

Impact of the Three Gorges Dam on Poyang Hu Lake

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ABSTRACT: Lakes are the crucial features of the global ecosystem, although they contribute a tiny segment of the ground surface. Due to environmental impact and global climate change, these surface water carrying systems face surviving challenges and become fragile. The Three Gorges Dam is one of the world's largest power generating dam situated in China. In this study, the effect of the Three Gorges Dam on the Yangtze River and Poyang Lake, the biggest freshwater lake in China, will be investigated. The influence of dam over the water discharge and water level of the Yangtze River and Poyang Lake will be determined. The impacts of these changes into those two hydrological entities will be examined, and the consequent environmental and societal effects will be discussed. The historical data will be analyzed to demonstrate the impact.

1. INTRODUCTION

1.1 Background of Study

The Three Gorges Dam (TGD) was constructed on the Yangtze River in a stretch characterized by three Gorges, namely, Xiling, Wu, and Quatang [1]. The Three Gorges Dam is nearly 200meters and 600km long, which creates reservoir storage of capacity 40billion cubic meters. Despite constructed mainly to control flood, the functionality of the dam is expanded to power generation, water transport, and water supply [2]. The Poyang Lake, also known as Lake Poyang-hu, is connected to the Yangtze River at the nearby location of the TGD. The study area of this research includes the TGD, Yangtze River, and Poyang Lake.

1.2 Problem Statement and Rationale of Research

The TGD possesses several detrimental environmental, economic, and social impacts [3], which lead to the submergence of nearby villages, displacement of people, and disruption of ecosystems [4]. The presence of this dam affected the hydrological regime of Lake Poyang, which has put a strain on the downstream end [5]. In the recent past, Yangtze Basin has experienced two severe droughts in 2006 and 2010 at Sichuan and Chongqing. It is assumed that TGD yielded climate changes that produced pressure zone, which affected the atmospheric flows causing the occurrence of the droughts [6]. Besides, as per geologists, due to the reservoir induced seismic activity created by TGD, two earthquakes of magnitude 4.3 and 4.7 on the Richter scale occurred at Zigui County in March 2014 [2]. To address the problems generated by TGD, it is essential to understand the magnitude of the adverse impact of TGD. This research will explore the historical data and collect present field data to accomplish the goal of assessing the effects of TGD.

1.3 Research Objectives

- (i). Estimate the fluctuation of the water discharge and water levels at the Yangtze River and Poyang Lake due to the presence of TGD.
- (ii). Analyse the impact of discharge and water level fluctuation in hydrological entities.
- (iii). Measure the impacts of TGD on the environment and society.
- (iv). Provide some viable solutions to address the negative impacts generated by TGD

2.METHODOLOGY

In this research, a desk study approach is carried out to review previous studies within the same project and analyse the adequacy of the studies. This approach allows the researcher to critique the previous studies, identify any gaps not addressed, and creates a hypothesis of the problem statement. The desk study approach is adopted because it is highlighted that numerous researches have been conducted.

The data for this study is mainly collected from previous studies and historical databases. The professional research work about the Three Gorges Dam and Poyang Lake that conducted within three years is investigated.

In order to evaluate the capability of the data, the author determine the data reliability, i.e., the degree of consistency of collected data, and data validity, i.e., the accuracy of the collected data, and validity of the data. In order to analyse the collected data, Microsoft Excel or STATA, statistical analysis software, are utilized in this study to establish the similarity and discrepancies in the available data for analysis, such as hydrological data.

The duration in undertaking the research is estimated to be an overall three-month assignment. The specific tasks and duration are mentioned in Table 1.

Table 1: Estimated time inputs for research assignment

Tasks ↓ \ Month →	1	2	3
Literature Review			
Data Collection			
Data Analysis			
Results and Discussion			
Thesis Writing			
Submission of Thesis Report			

3.ANALYSIS

This section will describe the stated problems due to the Three Gorges Dam, proof of the arguments from some previously conducted scholarly work about the Three Gorges Dam, and the summary of the analysis.

3.1 Putting Forward Arguments

The impact of the Three Gorges Dam in the environment and the streamflow patterns of Yangtze River and Poyang Lake is getting attention among the researchers of hydrology and environment fields. Several pieces of research have been conducted so far to assess the negative impact of the Three Gorges Dam in the water level and water discharge of Yangtze River and Poyang Lake due to reservoir refill operation; in the river bed erosion; and ecology of the surrounding area.

3.2 Proving of Arguments

3.2.1 Impact on Water Level and Consequent on Hydrological Regime

According to Wang et al. (2019), the fluctuation in the water discharge and water levels is an indication of the change in the hydrological regime and anthropogenic activities, which in turn influence the productivity of the lake, affecting species diversity among other characteristics [7]. This report concluded that the water level of Poyang Lake varies with seasons, and its flow significantly affects the Yangtze River. Between April and July, the water level in the lake increases due to inflow

from the catchment, which eventually creates flooding around Lake bay. However, the water level of the Yangtze River rises later from July to September and remains high until October [7]. Liu et al. concluded that the replenishment process of the Three Gorges Reservoir, after the flood season, reduces the flow discharge of the Yangtze River, which eventually decreases the level of water the Poyang Lake [8]. Some multiple linear regression models were developed to calculate the water level and discharge of the streams due to the presence of the dam by considering water flows as the mandatory model variables. It was observed that the level of water in the Poyang Lake was reduced by 1.28, 0.87, and 0.50 meters due to the refill operation of the Three Gorges Dam, corresponding with design frequencies of 50, 90, and 99 %.

