

## *Original Paper*

# Study on Ecological Environment Control in the Three Gorges Reservoir Area—A Case Study of Water Level Zone Control

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### ***Abstract***

*On ecological environment governance, the General Secretary has repeatedly put forward the ecological concept of "green mountain is gold mountain and silver mountain". After the completion of the Three Gorges Dam and the storage of the reservoir, a water-level zone with a drop of up to 30m has been formed. This paper discusses a series of problems in the treatment of water-level zone, such as the slow progress of the work, the existence of secondary pollution and the lack of relevant support, and puts forward measures to strengthen management, environmental monitoring and vegetation restoration in view of the existing problems.*

### ***Keywords***

*Water-level zone, Ecological governance, Three gorges reservoir area*

## **1. Research background**

The Three Gorges Reservoir area has the world's largest hydropower project, namely the Yangtze Three Gorges Project, also known as the Three Gorges Project. The construction of the Three Gorges Project has brought great benefits to the reservoir area, such as flood control, shipping and power generation functions. However, the construction of the Three Gorges Project has also brought damage to the ecological environment in the surrounding areas, such as the water-level drop zone of 30m, resulting in a series of ecological and environmental problems. In the past, the ecological restoration of the water-level zone of the Three Gorges Reservoir paid more attention to the screening of flood-tolerant plants, soil erosion and non-point source pollution prevention, etc. Most of them ignored the natural changes of the water-level zone after the storage of the Three Gorges reservoir. In the face of unprecedented complexity and severe adversity, nature-based solutions are an important way to solve complex problems in the subsidence zone. The ecological environment governance is closely related to

our production and life, but most of the current research on environmental governance in China exists in urban environmental governance, and there are few studies on ecological environment governance in water-level zones. Research and exploration on ecological environment management in the Three Gorges Reservoir area can realize regional sustainable development.

## **2. Research Objectives and Methods**

### *2.1 Research Purpose*

Taking the typical water-level zone ecological environment management of the Three Gorges reservoir area as an example, it provides a feasible reference for the ecological environment management of the Three Gorges reservoir area.

### *2.2 Research Methods*

Case analysis: The case of ecological environment management in the Three Gorges Reservoir area was comprehensively analyzed.

Documentation method: According to the research content, by searching the electronic database of China Journal Network, the library of Chongqing Three Gorges University and monograph books, and taking the Three Gorges Project, ecological environment governance and water level zone as keywords, the existing research results at home and abroad were extensively collected and sorted out, analyzed and classified, so as to understand the research direction and hot spots of ecological environment governance at home and abroad and form the research basis.

Interview method: In the collection of materials for this paper, leaders of relevant county governments, water departments, ecological environment departments and other relevant departments along the Three Gorges Reservoir area were interviewed. They visited and investigated areas with soil erosion in the Three Gorges Reservoir area, and randomly interviewed some rural residents to understand their opinions and views on the ecological environment management in the Three Gorges Reservoir area. As the basis for the selection of governance suggestions in the later stage of the paper.

## **3. Formation of Subsidence Zone in the Three Gorges Reservoir Area**

The typical geological disasters in the Three Gorges Reservoir area are landslide and collapse, among which landslide is the most serious. After water storage in the Three Gorges Reservoir area, the water level of the Three Gorges Reservoir is in the slow ebb stage from March to April, the rapid ebb stage from May to June, the flood season from July to August, the storage stage from September to October, and the high water level of the reservoir is 175 m from November to February of the following year. Due to the change of reservoir water level, the effect of river water on bank slope reconstruction is strengthened, and the long-term soaking and wave impact on bank lead to the overall stability of bank slope rock mass decline, which aggravates the occurrence of landslide disaster in the Three Gorges reservoir area. It is found that the Badong Formation is widely developed in the Three Gorges reservoir area, mainly marl formation. The marl has widened the cracks in the bank slope and gradually

