

Grounded theory and sustainable development research of interconnected river system networks

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Abstract. As an important carrier of water resources, interconnected river system networks are an important part of the ecological environment and an important strategy for water management at this stage in China. At present, the theoretical basis of China's interconnected river system network is fragmented and not perfect enough to form a complete system, while a complete theoretical system has a guiding role for the practice of interconnected river system network engineering. Based on the theory of river-lake system connectivity, the characteristics of interconnected river system networks and the current situation of research, this paper compares multiple research areas and forms the framework of research system at the present stage of river-lake system connectivity in order to promote the in-depth research of river-lake system connectivity, and then look forward to the sustainable development of river-lake system connectivity.

Keywords: Interconnected network of river systems; Sustainable Development; Water Resources Allocation ; Theoretical Foundations; Research Areas

1. Introduction

The intensification of global human activities has led to many extreme disaster problems, resulting in an overall lack of water resources capacity. Compared with most countries in the world, China is characterized by a small amount of water resources, a large population, and an uneven distribution of water resources in time and space, which leads to problems such as the overall low allocation capacity and utilization of water resources. River and lake water system connection project as China's water conservancy sector in the new era of sustainable development in the direction of new strategies and initiatives, its model can not only maintain a certain degree of ecological stability, while promoting the synergistic development of social and economic[1] .

Sustainable development is the ability to meet all aspects of current human needs and ensure future development needs through production and development without destroying existing conditions in the process of steady human socio-economic development. The interconnected river system network strategy ensures the sustainable development of water resources in multiple directions through the rational development of relevant engineering measures for the rational use of water resources[2]. Based on the theory of river-lake system connectivity, this paper compares the directions and forms the framework of research system that can be implemented at the present stage of river-lake system connectivity, in order to promote the in-depth research of river-lake system connectivity, and then look forward to the sustainable development of river-lake system connectivity.

2. The concept and connotation of interconnected river system networks

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2.1 The concept of an interconnected network of river systems

As an important carrier of today's available water resources, river and lake systems play a particularly important role in the daily life of human beings and in the future development of society. The network of interconnected river systems is a rational linkage between rivers, lakes, wetlands, reservoirs and other water systems by means of normative engineering implementation, using dredging, communication, diversion and storage [3]. In order to change the problems related to the unreasonable distribution of water resources in the country at this stage, adjust the distribution of water resources in each region, and ensure a dynamic balance between the total amount of water resources required by users in each sector and the amount of water resources that can be allocated.

2.2 The connotations of an interconnected network of river systems

The interconnection of river and lake systems has many connotations, including the basis for the implementation of the interconnected river system network is to form a "natural - artificial" composite water system; the necessary means of the interconnected river system network is through reasonable diversion, drainage, scheduling and other measures; the ultimate goal of the interconnected river system network is to follow the laws of nature, based on the formation of a positive water cycle in the environment.

2.2.1. Implementation basis - constitute a "natural - artificial" composite water system.

The network of interconnected river systems is built by relying on natural water systems that are already present in nature, but also by combining and adapting artificial water projects. While the combination of natural and artificial processes can enhance the advantages of interconnected river systems networks, there is also a risk of damaging the earth's original ecological environment, destroying the intrinsic balance of water resources and causing some water environment problems. Therefore, it is necessary to respect the laws of nature and to intervene artificially in order to play a relevant regulatory role in water projects, which is a necessary condition for the sustainable development of the water environment and a necessary consideration before the implementation of the interconnected river system network project.

2.2.2. Necessary means - scheduling and distribution measures.

A network of interconnected river systems regroups and redistributes existing water resources through rational channels. Therefore, the scheduling and distribution of water becomes a necessary tool for the network of interconnected river systems and a necessary part of the implementation of the network of interconnected river systems. If you want to adjust the relationship between rivers and lakes and carry out reasonable distribution of water and water resources, you should not only consider the impact of the project on the ecological environment, but also consider the social, production and economic factors involved in the project, and build a multi-objective, multi-angle, multi-influencing factor and multi-level water network system to ensure that the water quality and quantity simultaneously meet the standards required by people's daily life and finally achieve sustainable development.

2.2.3. The ultimate goal - to form a virtuous water cycle and sustainable development.

The process of selecting the connected area should ensure that all influencing factors do not damage the ecological environment and water functions while meeting the requirements. Before the establishment of the interconnected river system network project, we should consider the positive effect of the project on the water cycle in the basin, analyze the distribution and transformation process of water resources in the basin after the project operation, and the transfer process of energy and ecological effects; on the other hand, we need to clarify the influence of climate and topography on the interconnected river system network project. It ensures the smooth implementation of the interconnected river system network project and the virtuous cycle and sustainable development of water resources in the basin where it is located[4].

