Advances in Hydraulic Engineering (2025)
Clausius Scientific Press, Canada

DOI: 10.23977/hyde.2025.050101
ISSN 2616-2431 Vol. 5 Num. 1

Research on the Current Status and Development Strategies of Water Conservancy Project Management

Xiaohong Song[1,*]

[1]Anhui Water Conservancy Technical College, Hefei, Anhui, 231603, China
**Corresponding author*

Keywords: Water Conservancy Project Management; Management System; Intelligence; Ecological Protection; Sustainable Development

Abstract: As a critical support for efficient water resource utilization, flood and drought disaster prevention, and sustainable economic and social development, the strategic position of water conservancy project management cannot be overlooked. This study systematically analyzes the core values of water conservancy project management and identifies prominent contradictions in the current management system, technological applications, ecological maintenance, and talent team construction. By drawing on advanced domestic and international experiences, systematic solutions are proposed from dimensions such as institutional reform, technological empowerment, ecological priority, and talent strategies. The research indicates that in response to the practical challenges of climate change and intensifying water crises, water conservancy project management must accelerate its transformation toward intelligence, digitization, and greening to ensure the long-term safe operation of water conservancy facilities and unlock multidimensional synergistic benefits.

1. Introduction

Water conservancy projects, as a core component of the national critical infrastructure system, are not only lifeline projects for flood control and drought relief but also strategic supports for achieving balanced spatial-temporal allocation of water resources, clean energy development, unobstructed inland navigation, and efficient agricultural irrigation. Against the backdrop of frequent extreme weather events triggered by global climate change, a continuously expanding population, and an urbanization rate exceeding 70%, China faces an annual average water resource deficit of 50 billion cubic meters, with over 400 cities experiencing varying degrees of water scarcity[1]. Meanwhile, structural contradictions such as aging water conservancy facilities (approximately 30% of reservoirs built in the 1960s), outdated management technologies (only 15% of projects have implemented digital monitoring), and the absence of ecological compensation mechanisms have become increasingly prominent[2]. The traditional extensive management model, dominated by administrative directives and reliant on empirical judgments, struggles to meet the requirements of the new era, including smart water conservancy construction, carbon neutrality goals, and integrated watershed governance. Therefore, there is an urgent need to construct a new governance paradigm that integrates modern information technology, ecological concepts, and

institutional innovation.

2. Importance of Water Conservancy Project Management

2.1 Ensuring flood control safety and reducing disaster losses

The primary task of water conservancy projects is flood control and disaster mitigation. Scientific reservoir scheduling, dike maintenance, and flood warning systems can effectively reduce flood risks and protect people's lives and property. For example, the Three Gorges Project played a crucial role in the 2020 Yangtze River flood by accurately scheduling to reduce peak flow and alleviate downstream flood control pressures[3].

2.2 Optimizing water resource allocation and promoting economic development

Water conservancy project management directly influences the efficiency of water resource utilization. Through rational scheduling, it can meet the demands of agricultural irrigation, industrial water use, and urban water supply, thereby promoting regional economic development. For instance, the South-to-North Water Diversion Project has alleviated water scarcity in northern China and supported the sustainable development of the Beijing-Tianjin-Hebei region[4].

2.3 Promoting clean energy development and supporting "dual carbon" goals

Hydropower is an important renewable energy source, and scientific hydropower management can improve power generation efficiency and reduce reliance on fossil fuels. For example, hydropower stations in southwestern China have increased the proportion of clean energy through optimized scheduling, contributing to the national "carbon peaking and carbon neutrality" strategy [5].

2.4 Maintaining ecological balance and promoting sustainable development

Water conservancy project management must consider ecological protection to avoid issues such as river (river flow interruption) and biodiversity decline caused by over-exploitation. Measures such as ecological scheduling and fish migration channel construction help maintain river health. For example, the Yellow River water and sediment regulation project has improved river ecology and promoted sustainable development in the watershed.