disintegrated the rock mass through the rise and fall of the reservoir water level, rainfall or long-term weathering, forming the bank slope with layered cataclastic rock structure. Karst weathering is the root cause of the existence of highly weathered mudstone. Marl has the dual characteristics of limestone and mudstone. The calcareous components in the limestone are dissolved by water flow, and mudstone is enriched by the weathered mud, the rock structure is loose, and cracks develop in the slope, which become a new channel for the dissolved liquid and intensify the weathering process of marl. At the same time, for a specific bank slope, the degree of karst weathering is different in different parts of the slope body. In general, karst development is not developed on the shoulder of the bank slope, while karst development is significant at the foot of the slope. According to statistics, about 4683 landslides have been verified in the Three Gorges Reservoir area, of which more than 2000 are typical marl water-related landslides, and thousands of landslides have not been controlled, among which more than 400 are major marl water-related landslides. Under the current water level operation, the reservoir water level has a long-term impact on this type of landslide disaster.

#### **4. Case Study: Ecological Management Practice of Water-level Zone in the Three Gorges Reservoir Area**

##### *4.1 Dense Zhongshan Fir Forest Builds a Green Barrier (Wanzhou District)*

In Wanzhou section of the Three Gorges Reservoir area, the subsidence zone is about 24 square kilometers, of which the area suitable for planting Zhongshan fir is 9375 mu. Since 2002, Wanzhou has introduced Zhongshan fir to carry out the ecological restoration project of the water-level zone, and gradually planted in the water-level zone of eight township streets, such as Xintian Town, Wuling Town, Dazhou Town, Gaobao Town, Baianba Street, etc. At present, the planting area of Zhongshan fir has reached more than 1,800 mu, forming a green ecological corridor of nearly 50 kilometers on the river bank. In 2016, a "Demonstration Forest for Ecological Restoration and judicial Protection in the Three Gorges Reservoir Area" was built in Dazhou Town, which is located on the bank of the Yangtze River, realizing the effective connection between ecological protection and judicial education in the Yangtze River. Every winter, the Zhongshan fir is the most colorful time, red, yellow, purple, green leaves with the blue river each other. Dazhou Town in the use of Zhongshan fir treatment of the water-fall zone at the same time, but also the use of this beautiful scenery to create a riverside 10-mile corridor, nearby farmer's home, camping barbecue, open-air chess room and so on.

##### *4.2 Four-level Three-dimensional Ecosystem to Build the Ecological Barrier of the Subsidence Zone (Kaizhou District)*

The area of the subsidence zone in Kaizhou District is 42.78 square kilometers, accounting for 13.9% of the area of Chongqing. Kaizhou District first built a water level control dam on Pengxi River, a tributary of the Yangtze River, to divide the subsidence zone into upper and lower parts. The upstream water level is regulated by the dam and remains relatively stable all the year round. The vast subsidence zone is covered by Hanfeng Lake, and only a small part of it is exposed to the water surface. The local

government also dotted the park and several 10 kilometers of walks around the lake in the area along the lake, the entire city is spread out by the lake, and the urban environment has been significantly improved. In view of Pengxi River area, where the water level of the downstream of the dam changes greatly, Kaizhou has built a three-dimensional ecosystem covering bird shelter forest, Linze, basement pond and beach ecological conservation projects. The management team screened out more than 10 kinds of watering-resistant woody plants, and put on a green coat of about 10 meters wide to the fall zone, so that it can play a comprehensive benefit such as bank protection, ecological buffering, landscape beautification, etc. After more than nine years of exploration, Kaizhou District has built ecological barriers in the originally fragile landfall zone, creating more hydrophilic leisure space for the people, and the biodiversity of the landfall zone is also recovering. Statistics show that compared with the pre-treatment, there are more than 40 species of plants and 21 species of birds. More than 20 species of herbaceous plants and 10 species of woody plants adapted to seasonal water level changes had good survival conditions.