3. Network characteristics of interconnected river systems

The river and lake system connection project integrates the foundation of water conservancy with the development of water conservancy that adapts to new ideas of water management, not only with the support of the basic theoretical system of water conservancy engineering, but also to the characteristics of the receiving area, so the interconnected river system network has the characteristics of integration, wholeness and crossover.

3.1 Convergence

The interconnected river system network project is established in different water system areas to ensure the characteristics that different receiving areas have, and should also take fully into account the functional needs within the different areas. With different demand objectives, the interconnected river system network engineering establishes more directions, increased functions, increased risks, and complex connectivity areas, and fuses the above issues to form a complex system with multiple directions, while facing a gradual overlap of water environment problems, socioeconomic problems, and ecological environment problems, resulting in the interconnected river system network engineering becoming complex and convergent [5].

3.2 Holistic

The ultimate goal of the idea of an interconnected river system network is to create a water network system that maintains a good water cycle function and ensures a multi-level, multi-faceted and multi-objective system. The interconnected river system network is established based on certain theoretical studies to interact with socio-economic, aquatic system, and ecological environment system, and to comprehensively explore the structural composition, association patterns, and interrelationships of the period with certain regularity, wholeness, and systematicity, and further explore the research directions of the interconnected river system network in multiple directions[6].

3.3 Intersectionality

The establishment of the interconnected river system network project requires the intersection of multidisciplinary research contents. The theoretical study of the interconnected river system network should systematically take into account the relationship between ecological life, sustainable development theory, ecological development theory, water allocation theory, etc. Nowadays, the network engineering of interconnected river systems is gradually developing and its theory is being improved and updated, and more disciplines need to be introduced to integrate and provide more complete and favorable support and reference for the theoretical system of interconnected river systems network.

4. Research Areas and Research Frameworks for Interconnected River System Networks

4.1 Research areas of interconnected river system networks

At present, since the theoretical basis and research process cognition of interconnected river system networks have not yet been formed, there are still shortcomings such as poor correlation, insufficient coordination and insufficient systematization in the integrated practical sessions. In order to prevent blindly carrying out related interconnected river system network work, the theoretical basis of interconnected river system network should be studied in depth, drawing on relevant knowledge from various disciplinary fields to establish a complete research system, the priority areas and research directions of interconnected river system network research are summarized.

4.1.1. River and lake system connectivity evaluation and methodology

River and lake system Ensuring the integrity of the water system is an important area that cannot be neglected in the planning stage of interconnected river system network engineering, and the scientific connectivity mechanism should also ensure the positive socio-economic development of the location. Therefore, an overall evaluation system for the integrity of river-lake system connectivity should be established, focusing on relevant research in the fields of topography and geomorphology discipline and landscape ecology discipline, while selecting evaluation indexes, evaluation criteria and models based on economics, and proposing a complete theory and method for the evaluation of river-lake system connectivity that ensures the functional and socio-economic synergistic development of the connected area [7,8].

4.1.2. Integration study on sustainable development of water system connectivity.

Through the establishment of the river and lake system connection project to respond to the existing policy of river and lake management and protection to achieve new goals of human social development. For the sustainable development stage should be more integrated with the conflict of interests and needs of multiple sectors such as green, technology, sharing, and comfort for the future development of the country, and should pay more attention to the research progress of the overall plan for the construction of ecological civilization in China based on the research of system science, ecology and other related fields to ensure the smooth promotion and development of the interconnected river system network strategy [9].

4.1.3. Interconnected River System Network and Eco-Economic Development Study.

The relationship between the interconnected river system network project and economic development and the water ecological environment as a whole should be properly handled, combining ideas and research results in the fields of economics and ecology with the interconnected river system network, gradually forming an adaptive theory that facilitates economic-oriented development [10]. To study the interaction between network engineering of interconnected river systems and environmental improvement, and to form a theoretical system for ecological and environmental water security, to protect the health of rivers and lakes while maintaining the biodiversity in rivers and lakes [11,12].

