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Impact Assessment of Hydroelectric Facilities on Regional Economic Development

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Abstract. As China's economy continues its rapid growth, hydropower station construction has emerged as a crucial pathway for converting regional resource advantages into economic benefits. Drawing on regional economic development theory and the characteristics of the hydropower industry, this study examines the Dachaoshan Hydropower Station as a case study. Through multiple research methodologies including case analysis and literature review, we analyze the mechanisms through which hydroelectric facilities influence local economic development from both direct and indirect dimensions. Our findings reveal that during the construction phase, hydropower stations effectively stimulate the development of local construction, building materials, and related industries through large-scale investment, while creating substantial temporary employment opportunities. During the operational phase, they provide stable employment positions and considerable tax revenue contributions, becoming an essential pillar of local government finances. From an indirect perspective, hydropower station construction drives the extension and development of related industries, optimizes regional infrastructure conditions, promotes green upgrading of industrial structures, and achieves sustainable regional economic development. The study also addresses the negative impacts on river ecosystems caused by hydroelectric facility construction and human control, as well as social issues related to resettlement. Our comprehensive assessment demonstrates that hydroelectric facilities significantly promote regional economic and social development, with positive effects substantially outweighing negative impacts. However, establishing comprehensive ecological compensation mechanisms and resettlement security systems remains necessary to achieve an organic unity of economic, ecological, and social benefits.

Keywords: Hydroelectric facilities, Regional economy, Impact assessment.

1. Introduction

1.1. Research background and theme

In response to global trends toward low-carbon and sustainable development, clean energy has garnered significant attention. As a renewable clean energy source, hydropower development and utilization has become a priority for countries worldwide. China possesses abundant hydropower resources, ranking first globally in both theoretical reserves and technically exploitable capacity [1].

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With China's sustained rapid economic growth, energy demand continues to rise, while traditional fossil fuels face numerous challenges including resource scarcity and environmental pollution. Under these circumstances, hydropower development has become a primary force in optimizing China's energy supply structure and reducing carbon emissions.

From a regional economic development perspective, China's hydropower resources are unevenly distributed, primarily concentrated in central and western regions and remote mountainous areas. These regions often lag in economic development yet possess rich hydropower resources. Hydropower station construction has become an important means of transforming regional resource advantages into economic advantages. Through hydropower development, these projects not only meet local and surrounding areas' electricity demands but also drive the development of related industries, promote regional economic growth, and narrow development gaps between regions.

1.2. Research purpose and significance

Based on this research context, this study aims to deeply analyze the specific impacts of hydroelectric facilities on regional economic development. Using the Dachaoshan Hydropower Station as a case study, we focus on exploring the mechanisms through which hydropower station construction and operation affect local economic development, including direct economic effects such as job creation, tax contributions, and industrial stimulation, as well as indirect impacts like infrastructure improvement and industrial structure optimization.

From a theoretical perspective, analyzing the regional impacts of hydroelectric facilities can establish a comprehensive evaluation system, providing methodologies for scientific and accurate impact assessment. Additionally, through research on economic impact analysis methods in the hydropower industry and establishing a systematic evaluation framework, we can adapt to different environments and conditions, ensuring the evaluation system's applicability. This analysis provides new perspectives for hydroelectric facility development research and enriches the theoretical evaluation framework, ensuring scientific validity.

From a practical standpoint, by studying the construction, operation, and stable functioning phases of hydropower stations, we can develop indicator systems for economic growth and social stability, validating the relationship between hydropower development and socioeconomic impacts. Given China's substantial theoretical hydropower reserves, this provides valuable references for hydropower resource development and utilization in other regions.

1.3. Research methods and framework

The economic impacts of hydroelectric facilities have attracted considerable scholarly attention, resulting in diverse methodological approaches including fuzzy analysis, case studies, analytic hierarchy process, literature review, and various evaluation indicators [1].

Isserman and Beaumont pioneered the use of quasi-experimental control group methods to evaluate hydropower projects' regional economic impacts. Their work, along with subsequent studies by Rephann and Isserman, and later collaborative research, demonstrated that hydropower construction consistently generates positive economic impacts across different regions, with minimal variation in key economic indicators between study and control areas [2-4]. More recently, Tan-Mullins, Urban, and Mang surveyed four major hydropower projects across different regions, concluding that these projects play increasingly important roles in economic development [5]. Luo et al. employed a Delphi entropy weight fuzzy optimization model, identifying political support and hydropower construction as critical factors for regional economic development [6]. Wu et al.