#### *4.3 Wetland Ecological Buffer Zone and Soil Stabilization and Bank Protection (Zhong County)*

Zhongxian county, located in the middle reaches of the Three Gorges Reservoir area, has 88 kilometers of Yangtze River flow path and 28 rivers, with a long shoreline and a large area of subsidence zone. Since 2007, Zhongxian County government and Chengdu Institute of Mountain Science and Technology of the Chinese Academy of Sciences have jointly built the Three Gorges Reservoir Area (Zhongxian) Soil and Water Conservation Science and Technology Demonstration Park (Three Gorges Station of the Chinese Academy of Sciences), and signed a long-term scientific cooperation agreement on subsidence zone management. And coordinate the subsidence zone of 15 km from Shibao Town in Zhongxian County to Ruxi estuary for scientific research and demonstration. Based on the overall idea of retaining soil and improving vegetation habitat, and controlling the production of minimum secondary biological pollution, the research team successfully established a wetland ecological buffer zone to block and absorb pollutants around the reservoir, and screened out more than 10 suitable plants in the water level zone for vegetation restoration and reconstruction experiment demonstration, including willow, wild ancient grass, dog's root, flathead bullbena, fenestris, etc. The environmental adaptability and mechanism of some species were studied. At present, Shibao Town to Ruxikou water level zone governance has achieved initial results, demonstration area of more than 1000 mu, has formed a "sea", "willow shade", "lotus fragrance", "water and grass" and other beautiful landscape water level zone governance model. Not only the soil on the bank of the reservoir is protected, but also the vegetation in the subsidence zone beautifies the reservoir area and promotes the development of local ecological animal husbandry and fishery.

## **5. Problems in the Governance Process**

### *5.1 The Progress of Ecological Management in the Water-level Zone is Slow*

Although a number of water-level zones have achieved phased results, most of the results are more than

10 meters below the 175-meter water level, and there are nearly 20 meters of water-level zones that have not yet found effective methods. It is reported that there are inconsistent promotion and management models in the reservoir area, insufficient scientific support and other reasons, resulting in the slow progress of the work. Some of the tree species, such as bamboo and willow, used in the control of the water-level zone in the Three Gorges Reservoir area are exotic species. In order to reduce the damage to the local ecological environment, the planting area of exotic species is bound to be reduced. In addition, there is still a long way to go before suitable plants can be planted within 20 metres above the 145m water level.

### *5.2 Secondary Ecological Pollution in the Fluctuation Zone*

The water level zone control area often causes the second pollution, white garbage pollution and so on. The second pollution after the treatment of the fluctuation zone. As most of the water-level zones are located in natural ecological areas, the geographical location is relatively remote, and there is a lack of relevant supervision personnel, so there are often dirty garbage near the water-level zones, which is easy to bring damage to the newly restored water-level zones, and these garbage will pollute the nearby waters. In the field investigation of Wanzhou District Tuokou section of the water level zone control, it was found that many people in the picnic, camping and other activities, produced a lot of white garbage pollution, to the original fragile water level zone brought a threat again.

### *5.3 Lack of Support for Ecological Management of Water Level Zone*

An official said that on the one hand, the restriction of development and the emphasis on ecological environmental protection and construction, on the other hand, the lack of economic policies and external support, only relying on the reservoir area itself to "practice internal skills" for development, which has no successful precedent at home and abroad. The problem of fluctuation zone cannot be solved by one person alone. For example, although the forestry institute is responsible for screening tests of plants planted on the local landfall belt, the problem of some land landslides belongs to engineering control and is responsible for by the local Three Gorges Bureau, "not a department". It is necessary to form a whole and a system for the ecological management of the water level zone, and to increase the financial and policy support for the ecological environment management of the water level zone.

## **6. Countermeasures and Suggestions**

### *6.1 Strengthen the Treatment and Management of the Water Level Zone*

In view of various ecological environment problems in the Three Gorges Reservoir area, the form, scope, spatial distribution and ecological environment status of the water-level zones at different water storage points should be investigated. According to the natural geographical characteristics, ecological environment problems and the requirements of safe operation of the Three Gorges water conservancy project in different regions, the ecological environment protection and utilization planning of the water dissipation zone are formulated, and the functional zones are divided. It can be used as the guiding

basis for land use and ecological protection in the Three Gorges Reservoir area, and provide the basis for future research.

