

Evolution of Jiangnan Lakes and regional sustainable development *

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Abstract—Jiangnan Lakes lie in the middle reaches of the Yangtze River. The evolution of the lakes during Holocene can be divided into three periods. Since Ming Dynasty, owing to natural factors and human activity, the lakes have accelerated the shrinking process. This has resulted in a series of rural and urban environmental problems, such as the disasters of flooding, inundation, and waterlogging; declination of aquatic resources; increase of diseases; swamping of lake districts; and deterioration of urban environment (taking Wuhan City into consideration). In order to realize sustainable development in this area, several corresponding countermeasures should be taken.

Keywords: Jiangnan Lakes, evolution of lakes, environmental problems, regional sustainable development.

1 Introduction

Jiangnan Lakes lie in the middle reaches of the Yangtze River, approximately 39 thousand square kilometers in area. It is renowned as a “country of fish and rice” in China and an important base of agricultural and industrial production.

The lakes in this area are divided into five types: interfluvial depression lake, flood land lake, dammed lake, submerged lake, relict lake from the river. Based on the comprehensive characteristics, it is also divided into two patterns: flood land lake and interfluvial depression lake.

2 Evolution of Jiangnan Lakes

The present landscape of rivers and lakes in Jiangnan Plain are formed after a long term of evolution. From the analyses of core samples, pollen, archaeological studies, dating and historical document, the evolution of the lakes during Holocene can be divided into three periods:

Low water level period of the lakes from the late pleistocene to early Holocene(10000—7500a. B. P.). In the early Holocene, the temperature rose quickly and the precipitation increased. Although the lakes extended, the area was still small.

High water level period of the lakes during the Mid-Holocene(7500—3000a. B. P.). In this period, the climate was warm and humid, the forest was thick in Jiangnan Plain and nearby areas, the rivers contained little sediment and much suspended material, inundation often occurred, so many lakes evolved in the depression between rivers and on the edge of the plain. The rise of sea level also accelerated the enlargement of Jiangnan Lakes. About 3000a. B. P., Jiangnan Lakes went into its expanding peak.

Alternation stage of high and low water level in late Holocene(3000a. B. P.-present). While Jiangnan Lakes was affected by climate and sea level fluctuation, the dominant role of human activity became more and more apparent. After Song Dynasty, especially since Ming Dynasty, reclamation of land from the lakes has accelerated the shrinking process of the lakes, and given rise to a number of ecological problems(Fig.1). After a long time of reclamation, the levee breaches along the river closed one after another, the rivers and lakes separated. The separation promoted the reclamation and accelerated the extinction of Jiangnan Lakes.

3 Impacts on rural and urban environment

The evolution of the lakes results in a series of rural and urban environmental problems.

* Supported by the National Natural Science Foundation of China (Nos. 49541070 & 49070060)

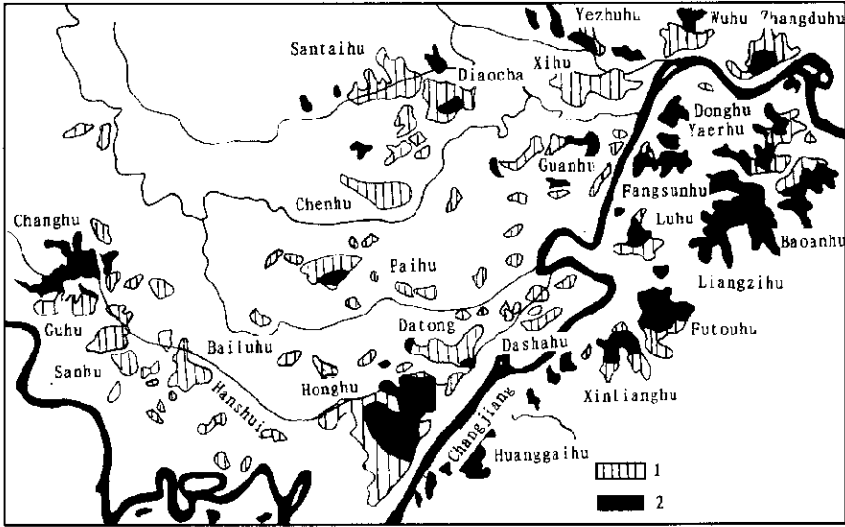


Fig.1 The reduction of Jiangnan Lakes (1. reclaimed area; 2. remaining area)