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addressed multiple phases of hydropower generation, using dynamic models and empirical data analysis to clarify the effectiveness of hydropower development planning [7]. Li applied regional economic and industrial linkage methods to analyze the role of hydropower station construction in regional economic development [8]. Zheng et al. used the Three Gorges as an example, evaluating its hydropower resource value through economic rent calculation models, clarifying hydropower resources' value in economic development [9]. Chen examined a specific hydropower station, analyzing risk indicator weights and levels through analytic hierarchy process and fuzzy risk evaluation methods, providing methodologies applicable to studying hydropower's regional economic development impacts [10]. This paper draws support from Wu's master's thesis “Research on Regional Economic Impacts of Large Hydropower Stations - A Case Study of Dachaoshan Hydropower Station” [11].

This paper first discusses the research background, objectives, and methodologies, laying the foundation for subsequent research. It then presents research methods and theoretical foundations, including a review of industry economic impact analysis methods and specific research approaches and case sources. The study analyzes hydroelectric facilities' impacts on regional economic development from multiple dimensions including direct impacts, indirect impacts, and sustained economic transformation. Subsequently, discussion and analysis cover cost-benefit comparisons, market competition analysis, and indirect economic losses from ecological impacts. Finally, the paper concludes with a summary, considers research limitations, and provides future outlook for this research direction.

2. Analysis of direct and indirect impacts of hydropower station construction

2.1. Direct impacts

2.1.1. Construction phase

During the Dachaoshan Hydropower Station's construction, large-scale investment generated significant multiplier effects. With massive total investment, funds were primarily allocated to various engineering construction components, including dam construction, underground powerhouse excavation, and water diversion power generation system installation. These investments directly stimulated the local construction industry's robust development and created substantial demand for building materials (cement, steel, sand, gravel, etc.). Simultaneously, the engineering construction required extensive labor, attracting large numbers of construction workers from surrounding areas and even other provinces, providing numerous temporary employment opportunities for local and surrounding regions and increasing residents' labor income. This investment-driven effect not only promoted local economic growth in the short term but also laid infrastructure foundations for subsequent industrial development.

2.1.2. Operational phase

During the operational phase, the Dachaoshan Hydropower Station's direct contributions to the local economy are primarily reflected in employment and taxation. Hydropower station operations require professional technical and management personnel across various functions from routine equipment inspection and maintenance to power generation dispatch. According to statistics from Dachaoshan Hydropower Co., Ltd., the station directly employs several hundred staff members, mostly from local or surrounding areas, providing stable employment opportunities for local residents. These

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positions span different professional fields, including electrical engineering, mechanical engineering, and automation control, not only raising local residents' income levels but also promoting the concentration and cultivation of relevant professional talent locally. Regarding taxation, the Dachaoshan Hydropower Station's annual tax payments constitute a significant proportion of local tax revenue, providing local government with sufficient fiscal resources for infrastructure construction, education, healthcare, and other public services, powerfully promoting local socioeconomic development.

2.2. Indirect impacts

2.2.1. Extension of related industries

The Dachaoshan Hydropower Station is located in the middle reaches of the Lancang River, at the junction of Yun County and Jingdong County in Yunnan Province. As a downstream cascade station of Manwan, it primarily focuses on power generation with an installed capacity of 1.35 million kilowatts and multi-year average power generation of 5.931 billion kilowatt-hours. The Dachaoshan Hydropower Station is a national key project and was the first large-scale hydropower project completed and put into operation in the new century.

The construction and operation of the Dachaoshan Hydropower Station has driven the extension and development of a series of related industries, promoting industrial chain improvement and industrial cluster formation. Based on reliable power supply, local energy-intensive industries have developed rapidly, including electrolytic aluminum and ferroalloy production. These industries leverage abundant and relatively inexpensive hydropower resources to reduce production costs and enhance market competitiveness. Additionally, the hydropower station's construction and operation has spawned numerous supporting service industries, such as equipment repair and maintenance, power engineering design, and logistics transportation. As related industries continue developing, synergistic effects between industries gradually emerge, forming an industrial cluster centered on hydropower, further enhancing the region's overall economic competitiveness.