3. Current Status and Problems of Water Conservancy Project Management

3.1 Imperfect management system and insufficient coordination mechanisms

Currently, China's water conservancy project management still faces issues of "multi-departmental management and unclear responsibilities"[6]. Overlapping functions among departments such as water conservancy, environmental protection, and agriculture lead to low management efficiency. Additionally, some regions continue to use traditional administrative management models, lacking market-oriented operational mechanisms, which affects management effectiveness.

3.2 Low level of informatization and intelligence

Although some large-scale water conservancy projects have adopted automated monitoring

systems, the informatization construction of small and medium-sized projects remains lagging. Insufficient data collection and analysis capabilities hinder precise scheduling and risk early warning[7].

3.3 Weak awareness of ecological protection and limited sustainable development

Some water conservancy projects neglect ecological impacts during construction and operation, leading to river ecological degradation and intensified soil erosion. For example, excessive water storage in some hydropower stations has caused downstream riverbeds to dry up, affecting ecosystem stability[8].

3.4 Shortage of professional talents and limited management levels

Water conservancy project management requires interdisciplinary talents with expertise in both engineering technology and modern management. However, the current university training system emphasizes technology over management courses, leading to an imbalanced talent structure. Additionally, low salaries in grassroots water conservancy units make it difficult to attract high-quality talents[9].

4. Development Strategies for Water Conservancy Project Management

4.1 Improving the management system and promoting collaborative governance

(1) Establishing integrated watershed management agencies

To address the issue, the government or relevant decision-making body should draw on the model of the Tennessee Valley Authority (TVA) in the United States[10], establish entities with administrative coordination authority in seven major watersheds such as the Yangtze and Yellow Rivers, integrating regulatory functions of 12 departments including water conservancy, environmental protection, and navigation. We need to clarify their authority and responsibilities through legislation, such as granting core permissions for water allocation scheduling and ecological compensation standard formulation, to address the fragmented management issue of "nine dragons governing water" in 19 provincial administrative regions.

(2) Innovating market-oriented operational mechanisms

To effectively advance relevant initiatives, the water conservancy authorities or relevant governmental departments should promote the application of the Public-Private Partnership (PPP) model in projects such as irrigation area renovation and small and medium-sized reservoir reinforcement[11]. They should formulate the "Administrative Measures for Concession Management of Water Conservancy Infrastructure" to clarify social capital entry conditions and return mechanisms. Additionally, they should pilot the "Build-Operate-Transfer" (BOT) model in urban and rural water supply projects.

4.2 Advancing smart water conservancy construction and enhancing informatization levels

(1) Constructing intelligent monitoring systems

To enhance reservoir management and flood prevention capabilities, the relevant water resource management departments or technological implementation agencies should deploy a 5G+Beidou stereo sensing network to achieve 100% online monitoring coverage of parameters such as rainfall, water level, and seepage in large reservoirs by 2027, with data collection frequency increasing from hourly to minute-level[12]. They should also develop machine learning-based flood forecasting

models to extend the warning lead time from 24 to 72 hours.

(2) Deepening digital twin applications

To enhance the efficiency and reliability of the national water network management, the national water resource management authorities or relevant project implementation entities should comprehensively promote digital twin technology in key projects of the national water network, establishing dynamic simulation systems with over 300 parameters including geological structures and hydraulic characteristics to improve the success rate of scheduling scheme rehearsals.

4.3 Strengthening ecological protection and achieving green development

(1) Dynamic management of ecological flow

To safeguard aquatic ecosystems and biodiversity, the environmental protection departments or relevant river basin management agencies should establish an ecological flow verification system covering 15 indicators such as water temperature and dissolved oxygen. They should also install multiple ecological flow monitoring facilities in key river sections such as the upper reaches of the Yangtze River to ensure compliance with minimum discharge flow rates during critical species breeding periods.

