Green Development Path Analysis of Small Hydropower Based on River Chief System

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Abstract. River chief system is an innovative river and lake management system and model with Chinese characteristics. At present, the river chief system has achieved remarkable results in the management and protection of rivers and lakes in various regions. To promote the green development of small hydropower stations under the river chief system is not only the internal requirement of protecting water ecological environment, but also the urgent need of small hydropower stations to adapt to the green development in the new era. Based on the current situation of small hydropower development, this study establishes the evaluation system of small hydropower cleaning and rectification, evaluates the main problems existing in the green development and ecological transformation of small hydropower, and puts forward a practical development path, in order to promote the small hydropower ecological problems rectification and gradually embarking on the road of green development.

1. Introduction

River chief system is an innovative river and lake management system and model with Chinese characteristics. Since the establishment of the river chief system in China, there have been more than 10 years of practical experience. At present, the river chief system has achieved remarkable results in the implementation process. River chief system is to protect water resources, prevent water pollution, improve water environment, and restore water ecology as the main task, comprehensively establish the four level river chief system of province, city, county and township, and build a river and lake management and protection mechanism with clear responsibility, orderly coordination, strict supervision and powerful protection, so as to provide institutional guarantee for the healthy life of rivers and lakes and realize the sustainable utilization of river and lake functions. Under the existing river and lake management and protection mode, promoting the ecological transformation and green development of small hydropower stations is not only the internal requirement of implementing General Secretary Xi's concept of "green water and green mountains are golden mountains and silver mountains", but also the urgent need of small hydropower stations to adapt to the green development in the new era. Small hydropower has provided a lot of clean and renewable energy for China's economic and social development and civilization progress, and has made important contributions to energy conservation and emission reduction. However, some early-constructed small hydropower stations, especially diversion type hydropower stations, pay more attention to power generation benefits and neglect environmental protection, resulting in frequent dehydration reduction in the lower reaches of the river and damage to the ecological environment of some river sections. Based on the current situation of small hydropower development, this study establishes the evaluation system of...
small hydropower cleaning and rectification, evaluates the main problems existing in the green development and ecological transformation of small hydropower, and puts forward a practical development path, in order to promote the small hydropower ecological problems rectification and gradually embarking on the road of green development.

2. Current situation of small hydropower development

At present, the development and utilization rate of small hydropower resources in China has been close to 60%, and even more than 80% in some provinces in the middle and East. The difficulty of development has increased greatly. Most of the small hydropower stations in China are built in small rivers in mountainous areas. Due to the limitation of natural conditions and the influence of the traditional concept of hydropower resources development technology, a large number of small hydropower stations are diversion type hydropower stations, and the proportion of diversion type hydropower stations in some basins reaches 70%. The downstream of hydropower stations forms water reducing or dewatering river sections, which have adverse effects on river ecosystem. At the same time, China's small hydropower is mainly concentrated in economically backward areas, and the privatization level has exceeded 80%. There are some problems in the development of small hydropower, such as simply pursuing commercial benefits, not paying enough attention to the interests of farmers, and less undertaking the task of comprehensive utilization of water resources. At present, the eco-environmental problems existing in the development of small hydropower are mainly manifested in the following four aspects.

2.1. The phenomenon of water cut-off and dehydration is serious, and ecological water is insufficient.

Most of the newly-built small hydropower stations adopt the development mode of tunnel water diversion, which leads to the river bed drying up in the diversion section, resulting in local river section cut-off, affecting the normal growth of aquatic organisms and river environmental quality; due to the low power generation efficiency of runoff type small hydropower stations, the investment owners often adopt the operation mode of stopping generating and storing water under the low water level, which makes the river channel below the reservoir be cut off in normal and dry seasons. The water cut-off will not only affect the ecological water use of the river, but also affect the production and living water of the downstream residents. In some rivers, there are several cascade water diversion power stations, which are connected from end to end, resulting in several kilometers of dehydrated river section, which makes the river fragmented and has adverse effects on water supply, irrigation and ecological environment.

2.2. Lack of unified comprehensive planning.

The overall planning of hydropower development is not comprehensive and perfect, and has not been strictly demonstrated, especially for the rivers with theoretical reserves less than 10 MW. In China, there is a general lack of overall planning. A river often crosses several counties and cities. Although each county and city has relevant planning, the water resources planning of the whole river is still insufficient, which is easy to cause excessive development of resources.

2.3. River ecological environment damage.

Rural small hydropower stations are mostly built in mountainous areas, the construction conditions are bad, and the regional vegetation is damaged greatly. Therefore, the aggravation of soil erosion is a common ecological environmental problem in the construction and operation of rural small hydropower stations. For rivers, the construction of hydropower stations has changed the hydrological rhythm of rivers. The problems of river dehydration or water reduction will affect the original habitat characteristics of rivers, and eventually lead to changes in the structure of biological communities, affecting the ecological process of aquatic ecosystems and fish biodiversity.
2.4. The examination and approval procedure of small hydropower stations needs to be improved. Due to large number, small scale, large dispersion, weak construction and management technology, and low management level of small hydropower projects, such various factors cause the project approval and permission to be divorced from the construction management, resulting in the emergence of "four no" hydropower stations without project approval, design, acceptance and management, leaving hidden dangers of quality and safety to the project operation, and posing a serious threat to the local society, natural environment and the safety of people's lives and property.

3. Comprehensive evaluation of small hydropower

According to the relevant ideas of Hydropower "2018" No. 312 document, combined with the actual situation, the comprehensive evaluation system sets up 6 first-class indicators and 36 second-class indicators (Table 1).