2.2.2. Optimization of regional infrastructure conditions

During hydropower station construction, to meet engineering construction and operational needs, local governments and enterprises increased infrastructure investment, improving regional conditions. In transportation, roads were built to hydropower station construction sites and operational areas. These roads not only facilitated material transportation and personnel movement for the hydropower station but also improved local residents' travel conditions and strengthened connections with the outside world. Simultaneously, hydropower project construction often accompanies communication facility improvements, enhancing local telecommunication network coverage. Furthermore, hydroelectric facility construction provides certain flood control and irrigation capabilities, safeguarding regional property security and living standards.

3. Analysis of sustained economic transformation

3.1. Promoting balanced regional development

The Dachaoshan Hydropower Station region, located at the junction of Yun County and Jingdong County in the middle reaches of the Lancang River in Yunnan Province, represents an area with relatively lagging economic development. The hydropower station's development transforms

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abundant local hydropower resources into economic advantages, promoting rapid local economic development through industrial stimulation, employment promotion, and tax contributions, narrowing the development gap with developed regions. For example, during hydropower station construction and operation, local infrastructure improved, industrial structure optimized, and residents' income levels increased significantly. Meanwhile, hydropower project development attracted external investment and talent inflow, injecting new vitality into local economic development. This transformation from regional resource advantages to economic advantages promotes balanced development between regions.

3.2. Industrial structure upgrading

As a clean energy project, the Dachaoshan Hydropower Station's development and operation have promoted green upgrading of the local industrial structure. With the hydropower station's completion and stable power supply, the locality has gradually reduced dependence on traditional high-energy-consumption, high-pollution industries, instead developing clean energy industries based on hydropower and related supporting industries. Additionally, surrounding the hydropower industry, new industries have developed including new energy technology R&D and energy management services, further optimizing the industrial structure. This green upgrading of industrial structure not only improves regional economic development quality but also enhances the region's sustainable development capacity.

4. Conclusion

Through this research analysis, we can conclude that hydroelectric facility construction and operation play a significant role in promoting local economic development, particularly in construction, building materials, and related industries, optimizing regional industrial structure. During construction and operational phases, extensive recruitment, especially long-term, stable positions during operations such as duty and inspection posts, increases local employment opportunities and raises regional residents' income. Hydropower station operations also contribute a certain proportion of tax revenue to local finances, even becoming an important pillar of local government revenue. Moreover, sustained and stable energy supply provides reliable assurance for regional residents' lives and enterprise production, reducing economic operating costs while ensuring steady economic development.

Additionally, this research examined aspects of industrial linkage and infrastructure construction. Regarding industrial linkage, industrial correlation effects drive coordinated development of upstream and downstream related industries, forming complete industrial chains. Industries such as hydropower equipment manufacturing, transportation, and catering services have all flourished due to hydropower station construction and operation, promoting diversified regional economic development. From an infrastructure perspective, hydropower station construction and operation have promoted regional infrastructure construction and improvement, enhanced transportation, communication, and water conservancy infrastructure conditions, and improving the region's comprehensive competitiveness. In terms of industrial structure optimization and upgrading, it has provided development opportunities for energy-intensive industries, attracting related industries and promoting regional industrial structure transformation toward green and low-carbon directions.

However, this research has certain limitations. First, this study analyzes only the single case of Dachaoshan Hydropower Station. While this case has certain representativeness, significant differences in geographical environment, economic foundation, and policy environment across

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regions mean the generalizability of research conclusions requires further verification. Future research could consider selecting multiple hydropower stations of different types and scales for comparative analysis to enhance the representativeness and generalizability of research results. Second, this research is relatively insufficient in quantitative analysis, primarily employing qualitative and descriptive analysis methods, lacking precise quantitative models to measure hydropower stations' specific contributions to regional economic development. In future research, we recommend using more rigorous econometric methods to construct scientific evaluation indicator systems and mathematical models to more accurately quantify the degree of hydroelectric facilities' impact on regional economic development.

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