



# THE ADVANCE IN THE ECOLOGICAL REGULATION PRACTICE OF THREE GORGES RESERVOIR, CHINA

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## ABSTRACT

*Three Gorges Project (TGP) in the Yangtze river is the world's largest water control facility, which produces multiple benefits, such as flood control, hydroelectric power generation, navigation and water resources utilization. The operations of TGP have changed the original hydrological regime of the Yangtze River, which also caused the irreversible impacts on the river morphology, ecology and environment. How to appropriately coordinate the operations of TGP and the ecology and environment protection has become a new challenge for the river basin development and management. In this paper, the advance in the ecological regulation of TGP in recent years, such as promoting fish breeding, preventing intrusion of saltwater and alleviating the low water situation of the downstream Dongting and Poyang Lake, are summarized and analyzed. The ecological regulation practice of TGP has achieved obvious ecological benefits for the Yangtze River Basin. Finally, a systematic roadmap and key topics of research to optimize the regulation rules of TGP aiming for ecological and environmental protection are proposed.*

*Dam construction is the way to develop river water resource, which has the benefits of flood control, water supply, electricity generation, recreation and irrigation. Now there are more than 87,000 dams in China. The operation of dams plays an important role in China's rapid economic development in recent years. However, in the meantime, the dam construction changes the natural river ecosystem, which has caused negative impacts on ecology and environment. How to appropriately coordinate the operations of dams and the ecology and environment protection has become a new challenge for the river basin development and management. The Three Gorges Project (TGP) in the Yangtze river, China, which is the world's largest hydroelectric dam, has tried to explore the solution by ecological regulation.*

*In this paper, the advance in the ecological regulation of TGP in recent years, such as promoting fish breeding, preventing intrusion of saltwater and alleviating the low water situation of the downstream Dongting and Poyang Lake, is summarized and analyzed. Then a systematic roadmap and key topics of research to optimize the regulation rules of TGP aiming for ecological and environmental protection are proposed.*

## 1. THREE GORGES PROJECT

The Yangtze River is the third longest river in the world and has a watershed of  $1.8 \times 10^6$  km<sup>2</sup>. The Three Gorges Project (TGP), which is located near the city of Yichang in the middle reaches of the Yangtze River in central China, is one of the largest dams in the world. It has been a dream of the Chinese for a century. After more than 40 years' investigation and argument, and 17 years of construction, the dream has become a reality with the erection of the dam and the impoundment of water. The dam is 2335 m long and 185 m high. The total installed capacity of the Three Gorges Hydropower Station is 18,200 MW with an annual electricity output of 84.68 billion KW/h. The water level is currently regulated. It is reduced to 145 m in a wet season from May to September for flood control and is raised to 175 m in the other seasons for power generation and shipping.

The TGP has many tremendous advantages. The flood storage capacity of Three Gorges Dam Reservoir is 22.15 billion m<sup>3</sup>, and this capacity can reduce the frequency of major downstream flooding from once every ten years to once every 100 years. The TGP has a installed capacity for 22,500 megawatts and the annual power generation is 84.7 billion kilowatt hours, which greatly relieves the electricity pressure in middle and eastern China. Besides, the Three Gorges Dam reservoir goes as far as to the southwest metropolis Chongqing, therefore it improves 660 kilometers waterway, and largely enable 10000 – tonnage fleets to navigate between Shanghai and Chongqing.



Fig. 1 : Yangtze River basin and Three Gorges Project

## 2. THE ECOLOGICAL IMPACT OF THREE GORGES PROJECT

There are also some adverse effects on local and regional ecosystems and other environmental factors caused by the TGP.

First, it is reported that the physical habitat of the aquatic organisms, including many rare species and fish with economic value, has been changed since the filling of the reservoir. The reductions in species populations are attributed mainly to the loss of spawning areas caused by dam construction.

Second, the impoundment of TGR changed the hydrological variability in discharge and water level in the downstream-linked rivers and lakes. The downstream-linked two largest Chinese freshwater lakes, Lake Dongting and Lake Poyang, which are important wetland and migrant bird habitats, have shown a recession trend.

Third, the operation of the Three Gorges Project changed the distribution of the Yangtze River's inflow to the sea. The saltwater intrusion in the Yangtze River estuary during September to November has occurred earlier and more severely.

