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Study on Problems and Countermeasures in the Construction of Warping Dam Projects in the Loess Plateau Area

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Abstract: In recent years, to better address soil erosion, the Loess Plateau area has seen a surge in the construction of warping dam projects. Warping dams have strong functions in soil and water conservation as well as warping for farmland creation, serving as a key support for ecological restoration and economic development in the Loess Plateau area in the new era. However, in light of practical conditions, there are many problems in their construction process, which have affected their actual operation quality. In this regard, while expounding on the value and significance of warping dam project construction in the Loess Plateau area, this paper discusses the existing problems and effective countermeasures, aiming to provide some references for relevant personnel.

Keywords: Loess plateau; Warping dam project; Value and significance; Existing problems; Effective countermeasures

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1. Introduction

The Loess Plateau spans multiple provinces and autonomous regions in China, covering an area of 640,000 square kilometers. Due to natural characteristics such as thick loess layers, low vegetation coverage, and concentrated precipitation, it has become one of the regions with the most severe soil erosion in the world. Relevant data show that the annual soil erosion volume in the Loess Plateau is about 1.6 billion tons. This not only affects the local soil fertility and leads to land degradation but also directly causes sedimentation in the lower reaches of the Yellow River, posing hidden dangers such as floods and waterlogging disasters, which directly impact local social security and economic development. Warping dam projects, which began in the 1950s, integrate functions such as soil and water conservation, flood prevention and disaster reduction, and warping for farmland creation, and have gradually become an important “lifeline” for ecological management in the Loess Plateau [1]. At present, although warping dam projects are constantly being constructed and innovated, there are still problems such as unscientific planning and design and uneven construction quality, which directly affect the ecological environment protection and development of the Loess Plateau area [2]. In this regard, it is imperative and timely to actively explore the countermeasure paths for the construction of warping dam projects in the Loess Plateau area in the new era.

2. The value and significance of warping dam project construction in the loess plateau area

2.1. Ecological value: Consolidating the barrier for regional soil and water conservation and ecological restoration

For a long time, the Loess Plateau area has been facing severe soil erosion. Warping dam projects themselves have the functions of "blocking, storing, and silting", which are of great significance for soil and water conservation in the Loess Plateau [3]. From the perspective of sediment interception, a single warping dam project can intercept 2,000 to 5,000 tons of sediment annually, which can effectively alleviate the problem of sedimentation in the lower reaches of the Yellow River [4,5]. From the perspective of water storage, the project can convert surface runoff into water resources, which can effectively improve the local water source conditions and promote the hydrological cycle. In addition, the project can promote the improvement of the local microclimate. For example, it can use functions such as water storage of the dam body to form a small wetland ecological environment, promote the growth of local herbs, shrubs and other plants, and improve the local ecological environment [4].

2.2. Economic value: Promoting sustainable agricultural development and rural economic growth

Affected by factors such as poor soil and uneven precipitation, agricultural production in the Loess Plateau area lacks stability. The advancement of warping dam projects can effectively improve this situation. On the one hand, it can increase soil fertility through "blocking, storing, and silting", which effectively promotes the sustainable development of the local agricultural economy. On the other hand, compared with other lands, the dam land created by the project is rich in humus, which can effectively increase crop yields and lay a solid foundation for local food security. In addition, the construction and development of the project have also brought new opportunities for the development of local characteristic agriculture. For example, in the process of warping dam project construction in areas such as Yulin, Shaanxi, industries such as jujube and apple planting have been vigorously developed, which has effectively increased the income level of local farmers and injected new impetus into the development of the local rural economy [6].