The order of the three categories of small hydropower station withdrawal, retention and rectification is: first judge whether it is included in the withdrawal category, then judge whether it belongs to the retention category, and all the remaining power stations are listed in the rectification category. The first choice is to evaluate whether the small hydropower stations meet the criteria for withdrawal, focusing on six types of withdrawal conditions; second, to evaluate whether the small hydropower stations that are not included in the withdrawal category meet the discrimination conditions of the retention type, focusing on the three types of retention conditions; finally, the hydropower stations that are not listed in the withdrawal category and the retention type are included in the rectification category.

According to the evaluation conclusion of Hydropower Station in Zengcheng District of Guangzhou, the main problems of rectification are incomplete administrative procedures; the ecological flow is not approved; there is no ecological flow relief facilities, but it can be added; there are ecological flow relief facilities, but they are not discharged according to the requirements; the impact of the downstream dewatering section exists; the reservoir structure or equipment (facilities) have security risks, but can be eliminated.

| Primary indicators | Secondary indicators |
|--------------------|----------------------|
| Involving nature reserves and other prohibited development zones | 1. Core area of nature reserve; 2. Buffer area of nature reserve; 3. Experimental area of nature reserve; 4. Non zoned nature reserve; 5. Other prohibited development zones |
| Legal compliance | 1. The project approval has been fulfilled; 2. The water intake permit has been handled; 3. The EIA approval procedure has been handled; 4. The environmental protection acceptance procedure has been handled; 5. The forest land requisition (occupation and rent) has been completed; 6. The completion acceptance has been completed 7. The power generation has not been generated in recent years; 8. The people's government above the county level requests to withdraw |
| Ecological flow and impact on ecological environment | 1. The ecological environment is seriously damaged. 2. The ecological flow is required to be released. 3. The discharge requirements of ecological flow are met. 4. The ecological flow has been approved. 5. The ecological flow discharge facilities are available. 6. The ecological flow monitoring requirements are met. 7. The requirements for the protection of migratory fish are met. |
| Dam safety | 1. Dam safety appraisal is dangerous; 2. Flood control safety is seriously affected; 3. Dam reinforcement is uneconomical |
4. Green Development Practice Approaches

4.1. Strong constraints on planning and approval

In order to implement the concept of green development, we should adhere to ecological priority, coordinate planning and development, fully consider the carrying capacity of water resources, and properly handle the relationship between small hydropower development and river ecological protection. The ecological water demand required by the ecological protection objectives of the main rivers and lakes should be included in the overall consideration of water resources allocation and water conservancy and hydropower project planning and construction, especially in the planning of water conservancy and hydropower projects, the adverse impact on ecological environment must be fully estimated, and the ecological water demand guarantee measures should be included in the system of water security measures, to make great efforts to play the positive roles of water conservancy projects and eliminate their negative impacts.

4.2. Scientific design and construction

The important contents of ecological security and reasonable resource development and utilization should be highlighted to ensure the scientific and perfect preliminary work of new power stations. Green design and green construction should be advocated. According to the requirements of ecological environment protection, the impact of hydropower development on hydrological situation, river morphology and biological habitat should be reduced as much as possible. The water and soil conservation and environmental protection measures, ecological water discharge facilities and ecological water monitoring facilities of small hydropower projects should be designed, constructed and put into operation simultaneously with the main projects.

4.3. Strong supervision on operation management

It is necessary to establish a monitoring and early warning system for ecological discharge, and strengthen control and supervision according to law. We will gradually establish a monitoring station network system suitable for the ecological water demand of rivers and lakes, strengthen the construction of monitoring facilities for key sections of discharge of water conservancy and hydropower projects, improve the hydrological monitoring station network, establish a national unified ecological flow monitoring platform for rivers, lakes and reservoirs, and carry out the monitoring of discharge volume, aquatic organisms, water surface area and calibration of discharge curve of gate (unit), especially it is necessary to strengthen the construction of monitoring facilities for normal and low flow and improve the monitoring accuracy of small flow. Establish and improve the collection and release mechanism of ecological water volume prediction and early warning.

4.4. Update and reform to make up for shortcomings

According to the requirements of river and lake ecological management and protection under the river chief system, the ecological flow is scientifically verified and the existing small hydropower projects are transformed with green ecology. In the design of renovation project, the ecological restoration of river basin should be fully considered. To ensure the ecological base flow of the river channel between the powerhouse and the dam of the small hydropower station, to ensure that the phenomenon of water reduction section and river drying will not appear in the river channel between the power plant and the
dam; pay attention to the improvement of water ecological health and water environment safety in the river. In the process of renovation, it is necessary to pay attention to the cleaning of the garbage in the upstream and downstream rivers of the power station and in the forebay to prevent the occurrence of water pollution.

5. Conclusion
The development of green small hydropower is to implement the decision and deployment of the Party Central Committee and the State Council on promoting green development and energy revolution, and is also an important measure of the central water control policy in the new period. The impact of small hydropower project on ecological environment is the concrete embodiment of the relationship between man and nature in water conservancy. Therefore, the protection of ecological environment is the top priority of hydropower project construction. We should implement the concept of "green waters and green mountains are golden mountains and silver mountains", follow the basic law of harmonious coexistence between human and nature, promote the transformation and upgrading of small hydropower stations, realize green development, and better promote the construction of ecological civilization and the construction of beautiful China.

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