3.1 The aggravation of the disasters of flooding, inundation, and water-logging

The decrease of the lakes influences drainage directly. It not only diminishes the storage, but also changes the drainage standard, and makes the whole drainage system lose balance, which lead to unavoidable disasters. In history, the lake was always the inundation area. After dikes were built, the natural water system changed, but lakes still play a role in modulating water volume. For nearly half a century, the contradiction between man and land has become more and more outstanding. A large number of lakes were reclaimed. In the 1950's, Hubei Province had 1066 lakes, but only 309 lakes in the 1980's. In the 1950's, the lake area along the Yangtze River was 16000 km², but now only 6000 km².

The flooding disasters of Jiangnan-Dongting Plain are closely connected with the flood of Jingjiang River. The latter is now in a state of a suspended river, with its river bed higher than the ground. During the flood season, a heavy load of water and the drainage of water from the lake district north of Jingjiang River, is bound to cause the occurrence of inundation. Besides, there is always water-logging even after the subsidence of flood.

Recent researches show that the flooding in 1998 is due to many factors, such as sunspot activity cycle, the sudden alternation between El Nino and La Nina. But the damage of eco-environment, such as shrinking of lakes, also contributes to the disaster greatly.

3.2 Decline of the aquatic resources

For example, the number of fish species in the lake assemblage of Jiangnan Plain reduced from more than 100 species in the early 1950s to 77 species in the early 1980s.

3.3 On account of the increase area of the sand bars in the lakes and the increase of infested area of the snail oncomelania, patients increase in number noticeably.

3.4 Swamping of the lakes was aggravated

At present, there are approximately 267 km² of lakes in the process of swamping(e.g., the Honghu Lake). When the swamped land is taken into consideration, the area is over 1333 km².

3.5 The deterioration of urban environment

Wuhan, situated in the center of China, is the capital of Hubei Province, with an area of 8467 km² and a population of 7.18 million. The Yangtze River, the third greatest river in the world,

and its biggest branch, Hanshui River join together at Wuhan, naturally dividing Wuhan into three towns: Hankou, Hanyang, and Wuchang. Located in the heart of China in geography, Wuhan is an important hub of railway, waterway, highway, aviation, postal service, and telecommunication in China. Wuhan has always been renowned for "a thoroughfare for nine provinces", with equidistance from Beijing in north, Shanghai in east, Guangzhou in south, and Xi'an in west by 1200 km². But with the development of human activity, the lake environment has changed greatly. This has obstructed the urban environment and the city's sustainable development.

Deforestation has led to soil and water erosion, siltation of river and lake, and reduction of the lakes. In Wuhan heavy rain mainly concentrates in summer. Once the vegetation is damaged, the soil and water erosion will be accelerated. For example, the forest was ever cut down on a large scale in 1958, 1968 and 1978. Now the rate of forest coverage is only 10.2%. This directly causes silt deposit and the shrinking of the lakes of Wuhan.

Filling the low lands has led to the change in geomorphology and reduced the ability of wetlands to purify the urban environment. With the population increase and economic development, the residents have to resort to low wetlands. They fill the low lands to increase fields. This changes the wetland environment and urban environment.

Reclamation of lakes has led to the reduction in their flood-storage capacity, Wuhan ever had a reputation of "the city of hundreds of lakes". According to statistics in the early 1950's, the lake area was 490 km², but owing to natural siltation and human activity, only 122.26 km² in the 1980's (Table 1). This trend is still accelerating. In 1996, survey departments did some comparison analyses of the five lakes in urban Hankou. From 1980 to 1995, 0.37 km² of lakes disappeared at the average rate of 44.06%. Donghu Lake decreased by 1094 km², equal to the area of 12 Xihu(in Hankou). In addition, the lakes has become shallower and shallower. It is estimated that the depth of the lakes at present is 1/3—1/2 less than the original. The decrease in the area and depth of the lakes reduces the storage ability. According to the statistics in 1995, the storage modulation ability of the lakes in Wuhan was only 30% of that 40 years ago. For instance, the Houhu Lake system could store over 7.0×10^7 m³ when the area was over 20 km², but unfortunately, the area is less than 2 km² now, then how much water can it store?