3.2.2 Ecological Impact of the Three Gorges Dam

Wu and Liu (2017) investigated the effect of the Three Gorges Dam on the ecology of Poyang Lake. The lake is characterised as an essential wetland due to the habitation of the extraordinary biological diversity of species of birds, invertebrate species, and aquatic plants. However, it undergoes pessimistic ecological alterations of these species since the commencement of operations at the Three Gorges Dam [9]. Some other research works demonstrated that the minimum elevation of vegetation covered area decreased by 7.9 cm per year due to the reduction of the annual submergence duration as a result of the installation of the Three Gorges Dam [10].

3.2.3 Environmental Impact of the Dam

Mei et al. (2015) examined the impact of the Three Gorges Dam in the shrinkage of Poyang Lake. It was observed that abnormal low-level of water appear during October in the lake, which eventually creates a dramatic recession [11]. Lai et al. (2017) observed that the presence of the Three Gorges Dam yielded river bed erosion in the middle of the Yangtze River [12]. They found that the sediment carrying capacity of the Yangtze River bed has been decreased from 0.25 kg m^{-3} to only about 0.05 kg m^{-3} since 2008 due to the dam.

3.2.4 Social Impact of the Three Gorges Dam

Wilmsen and Hulten (2017) examined the impact of the Three Gorges Dam on the livelihood of the resettle people around the dam area [13]. It was observed that the percentage of households with borrowings increased by 5.8% in the surrounding dam area from 2003-2011. Besides, the number of farmers and manuals labour has been reduced due to the dam.

3.3 Summarize of Arguments

The summary of the analysis of the impacts of the Three Gorges Dam is given below:

- (i). The dam has a negative impact on the discharge of the Yangtze River and the water level of Poyang Lake.
- (ii). The dam adversely modified the ecology of several species of animals and plants in the lake area and reduced the elevation of the vegetation.
- (iii). The Three Gorges Dam is responsible for the shrinkage of Poyang Lake and erosion of the Yangtze River.
- (iv). The dam has an unpleasant effect on the livelihood of the people around the dam area.

4. ANALYSIS RESULT

From previous research works conducted about the Three Gorges Dam, it is proved that the dam has a negative impact on the water discharge and level of streams surrounding ecology, environment, and society. Details about the analysis result are mentioned as follows:

- a) *Water Level and Discharge*: The water level and discharge of the Yangtze River and Poyang lake fluctuates due to the dam. The water level of Poyang Lake was reduced up to 1.27 meters after the flooding season due to the refill operation of the dam.
- b) *Ecological Impact*: The dam has adversely altered the ecology of the birds and aquatic plants of the Poyang Lake. It decreases the elevation of the vegetation-covered area decreased at a rate of 7.9 cm per year.
- c) *Environmental Impact*: The dam has reduced the sediment carrying capacity of the Yangtze River bed from 0.25 kg m^{-3} to only about 0.05 kg m^{-3} since 2008. It has also created the

shrinkage of the Poyang Lake due to the abnormal low-level of water that appears during October.

- d) *Social Impact*: It was observed that the percentage of households with borrowings increased by 5.8%, and the percentage of farmers and manual labours decreased by 14.5% and 15%, respectively.
- e) *Consequences*: If the impact of the Three Gorges Dam is not adequately managed immediately then the Yangtze River and Poyang Lake will face several droughts in near future, the aquatic life will be declined, vegetation-covered area will be voided, Poyang Lake will die as a result of continuous shrinkage, and the pattern of living of the people living around the dam will be changed.

5. Suggestions

Several measures can be taken to address the challenges created by the Three Gorges Dam in the Yangtze River and Poyang Lake. The suggested mitigations are described below:

5.1 Mitigation of the Impact on Water Level and Water Discharge

Reservoir refill operation is the main culprit to reduce the water discharge, as well as the water level. The water storing system of the reservoir can be improved to avoid the refill operation after the inundation period. For instance, the sluice gates of the dam can be managed in such a way that the flow remains constant throughout the year, and the excess water during the flood period should be preserved in a way that the excess water will contribute the after-flooding refill operation.

5.2 Mitigation of the Ecological Impact

The water flow is altered and regulated in the place of the Three Gorges Dam. Natural flow on the Yangtze River is required to preserve the aquatic life around the river and lake area. To maintain steady and natural flow, the main-stream of the river can be split by some floating or hydrological structure to separate the specific flow for the dam. Besides, the annual submergence duration reduction problem can be eliminated by maintaining a steady flow throughout the year.

5.3 Mitigation of the Environmental Impact

The water flow through the sluice gate of the dam can be regulated to reduce the terminal speed of flow in order to eliminate the scouring of the river bed at the location of the dam. In addition, dredging the bed and side of the Poyang Lake can be conducted to protect it from shrinking. Usually, dredging is conducted to acquire sands for civil engineering constructions, which also helps to keep alive any shrunk river or lake.

5.4 Mitigation of the Social Impact

Agricultural activities along the Three Gorges Dam area can be incorporated to enhance the self-dependence of the people. Moreover, involving local residents in the maintenance and management of the dam might be helpful to raise the livelihood of the surround people.

6. Conclusions

Although the Three Gorges Dam plays a vital role in the power generation of China, it has plenty of adverse impacts on the hydrological regime, aquatic ecology, environment, and social life. This paper is mainly based on the review of previous studies and historical data. Although it saves time on consuming and is less expensive in comparison to other research methods such as physical investigations, a conclusive and determinative study is not established. Therefore, in the future study field data will be collected and the author will further verify the authenticity and analyze other potential factors.

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