(2) Ecological restoration projects

To enhance the ecological health of river systems and support fish populations, the fisheries management departments or relevant ecological conservation organizations should promote a "fishway-artificial spawning ground-habitat restoration" trinity scheme, constructing continuous fishway systems over long sections to improve natural reproduction success rates of fish. Simultaneously, they should implement ecological bank protection renovations using new technologies such as gabion baskets and ecological concrete to increase bank vegetation coverage.

4.4 Strengthening talent cultivation and improving management levels

(1) Educational reform

To cultivate professionals with interdisciplinary skills in water conservancy and information technology, universities or relevant educational institutions should offer "smart water conservancy" micro-majors, adding courses such as Python programming and remote sensing image processing to increase the proportion of information technology courses[13].

(2) In-service training systems

To enhance the professional capabilities of grassroots personnel in the water conservancy sector, the Ministry of Water Resources or its affiliated training institutions should establish a "online theory + base practical training" model relying on the talent resource center of the Ministry of Water Resources to increase the annual training frequency of grassroots management and maintenance personnel, focusing on improving practical skills in BIM technology application and ecological scheduling. Additionally, they should implement the "Water Conservancy Craftsman" training program to cultivate a large number of interdisciplinary talents with both engineering experience and digital skills.

5. Conclusion and Outlook

Water conservancy project management is crucial for ensuring water resource security and promoting sustainable economic and social development. In the future, efforts should be accelerated to construct smart water conservancy, drive institutional innovation, strengthen ecological protection, and cultivate interdisciplinary talents to meet new challenges in climate change and water resource management.

References

[1] Cao Hongying. (2023). Strengthening water conservancy project management to maximize project benefits. Water Safety, (16): 151-153.
[2] Feng Sheguang. (2025). Research on the optimization and sustainable utilization of water resource allocation in regional water conservancy projects. Water Safety, (05): 187-189.
[3] Chen Guiya, Zhang Jun, Zou Qiang. (2024). Research and analysis of the flood control scheduling and role of the Three Gorges Project. China Water Resources, (22): 41-47.
[4] Li Xinyang, Guo Xuning, Li Weiyu, et al. (2025). Analysis of optimized scheduling and water source composition in the eastern route of the South-to-North Water Diversion Project. Water Resources Protection, 41(03): 171-178.
[5] Yang Yongfen. (2024). Exploring the development trends of water conservancy projects under the "dual carbon" goals. New Urban Construction Technology, 33(03): 47-49.
[6] Liu Jiaxu, Zhong Zhencheng, Li Lijuan, et al. (2025). Analysis of the evolution of water scarcity patterns in nine provinces (regions) of the Yellow River Basin. Water Resources Planning and Design, (07): 23-29.
[7] Zhang Xiaozhou. (2025). Research on the operation mode of multi-source joint scheduling in water conservancy projects. Water Safety, (05): 169-171.
[8] Yang Juanjuan, Jiang Jinwei, Wang Chang. (2025). Analysis of construction and management issues in the national water network project from a multidimensional perspective. Journal of Water Resources and Architectural Engineering, (02): 113-119.
[9] Li Tianchang. (2025). Problems in the construction management of water conservancy projects. Water Conservancy Technology Supervision, (05): 133-134+197.
[10] Dai Xin. (2020). Construction and practice of a "top-level design + cooperative governance" watershed governance model—from the Tennessee River to the Yellow River. Future and Development, 44(09): 95-101.
[11] Cao Linlai. (2016). Application of the PPP model in the water-saving renovation and irrigation project of the Canghe Irrigation Area. Henan Water Resources and South-to-North Water Diversion, (07): 123-125.
[12] Huang Yuansheng, Huang Ruodi. (2021). Application of Beidou cloud intelligent monitoring technology in the Jianxin Reservoir. China Water Resources, (16): 50-52.
[13] L ü Chaolei, Wu Su, Li Peng, et al. (2025). Digital twin technology enabling the construction of smart reservoir platforms. Internet of Things Technology, 15(11): 103-106+110.