## 3. THE PRACTICE OF THE ECOLOGICAL REGULATION

Ecological regulation is a new concept concerning the effect of hydraulic projects on the river ecosystem health, a result of optimization and balance between the ecological environment and economic interests in a certain period. The concept of ecological regulation is of great importance in protection of river ecosystems. The ecological regulation is practiced in TGP to alleviate the adverse ecological effects.

In 2011, ecological regulation trials began with the TGP for breeding four aquacultured fish species (black carp, grass carp, silver carp, and bighead carp). During the breeding period of the four fish species from late May to mid-June, the water temperature in the river course downstream of the dams site was higher than 18 °C. In combination with requirements for emptying the storage capacity, and in accordance with the upstream water regime, 1–2 rising processes (lasting for about 10 days) were completed throughout the operation. A discharge of 11 000 m<sup>3</sup>/s in the Yichang Hydrometrical Station was used as its initial discharge; the discharge was increased by 8000 m<sup>3</sup>/s within six days, and finally increased to 19 000 m<sup>3</sup>/s, with an average daily rising amplitude of the water level of no less than 0.4 m. Monitoring results for an ecological operation test show that it promoted the breeding of the four aquacultured fish species, and increased the amount of eggs spawned during the operation period.

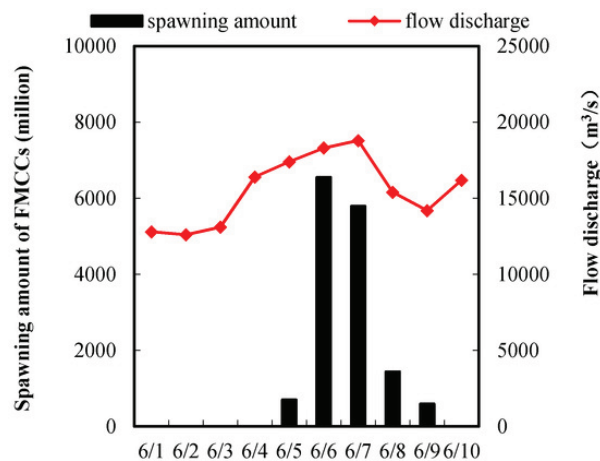


Fig. 2 : The response of four major Chinese carps spawning amount to water flow in 2014

From February 21 to March 3, 2014, the TGP was utilized to conduct a “desalinization” operation, and the daily average flow discharged from the Three Gorges Reservoir was increased from 6000 m<sup>3</sup>/s to 7000 m<sup>3</sup>/s, with a total added discharged flow of  $1.007 \times 10^9$  m<sup>3</sup>. To a certain extent, this operation mitigated the serious impact caused by salty tide intrusion upstream, and simultaneously relieved the water shortages in the middle and lower Yangtze River.

#### **4. THE SUGGESTIONS ON THE ECOLOGICAL REGULATION**

Considering the development of the ecological regulation of TGP and its long-term impact, the future work should be carried out according to the problem-oriented principle.

- (1) Analyze the problems. Comprehensively summarize the research results of the TGP on ecological and environmental issues, and analyze the existing problems. Analyze the problems and shortcomings, propose the specific objectives of ecological regulation.
- (2) Promote basic research. Lay out a comprehensive monitoring network for hydrology, water environment and aquatic ecology, and strengthen the forecast accuracy of hydrology, water environment and aquatic ecology.
- (3) Achieve technical breakthroughs. Using the latest scientific and technical knowledge to establish a variety of regulation models, and prioritize research on hot issues that attract the public’s attention .
- (4) Formulate a ecological regulation plan. Based on the results obtained from the above work, formulate a detailed and comprehensive ecological regulation test plan, and apply feasible and effective results to specific ecological regulation practices.
- (5) Repeated tests. Continuously carry out the test of ecological regulation, and verify the existing ecological plan. Gradually improve and optimize the ecological regulation according to the previous performance feedback..
- (6) Improve the ecological regulation plan. After 3-5 years’ mature practice, gradually integrate the ecological regulation into the daily work of integrated management of the Yangtze River Basin.

#### **5. CONCLUSION**

The ecological regulation of TGP, such as promoting fish breeding, preventing intrusion of saltwater and alleviating the low water situation of the downstream Dongting and Poyang Lake, has been practiced in recent years to alleviate the adverse ecological effects. Considering the development of the ecological regulation of TGP and its long-term impact, the future work should be carried out according to the problem-oriented principle.

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