2.3. Social value: Supporting rural revitalization and coordinated regional development

The construction of warping dam projects not only increases soil fertility and improves the yield of local food crops, but also promotes the "leveling" transformation of cultivated land, laying a solid foundation for the development of agricultural mechanization. Through the application of agricultural machinery, the efficiency of local agricultural production has been significantly improved [7]. At the same time, the project can also conserve local water sources, which can effectively solve the problem of domestic water use for local farmers. In addition, under the background of the project construction, industries such as rural tourism and rural e-commerce in the Loess Plateau area are developing vigorously, which also promotes the continuous upgrading of the agricultural industry and provides an important driving force for the implementation of the rural revitalization strategy and coordinated regional development.

3. Problems in the construction of warping dam projects in the loess plateau area

3.1. Planning and design level: lack of systematicness, scientificity, and poor adaptability

Scientific engineering planning and design are important foundations for ensuring the quality of warping dam projects. However, current warping dam projects in the Loess Plateau have problems such as insufficient systematicness, scientificity, and adaptability in planning and design, which affect the project quality and function

performance. For example, in some river basin areas, the local river basin hydrological conditions are not fully considered during the construction of warping dams, and the distance design between dam bodies is unreasonable. This directly increases the local flood risk [8]. At the same time, the dam body coverage is insufficient in some areas. The existence of such "blind spots" poses great challenges to the overall soil and water conservation work. In addition, some warping dam designs adopt a "one-size-fits-all" approach, and the parameter design is not combined with local actual conditions. This leads to insufficient adaptability of the project and affects its actual function performance.

3.2. Project construction level: Uneven construction quality and ununified construction standards

At present, construction quality issues are prominent in the construction of warping dam projects in the Loess Plateau. On the one hand, construction units have problems such as simple equipment and unreasonable construction processes, resulting in substandard quality of warping dams. On the other hand, some construction units do not do a good job in controlling the quality of raw materials, such as using low-quality raw materials. This directly affects the quality of warping dams. In addition, the problem of ununified construction standards is also widespread. There are certain differences in relevant construction standards among different provinces, autonomous regions, cities, and counties. For example, the dam height standards in some areas are inconsistent with those in other areas. This situation not only affects the actual quality of warping dams but also brings certain difficulties to subsequent project acceptance and maintenance management [9].

3.3. Operation and management level: Imperfect management and protection mechanisms, and lagging post-maintenance

High-quality operation and management are the key to ensuring the effective operation of warping dam projects. However, current warping dam projects in the Loess Plateau generally have the problem of "emphasizing construction while neglecting management". For instance, some areas do not attach importance to the subsequent operation and management after the completion of warping dams, nor do they establish special departments for supervision and maintenance. This causes some warping dams to suffer from severe sedimentation within 3 to 5 years after completion, affecting the performance of their soil and water conservation functions [10]. Secondly, there are also problems in post-maintenance. For example, there is a lack of sufficient fund planning, the channels for social participation in maintenance and management are not fully utilized, and the enthusiasm of the masses to participate in management is insufficient. These factors all affect the effective operation of warping dams.

3.4. Monitoring and early warning level: Imperfect monitoring system and weak risk prevention and control capabilities

Currently, the layout of warping dam monitoring stations in the Loess Plateau is not reasonable. They are mainly concentrated around some key river basins or large-scale warping dams, failing to achieve full coverage. This leads to inadequate monitoring during the subsequent operation of the dams. In addition, the risk response system for warping dams is imperfect in some areas. On the one hand, monitoring personnel still use manual inspection methods to collect and analyze data, which has obvious shortcomings such as poor timeliness and long cycles. This affects the actual risk prevention and control capabilities. On the other hand, due to the lack of scientifically designed emergency plans, the risk prevention and control as well as emergency response capabilities of warping dam projects in some areas are insufficient. This seriously affects the quality and function performance of warping dam projects.

