

## The Countermeasure Research of Sustainable Development in the Fuxian Lake Basin

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**Abstract:** The sustainable development of the Fuxian Lake Basin aims to maintain the sound and sustainable development of mountains, rivers, forests, croplands, lakes, and grasses in the basin and to coordinate the relationship of society, economy, environment, production, life, and ecological water utilization so that social economy in the basin can adapt to the carrying capacity of water resource environment to determine needs and development with rivers. Development is conducting in protection while protection is implementing in development, so as to strongly develop the circular economy. On the basis of the water environmental transition in the Fuxian Lake, this thesis analyzed the developmental status and existing problems of the Fuxian Lake Basin and put forward countermeasures from four aspects including ecological development, economic development, social development, and scientific development, hoping to provide theoretical support and practical experience of the sustainable development research for plateau lakes.

The Fuxian Lake is situated in Yuxi City, Yunnan Province. It is the deep-water freshwater lake with the greatest water storage and also the only high-quality freshwater lake of China. The Fuxian Lake steps over Chengjiang, Jiangchuan, and Huaning, situated in the central part of five lakes(the Fuxian Lake, the Xingyun Lake, the Qilu Lake, Yangzong Lake, and Dianchi)(Figure 1). The basin has the strong environmental sensitivity. Once it is polluted, it is hard for governance or it is even irreversible. To sufficiently develop the ecological benefits, economic benefits, and social benefits of land-water resources and other natural resources, by regarding the basin as the research object, this thesis was based on the long-term planning, sufficiently developed various functions in the basin, and adapted to the natural economic law to capacity, trying to realize the maximum comprehensive benefits in the basin.



Figure 1 the Geographical Position of the Fuxian Lake Basin

## 1. The sustainable development connotation of the Fuxian Lake Basin

The sustainable development connotation starts from the utilitarian goals of economic growth, social progress, and ecological safety and also begins with the rational goals of human civilization progress, so as to cover the full factors of “population, resources, environment, society, and economy”. The realization of the sustainable development goals in the Fuxian Lake cannot just realize the single goal of growth, equality, and ecological protection or the simple adding of multiple goals, instead it is necessary to value the interaction between multiple goals. On the relational treatment between man and nature, it is essential to remain harmonious development of society, economy, and ecology under the sustainable conditions of the ecosystem. On the relational treatment between people, it emphasizes the fair development between people, including intra-generation fair development and inter-generation fair development, so as to maintain the long-term benefits of human beings. The sustainable development of the Fuxian Lake Basin has the special connotation.

Firstly, sustainable utilization of water resources is used as the premise. As the water resources of the plateau lake basin, according to the space-time difference and mobility of water resources, within the allowable range of water environment capacity, the reasonable development and utilization mode can be used to sustainably and effectively improve the support degree of water ecology on various human production activities.

The second one is to stand out the harmonious development. On the one hand, the relationship between departments and regions in the basin must be coordinated. Also, it is essential to reasonably adjust the life and production structure in the basin. On the other hand, it requires to maintain the balance between the environment and development and maintain the balance between efficiency and fairness. Harmonious development even emphasizes internal efficiency and quality concept while focusing on the development. It also emphasizes on reasonably optimizing and regulating the wealth sources, wealth accumulation, wealth distribution, and wealth behavioral norms as satisfying people’s needs.

The third one focuses on the principle of fairness. Allocation and utilization of water resources must give priority to guarantee basic survival needs of human beings. It must leave the water quality less than the minimum safety standard for offspring. Hence, in the sustainable development practice of the basin, it must coordinate the relationship between the upstream and downstream, realize fair, reasonable and common development, also consider the poor lake mobility, long-term water exchange period (Table 1), and irreversibility of pollution control, and notice stability and quality of water quality in the lake.

**Table 1 Comparison of Water Exchange Periods in Several Lakes**

Lake name	The Poyang Lake	The Dongting Lake	The Taihu Lake	The Hongze Lake	The Fuxian Lake
Water	20 days	20 days	427 days	35 days	167 years

The material source: Materials of top 4 lakes come from the Comprehensive Development Strategic Research of the Poyang Lake, Huang Xinjian, Jiangxi People’s Publishing House, 2007.