Table 1 The change of the area of some lakes in urban Wuhan

Name of lake	Original (1980) area, m ²	Present (1995) area, m ²	Amount of reduction, m ²	Rate of reduction, %
Huanzi Lake	180005	98185	81820	45.45
Jiqidangzi Lake	165375	116413	48962	29.55
Beihu Lake	173129	103585	69544	40.16
Xihu Lake	90558	56036	34522	38.12
Houxiang River	197077	65263	131814	66.88
Lingjiao Lake	176756(1988)	112426(1997)	64330	36.39
Donghu Lake	31749987(1976)	31020951	729036	2.29
Total	32732787	31572859	1159928	3.54

On the whole, shrinking of the lakes increased the danger of city flooding. As a matter of fact, the total water amount in 1998 was not more than that of 1954, but the water level was far above. In turn, frequent floodings bring much silt into lakes, the lake area becomes less.

The shrinking of the lakes diminishes the ability of lakes to modulate regional climate: strengthening the "heat island" effect. Wuhan has obvious "heat island" effect, but in water bodies, such as Yangtze River, Shahu Lake, Donghu Lake and Moshan Lake etc., the temperature is relatively low. To some degree, it weakens the effect of heat island. Therefore, with the shrinking of lakes, the effect is then reinforced.

4 Countermeasures

Forbid reclamation of land from the lakes, and reconvert part of the “yuantian” field into lakes in order to prevent flooding and water-logging through expanding water storage capacity of the lakes.

Coordinate the relationship between lake and river.

Evaluate various models of exploitation of wetland and agriculture. In the Jianghan Plain, there have been the models of Xinxing Yuan-with fish as the main product, the comprehensive agriculture model of Diaochahu Lake, the Honghu Lake enclosure fishery model, and so on. Their experiences are worthy of evaluation, promotion, and extension.

For sustainable development, priority should be given to urban water resources and water environment protection and harnessing. In the “9th Five-Year Plan for Developing Wuhan’s National Economy and Society and the Program for Long-Term Objectives by the Year 2010”, the strategic frame work for the sustainable development of the city is put forward; conscientiously implementing the basic natural policy of environmental protection, carrying on the strategy of sustainable development, implementing China’s Agenda 21, reinforcing the protection and comprehensive improvement of the environment, pursuing cleaner production, making great efforts to create a good ecological cycle, and building a garden city with historical and cultural characteristics. Some lake protection measures are also raised:

Establish laws and regulations for preventing the lakes from siltation. “The mountain and lake protection regulation of Wuhan City” is in the process of being improved.

Forbid reclamation from lakes, building factories by filling in the lakes, and dumping the wastes into lakes, in order to stop the shrinking of lake area and to maintain the storage ability.

Harness the lakes in urban districts, e. g. plant trees and grasses; forbid cutting down trees along the lakes; control or diminish the silt deposit so as to prolong the life of lakes.

Reinforce the research on eco-environment of the lakes.

In “Master Plan of Wuhan City 1996—2020”, 27 lakes in urban area will be protected as relics. Among them, Donghu and other 11 lakes are protected as the first-level lakes, and the water area is 1050 hm². For all these protected lakes, “thrice-line” management will be carried out:

Blue line-water body protection line or water surface margin: inside this line, rigid prohibition from occupation.

Green line-margin of land around lakes or greening line to protect lakes: principally not for development.

Grey line-control line of construction density and height: only usable under permission of the planning department of city.

Acknowledgement— The authors gratefully acknowledge the help of Professor Liu Jiankang in the preparation of this paper.

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