4.1.4. Interconnected river system network-related giant system complexity simulation study.

The interconnected river system network is a complex theory, and its research theories include hydrohydrodynamic, meteorological, geological and other related environmental theories as well as risk management, economics and other related financial theories, and the interconnected river system network cross-fertilizes multiple disciplines to form a giant system. The research focuses on the uncertainty and complexity of river and lake system connectivity under the changing environment, and proposes countermeasures and regulation in the face of sudden events and major disasters. We will establish relevant models and simulate them, and combine them with Internet big data and other technologies as theoretical support, so as to optimize and improve the functionality of the river-lake water system connection and control model.

4.2 A research framework for interconnected river system networks

A more complete framework of the interconnected river system network theory system is established by the above interconnected river system network foundation theory as shown in Figure 1. The content includes the characteristics of interconnected river system networks, the theoretical basis, the research area and the ultimate purpose. On the basis of economic theory, ecological theory, water allocation theory, water cycle theory and risk control theory, the research areas of water system connectivity evaluation and methodology, sustainable development integration research, interconnected river system network and ecological and economic development research and related giant system complexity simulation research are explored through the interconnected river system

network project with integration, holistic and cross-cutting characteristics to finally improve water resources allocation capacity, enhance the ability to resist water and drought disasters, improve river and lake health and achieve sustainable development [13].

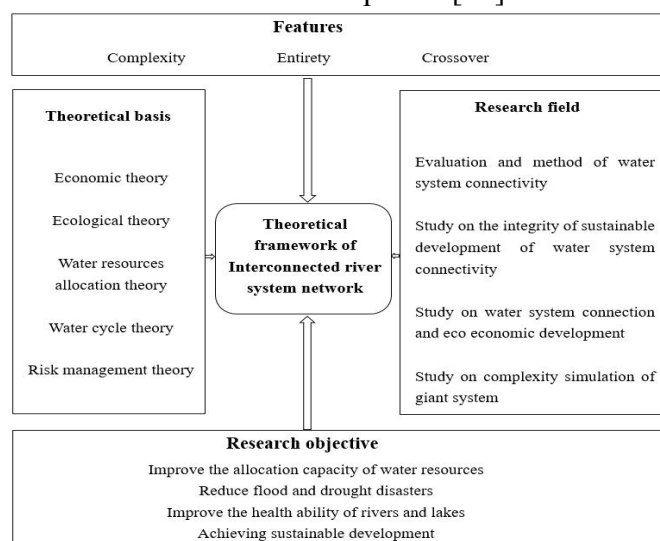


Figure 1. Theoretical framework for interconnected river system networks.

5. Interconnected river system network and Sustainable Development

Sustainable development is the ultimate goal of theoretical research and practice of river-lake linkage project, as well as the beautiful aspiration for future environmental and ecological development, and also as an important foundation for the smooth implementation of river-lake linkage project. The sustainable use of water resources is an important guarantee for the successful and sustainable development of the country. At the same time, the ideas of sustainable development theory are adopted and rationally applied in practical engineering projects such as river and lake linkages[14].

The river and lake system connection improves the coordination and deployment of water resources by artificially establishing hydraulic connections to rivers, lakes and other water systems. On this basis to further restore and improve the water ecology, enhance the hydraulic connection, but also to prevent unexpected water conditions, to resist natural disasters, to ensure regional water security. Ultimately, it is reasonable to achieve water recycling and support steady socio-economic development for sustainable development[15]. Therefore, it is important to clarify the overall goal of river and lake connectivity, control the environmental and economic factors in the process, consider the needs of development, security and culture in an integrated manner, and carry out a complete implementation of all stages of its planning, implementation, operation and management, so as to finally achieve the sustainable use of water resources as well as the sustainable development of ecological economy and society in an integrated manner.

6. Conclusion

As a key water management strategy that China is promoting at this stage, interconnected river system network must be based on scientific and systematic theoretical guidance. At present, the theoretical study of interconnected river system network is not specific enough to form a complete research system. Therefore, it is especially important to provide a more complete theoretical support for the implementation of the interconnected river system network project. Based on the connotation of river-lake connectivity and the characteristics of river-lake connectivity, this paper proposes the key areas and research directions of river-lake connectivity at this stage These include the evaluation and methodology of river-lake system connectivity, the study of integration of

sustainable development of water system connectivity, the study of river-lake connectivity and eco-economic development, and the simulation study of complexity of giant system related to river-lake connectivity. It also composes the relevant literature to form a more complete theoretical framework of river-lake connectivity, and discusses the sustainable development of river-lake connectivity for regional environmental economy.

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