## **2. The developmental status and existing problems of the Fuxian Lake Basin**

### **(1) Fragile ecological environment of the lake and the poor self-anti-pollution capacity**

The Fuxian Lake's altitude is 1722.5m and water storage is 20.62 billion m<sup>3</sup>, amount to the water storage of 12 Dianchi lakes, 6 Erhai lakes, and 4.5 Taihu lakes, accounting for 9.16% of the total water storage in the national freshwater lakes, 72.8% of total water storage in nine plateau lakes in Yunnan, and over 90% of key category I lakes. With the abundant water resources, it is the important strategic water resource in China. The Fuxian Lake is equipped with the comprehensive functions of flood control, irrigation, industrial water, fishery, domestic water, and tourism. The ecological value is extremely high. However, the Fuxian Lake Basin has the relatively small area, resulting in the extremely limited runoff from rainfall. The lake is encircled by mountains, showing the semi-closed state. No water passes through the territory in the basin. The lake evaporation is extremely higher than the lake rainfall. The above-mentioned causes result in the poor mobility and anti-pollution capacity in the Fuxian Lake. Particularly, compared with the open lake in the east, its anti-pollution capacity is even worse. The Fuxian Lake cannot implement water quality optimization and improvement, thus it must be regulated through the external human factors.

### **(2) Year-by-year increase of nitrogen and phosphorus pollution and prominent contradiction between the social economic development and ecological environmental protection<sup>1</sup>**

With the constant economic development, the total GDP in counties along the Fuxian Lake was stably rising. It was increased to 20.032 billion RMB in 2018 from 6.20168 billion RMB in 2008. The proportion of the tertiary industry was gradually rising. It was increased to 49% in 2018 from 42% in 2009. The proportion of the secondary industry basically maintained unstable. The proportion of the primary industry was obviously reduced. It was reduced to 17% in 2018 from 26% in 2009. The county-territory population along the lake reached 656900 in 2008 and reached 691700 in 2018, showing the slow population growth, which was less than the economic growth. GDP per capita basically maintained 10% of the growth rate in recent four years.

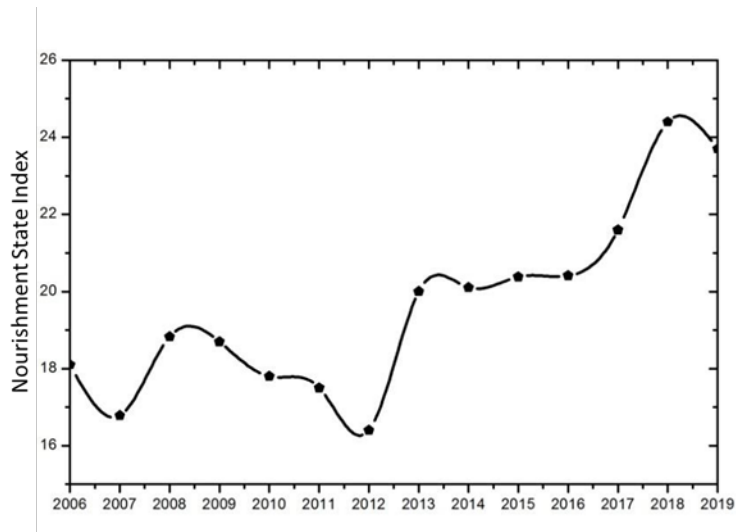
Primary pollution sources in the Fuxian Lake Basin include domestic sewage of residents in the basin, non-point source pollution of farmlands in the basin, as well as pollution and industrial point source pollution from livestock breeding in the basin. The non-point source pollution of agriculture and rural areas is disperse, hidden, and difficult to be cured. Moreover, due to existing traditional development of agriculture, mineral, electricity, and building materials and excessive dependency on natural resource input, it is hard to maintain the pattern of the large-scale resource development and sustainable expansion of the investment scale with the intensification of resource constraint, decrease of marginal efficiency of investment, and extensive mode of economic growth. The power of high economic growth is severely insufficient. At the same time, the traditional mode has more investments but fewer outputs and lower economic efficiency, resulting in excessive resource waste and relatively severe destruction of the ecological environment. Furthermore, more than 8 million visitors go to the Fuxian Lake scenic area every year and it is gradually increasing at the speed of 1 million person time every year. The control strength in the basin space is still insufficient to form the relatively high environmental pressure on the Fuxian Lake.

