MSS image, the erosion load was calculated: 16 million ton—22 million ton of soil eroded away per year (Table 2). Most of these eroded sediment were delivered by water into rivers, ponds, and the Chaohu Lake. The soil material on average contains data as 2.68% of organic, 1.35% of nitrogen, 0.11% of phosphorus and 1.84% of potassium. This corresponds with 436,223 ton/year organic, 219,739 ton/year nitrogen, 17,579 ton/year phosphorus and 299,496 ton/year potassium lost into watercourses.

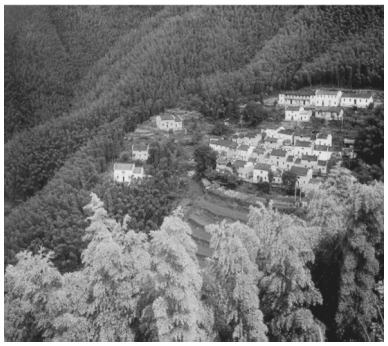
Table 2 Nutrient Lost by Erosion in the Chaohu Lake Basin

Class	Intensive erosion	Medium erosion	Light erosion	No distinct erosion	Total
Area(km^2)	796.136	1,437.062	2,623.962	4,272.84	9,130
Percent(%)	8.72	15.74	28.74	46.8	100
Erosion modulus ($t/km^2 \cdot a$)	5,000—8,000	2,500—5,000	500—2,500	500	
Load (average)(t)	5,174,884	5,029,717	3,935,943	2,136,420	16,276,964
Load (max)	6,369,088	7,185,310	6,559,905	2,136,420	22,250,723
Organic(t)	138,687	134,796	105,483	57,256	436,223
N (t)	69,861	67,901	53,135	28,841	219,739
P (t)	5,589	5,432	4,251	2,307	17,579
K (t)	95,218	92,547	72,421	39,310	299,496

3 Soil and water conservation in chaohu lake

The goal of soil and water conservation practices is to keep erosion rates and subsequent soil and pollutant losses within acceptable limits. Because most of the erosion is produced at the upper stream in the Chaohu Lake basin, we must strengthen conservation projects in this area. According to the Chinese soil conservation experiences, the comprehensive erosion control in small watersheds (area < 20 km^2) are suitable methods, where different measures can systematically be implemented. Most of the small watersheds are described by both their geographical and erosion distinctions with villages at the boundaries. 16 small watersheds can be chosen for a comprehensive erosion control in the upstream.

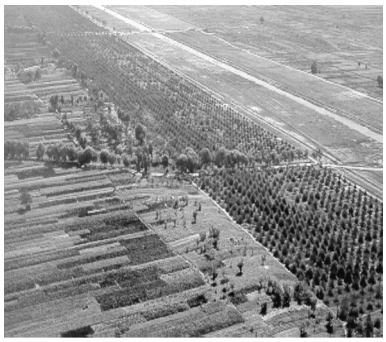
Cultivating on the steep slopes (>25º) must be stopped and decisively returned to forest on the upper side of the slope. On the middle section of the slope, contour farming or terracing can been practised. In the farmlands located at the foot of the hill, conservation cropping and tillage must be applied with proper plant cover and crop residue use. In order to prevent sediment passing over farmland, field borders and filter strips can be cultivated. Diversions or sediment basins (detention ponds) must be constructed to collect and store sediment, and down slope runoff in gullies or channels. In the critical areas with highly erodible or eroding areas, some vegetation such as trees, shrubs, vines, grasses or legumes can been planted (See Fig.3). Based on these conservation measures and good management, 33% of sediment can be controlled (Shi, 1997). According to the index in Table 2, there can be decreased sediment load 5,371,400 ton/year, which contains organic 143,953 ton/year, N 72,514 ton/year, P 5,800 ton/year, K 98,830 ton/year.



Forestation

Contour Farming

Conservation Cropping



Conservation Tillage

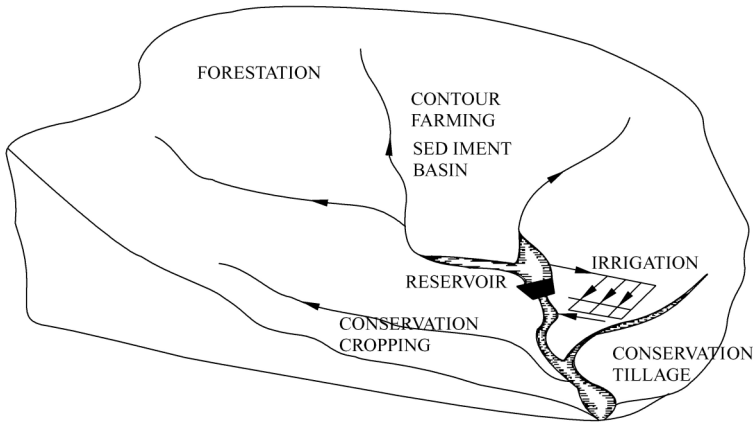


Fig. 3 Soil and water conservation in a small watershed

4 Conclusion

As one of five largest freshwater lakes in China, the Chaohu Lake is polluted by nitrogen and phosphorus and organic matter. The average entrance loading to the lake was 38,025 ton/year TN and 2,953 ton/year TP. 16 million ton— 22 million ton of soil eroded away per year. It is to say that the main source of nutrients (TN and TP) in the Chaohu Lake comes from agricultural activities. The origin of the non-point pollution from agricultural activities includes a large soil erosion and sediment delivered into the lake. In order to non-point pollution control from agriculture, many methods ought to be implemented. The government ought to organise soil conservation in small watersheds, the farmer need implement soil conservation planting methods and decreasing chemical fertiliser and pesticide use. The operation and

maintenance of irrigation and drainage system need be improved, for example increasing fund for repairing and rebuilt the aging and destroyed irrigation facilities, set up WUA to encourage the farmers' participation. For the application above control methods and new farming technologies, it is important that the farmer education and legislation. A clean and beautiful Chaohu should promote local, social and economical sustainable development, improving the environmental amendment.

Reference

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