### 6.2 Establish a Monitoring System for the Ecological Environment of the Fluctuation Zone

The supervision of ecological environment management in reservoir area is still incomplete, and improving the ecological environment detection mechanism of water-level zone is conducive to ecological protection and vegetation restoration in reservoir area. At the same time, we should increase the capital investment of the ecological environment in the reservoir area, and make full use of computer network information technology to monitor the environment in the fluctuation zone. Relevant departments and research institutes jointly establish a first-class intelligent monitoring team, and establish a sound and efficient environmental management system and advanced technology system in the reservoir area. The intelligent monitoring system mainly includes the monitoring of resource change, habitat succession, environmental pollution, geological disasters, soil erosion, biodiversity damage, etc., and carries out real-time monitoring of the ecological environment status of the water-level zone.

### 6.3 Increase the Intensity of Vegetation Restoration in the Subsidence Zone of the Reservoir Area

According to the characteristics of instability and easy to be disturbed, vegetation restoration should be carried out in the Three Gorges reservoir area according to the development law of regional natural ecosystem. Selecting suitable plant species and planting them at different locations in the reservoir area according to the characteristics of different plant species is the premise of vegetation restoration in the water-level zone. Among them, plants and shrubs can stabilize the riverbank through developed roots to prevent the erosion and erosion of the water-level zone by water flow. Herbaceous plants can reduce the rate of surface runoff by increasing surface roughness, thereby increasing the capacity of buffer zones to deposit pollutants. In addition, native species should be prioritized to achieve the lowest level of ecosystem construction.

## References

- Chen, G., Li, X. L., Huang, J. et al. (2012). Characteristics of plant communities and their relationship with environmental factors in the fluctuation zone of Zigui Section of the Three Gorges Reservoir. *Acta Ecologica Sinica*, 42(2), 688-699.
- Chu, S. Y. (2022). Public participation in environmental governance: characteristics, mechanism and guidance. *Administrative Reform*, 2022(06), 66-76.
- Jia, B. J., Zhang, J. Y., Huang, Z. et al. (2023). Risks and countermeasures of water ecological environment in the Three Gorges Reservoir area. *China Water Resources*, 2023(17), 19-23.
- Li, A. Q., & Xi, J. (2019). Analysis on the path of rural ecological environment governance under the strategy of rural revitalization. *Journal of Intelligent Agriculture*, 4(01), 91-94.
- Li, C. (2022). Research on the development of China's rural ecological environment governance modernization policy. *Academic Exploration*, 2022(08), 45-51.

- Li, C., Tao, J., & Li, T. W. (2019). Comparison of domestic and foreign rural ecological environment governance based on CiteSpace. *Central South Agricultural Science and Technology*, 44(11), 234-241.
- Li, Q., & Tang, S. H. (2019). Research on dynamic mechanism of environmental governance in Yangtze River Delta: Environmental decentralization or environmental legislation. *Journal of Chongqing University (Social Sciences Edition)*, 29(05), 1-17.
- Liu, Y. S., & Jade Road. (2022). Changes of land use pattern and evolution of man-land system in the Three Gorges Reservoir area in recent 30 years. *Resources and Environment in the Yangtze Basin*, 31(08), 1664-1676.
- Rao, J., Duan, D. Q., Tang, Q. et al. (2023). Vegetation elevation gradient differentiation in the Three Gorges reservoir and its response to habitat stress. *Acta Ecologica Sinica*, 43(16), 6649-6660.
- Wang, S. T., & Yan, C. H. (2023). The modernization of rural environmental governance enabled by digital technology. *Modern Economic Research*, 2023(12), 126-132.
- Wang, S., Zhang, Q., & Wang, Z. F. et al. (2022). Ecological risk assessment and ecological zoning construction in the Three Gorges Reservoir area based on GIS. *Acta Ecologica Sinica*, 42(11), 4654-4664. <https://doi.org/10.5846/stxb202104080909>
- Xu, X G. (2023). Comprehensive ecological restoration and management analysis of a typical steep slope subsidence zone. *Yunnan Hydropower*, 39(11), 22-25.
- Zhang, X. Y., Zhou, Q. G., Fu, J. Y. et al. (2023). Study on spatial-temporal variation of land cover in the Three Gorges Reservoir area. *Environmental Science and Technology*, 46(S2), 50-57.