According to the historical data of water quality, since 2006, water quality of the Fuxian Lake has been relatively stable, remaining category I as a whole. The comprehensive nourishment state index was less than 30, belonging to the oligotrophic lake. However, according to the water quality change trend analysis of the Fuxian Lake, the project group found that the comprehensive

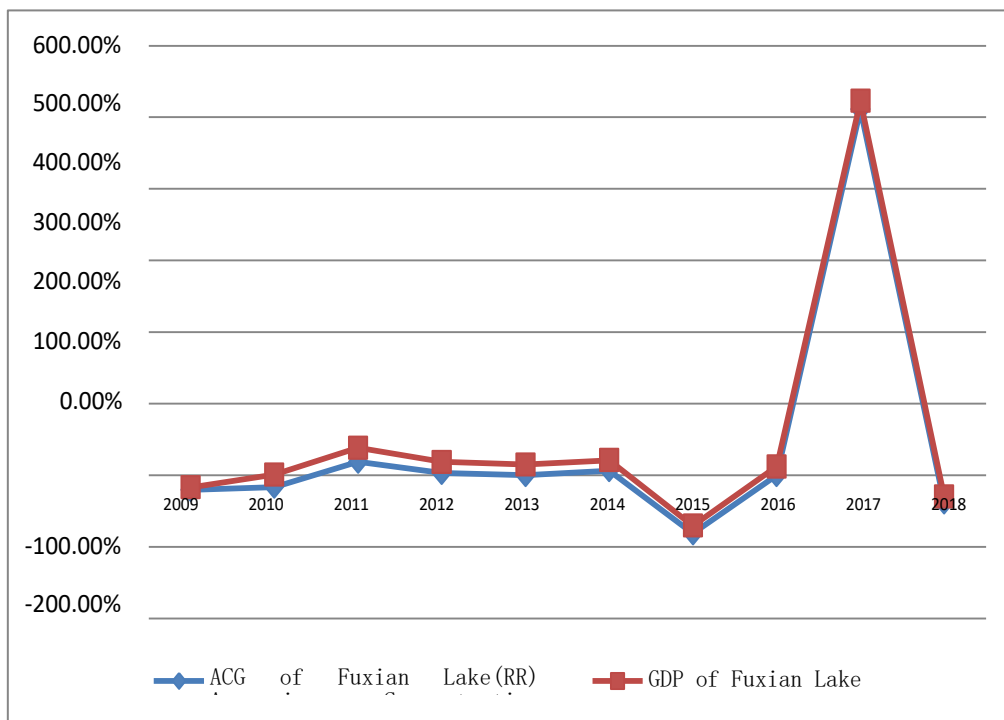
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<sup>1</sup> Data in this part apply the statistical yearbook data of Yunnan Province in 2019.

nourishment state index of the Fuxian Lake in 2006 only reached 18.1 and it has been rising in recent years. It was increased to 23.7 in 2019(Figure 2). The water COD, ammonia nitrogen, total phosphorus, total nitrogen, and algae index of the Fuxian Lake closed to the critical value of category I water quality index in individual months and areas, showing that the nitrogen-phosphorus pollution is increasing year by year. The potential risk pollutant is the permanganate index and total phosphorus. The overall concentration index is showing the rising trend slowly; GDP growth and water pollutant growth basically remain the consistent trend. The GDP growth is present in the positive proportional relation with the environmental change (Figure 3). The most direct result of GDP growth is the aggravated pollution of the lake.



**Figure 2 the Comprehensive Nourishment State Variation Diagram in the Fuxian Lake**



**Figure 3 the Ammonia Concentration Growth Rate of the Fuxian Lake and GDP Growth Rate of the Fuxian Lake in 2009-2019**

It is worth noting that in recent years, the local water areas like South Crucian Estuary, West Volcanoland, Boxi Bay, East Haozhijing, and North Littoral are affected by the dense villages and tourist development. Water quality of the Fuxian Lake shows the response characteristics of oligotrophy to nutrient lake transition. The risk of water ecological environment degradation is increasing year by year.

### **(3) Urban development and lagging social career**

To realize sustainable development, the basin should reduce ecological needs under the certain or the increased precondition of ecological supply. Therefore, positively developing ecological ecology, circular economy, and green industry is the only road for the basin development. However, the development of ecological economy, circular economy, and green industry requires the support of capital, technology, information, talent and knowledge and needs the urban development level, social undertaking, and the tertiary industry in the basin to support the economic structural adjustment and industrial transformation. However, at present, the quality of human capital in the basin is lower, bringing the limited foreign capital. Also, the social development degree is lower. Particularly, the urbanization level is still lower. Even if the rising speed of the tertiary industry is fast, the total value is lower. The urbanization level and the lagging tertiary industry severely restrain the industrial transformation of the basin and the sustainable economic development. In this way, strengths of natural resources cannot be fully developed. The industrial and agricultural development only can stay at the primary processing stage.

### **(4) The diversified interest appeal and difficult basin management**

The basic management is the complicated system engineering with the basin as the spatial unit, involved in social economic development, resource development utilization, and pollution control in the basin, so as to propose higher requirements for the management level, management mode, and personnel quality enhancement of the basic management institutions. Beyond that, the basin has the wide territory span and it often gets involved in multiple areas and departments. Each administrative area and each administrative department will have their own requirements and interest appeal for the basin management for their own benefits. It is not good for the sustainable development of the basin.

## **3. The sustainable development countermeasures of the Fuxian Lake Basin**

### **(1) Ecological countermeasures of the sustainable development with the boundary of ecological safety**

Currently, the eutrophication trend of the Fuxian Lake is still severe. The nitrogen and phosphorus pollution problem is still prominent. The Fuxian Lake and the coastwise land have the fragile ecology while showing the poor water storage and land protection performance. The non-point source pollution of agriculture and rural areas is still severe. Hence, it is necessary to ensure water quality in the lake to reach a standard. Industrial wastewater should reach zero release. The water quality in the riverway must keep the allowable range. During the control process, it is necessary to positively transform non-point source pollution into the point source pollution for concentrated governance. Also, it is essential to reinforce water resource management and strictly control the total quantity of the Fuxian Lake, ensuring that the inlet water is more than the outlet water. Besides, it is essential to improve water resource supply capacity, value the balance between pollution speed and water absorption capacity, and ensure the basic balance between water supply and water runoff. Thirdly, it is essential to reinforce the wetland construction, implement the comprehensive control

of the basin, ensure that the comprehensive control capacity speed in the lake is higher than the water quality pollution speed, and forbid the situation that rapid pollution may result in difficult change in a short time. Fourthly, the ecological landscape belt of the riverway and lakeside should be constructed. Also, it is essential to balance the urban greenland layout, construct the regional ecological system network, reasonably plan, develop, and use land resources, repair ecological environment of the Fuxian Lake, and ensure the environmental safety of the water source.

## **(2) The green ecological development countermeasures in the ecological threshold**

A. To sustainably promote the industrial transformation upgrading, lengthen the industrial chain, promote the traditional industry to develop towards scale, intensification and high end, strengthen the green industry scale, gradually realize the plant intensification, harmless raw materials, clean production, waste resource, and low-carbon energy, and construct the high-efficient, low-carbon and circular green system.

B. To positively optimize the industrial structure, reasonably arrange the green ecological industry of the Fuxian Lake Basin, enlarge the agricultural fallow crop rotation strength in the runoff area of the Fuxian Lake, expand the economic crop plantation of nursery stock and lotus with low emission and high output, expand the ecological plantation mode, advocate organic agriculture, strongly develop the ecological agriculture and modern special ecological plateau sightseeing agriculture, and develop the ecological tourist industry and health industry.

C. To positively strive for the special capital support of central finance, increase the local financial input year by year, set up the ecological control fund of the basin, promote the green recovery and repair of the water loss and erosion in the basin, positively implement farmland returning to woodland (or grassland), and provide the eco-migration compensation and wetland protective subsidy.

## **(3) Put people first and comprehensively develop social development countermeasures**

A. To continue promoting poverty alleviation, focus on the industrial development, carry out the industrial support policy through professional cooperatives and industrial leaders, guide the masses to develop pig cultivation, fruit and vegetable farming, implement the accurate industry poverty alleviation for poor households, and help poor households to increase incomes and become rich.

B. According to the principle of “subtraction along the lake and addition along cities”, promote eco-migration, strictly control the number of population in the basin, constantly increase population quality, and reasonably adjust the population structure.

C. Increase environmental awareness of residents, positively guide green consumption, advocate unpolluted consumption or contribute to the green products for people’s health; during the consumption process, value rubbish treatment and do not cause environmental pollution; guide consumers to change the consumption concept, value environmental protection, save resources and energy, and change unsuitable consumption mode for the environment.

## **(4) The scientific management countermeasures with multi-directional and multi-mean management**

It is necessary to reinforce the environmental administrative law making, increase the

environmental administrative law-making efficiency, establish and improve the official and high-efficient management institutions of the Fuxian Lake, realize uniform management of the runoff area, carry out the wisdom construction of the Fuxian Lake, realize the real-time monitoring of the riverway, implement ecological early warning mechanism for ecological evolution, conduct key monitoring and intervention for areas with early warning for pollution, establish the responsibility of management goals, establish and improve the environmental protective responsibility, improve the supervision management right, construct and improve individual environment rights, increase the environmental protective awareness and right safeguard awareness of citizens, and construct the environmental non-profit litigation and agricultural ecological compensation mechanism.

## References

- [1] Yuxi Fuxian Lake administration. Records of Fuxian Lake Protection [M]. Yunnan People's publishing house, 2016
- [2] Yuxi Municipal Bureau of statistics, Yuxi investigation team of National Bureau of statistics. Yuxi Statistical Yearbook [M]. 2017
- [3] Fanny and Li Jie. Material balance calculation of nitrogen and phosphorus pollution load in Fuxian Lake [J]. Environmental science guide. 2016:6:44-47
- [4] Yu Hui, Niu Yuan, Jiang Xia, analysis of ecological environment problems of Fuxian Lake and countermeasures [R], Institute of lake environment, Chinese Academy of Environmental Sciences, April 10, 2019
- [5] Study on the change trend of ecological environment in Fuxian Lake [R]. Chinese Academy of Environmental Sciences, January 20, 2019
- [6] Research group of Tsinghua University, strategic research on green economy and ecological civilization construction in Fuxian Lake Basin [R], Tsinghua University, November 2014
- [7] Chen Zijuan, Shi Benzhi. Study on quasi market model of watershed ecological compensation based on water environmental carrying capacity [J]. Qinghai Social Sciences, 2016 (9)
- [8] Wang Jianping. Protection of Fuxian Lake: practice, problems and countermeasures [J]. Journal of Yunnan provincial Party School of CPC, 2019, 20 (2): 128-132
- [9] gov.cn Xi Jinping's speech at the Eighth National Conference on ecological environment protection [EB/OL]. Chinese government network, 2018-05-19
- [10] Wang Dongliang. Analysis of environmental capacity of tourism destination based on ecological carrying capacity system model [J]. Environmental science and management, 2019 (4): 170-174
- [11] Zhang Zhaowen. The complexity, arduousness and long-term nature of the management of nine plateau lakes in Yunnan [J], 2012, 31(1): 19-20
- [12] Liu Juan. Study on Ecological Environment Control Countermeasures of Yangzong town in Chengjiang County [J]. Yunnan Environmental Science, 2006, 25 (1): 18-20
- [13] Zhong Maochu. The relationship between the meaning and misunderstanding of "sustainable development" and ecological civilization [J]. Academic monthly. 2008.7:5-14
- [14] Wang Ye, Zhang Huifang. Intergenerational resource management for sustainable development [J]. Economic issues. 2005.6:21-24
- [15] Liu Limei, LV Jun. the connotation of ecological security and its research significance [J]. Journal of Inner Mongolia Normal University (PHILOSOPHY AND SOCIAL SCIENCES EDITION). 2007.5:37

- [16] Zhou Qing, Guo Honglong, Tian Weigang. Ecological risk analysis and Management Countermeasures of tourism development in Fuxian Lake Basin [J]. Environmental science guide, 2016, 35, p160-163
- [17] Yan Jin Ming, Di Li Sha ti. Ya Ku Fu, Xia Fang Zhou. Connotation definition and threshold measurement of provincial land development intensity in narrow sense based on collaborative development [J]. Journal of agricultural engineering, 2019 (02) 255-262
- [18] Zhang Xiaozhong. On the construction of management function of ecological government [J]. Journal of Nanjing University of technology, 2010 (3): 16-19
- [19] Yunnan Provincial Bureau of Statistics <http://stats.yn.gov.cn/>
- [20] People's Government of Chengjiang County <http://www.yncj.gov.cn/>