4. Effective countermeasures for the construction of warping dam projects in the loess plateau area

4.1. Improve the planning system to realize the unity of "scientific layout" and "precise design"

Establishing a planning mechanism of "basin overall planning + regional adaptation" is the key to solving the planning and design problems of warping dam projects in the Loess Plateau area [11]. To this end, the overall plan for warping dam project construction should be formulated based on the conditions of the Yellow River tributaries. During this process, the construction scale, standards, and goals of warping dam projects in different river basins and regions should be clarified to implement the concept of "scientific layout". For example, in river basins with severe soil erosion such as the Wuding River, a "cascaded dam system" design should be adopted to increase the construction density of warping dam projects, thereby further highlighting their value in soil and water conservation. Secondly, systematic survey work should be carried out. For instance, a dedicated survey team can be organized to conduct detailed surveys and analyses of the hydrology, geomorphology, soil, climate, and other environmental conditions in the construction area. On this basis, warping dam projects that match and coordinate with the above factors should be built to ensure the scientificity and forward-looking nature of the project construction.

In addition, technologies such as BIM and artificial intelligence can be used to conduct model simulation and analysis for warping dam construction during this process, thereby further improving the adaptability and scientificity of the project construction [12]. Furthermore, the integration of warping dam projects with local industrial development should be considered. During the design process, full cooperation and planning with local agricultural, tourism, and other departments should be carried out to align the construction of warping dam projects with the advancement of the local rural revitalization strategy. For example, in areas with strong tourism development potential, facilities such as viewing platforms and running tracks can be planned and designed around warping dam projects to better meet the needs of local industrial development, maximize the radiating effect of warping dam projects, and achieve the goals of precise design and multi-party win-win.

4.2. Strengthen construction supervision to promote the coordination of "quality control" and "standard specification"

First, the access mechanism for construction units should be improved. For example, construction units must have relevant project experience or qualification to contract Grade III or above projects, and possess professional equipment and talents. This approach can effectively ensure the construction quality of warping dams. During the construction process, "third-party testing" can also be introduced to conduct full-process supervision of the construction process and ensure that the construction quality meets the standards. Secondly, the raw material quality inspection system should be improved. The application of raw materials in the construction of warping dams should be supervised throughout the process. Once quality problems are found, responsibility tracing should be carried out immediately.

On this basis, the scientificity and safety of raw material inventory should be ensured. For example, during the storage of cement, the warehouse should be treated to be rainproof and moisture-proof to ensure the quality of raw materials and their effective use in subsequent processes. Furthermore, the construction acceptance standards should be improved. Relevant departments can take the lead in accelerating the issuance of documents on the construction quality and acceptance standards for warping dams in the Loess Plateau, and clearly stipulate the quality indicators and technical requirements of the projects to ensure the construction quality of warping dam projects [13]. On this basis, attention should be paid to the dynamic update of standards. For example, relevant standards and specifications should be dynamically adjusted based on local climate change and technological

development in the new era to comprehensively improve their timeliness and scientificity.

4.3. Optimize the management and protection mechanism to promote the combination of "responsibility implementation" and "fund guarantee"

First, it is necessary to clarify multiple management entities and further define the responsibilities of entities at all levels. For example, a diversified warping dam management and protection model can be established, with government departments as the leading force, village collectives as the main responsible parties, and professional institutions extensively participating. This model can give full play to the management and protection efficiency of multiple entities. On this basis, the specific responsibilities of each entity should be clarified. For instance, relevant government departments are responsible for regularly assigning professionals to conduct dam inspection work to prevent potential risks. Village collectives can set up their own dam protection teams to take charge of the daily maintenance and management of warping dams. Professional institutions such as water conservancy management departments can provide professional technical services for the repair and maintenance of warping dams. Second, it is essential to improve fund guarantees.

Relevant government departments should establish a stable fund investment mechanism based on the actual situation of warping dam construction in the Loess Plateau. At the same time, they should actively encourage social capital to participate in the construction, management, and protection of warping dams. Relevant enterprises or individuals should be allowed to develop characteristic tourism, agriculture, and other industries around warping dam construction. This can better expand fund sources and give play to the role of warping dam projects in promoting local agricultural economic development [14]. Furthermore, the supervisory role of the masses should be fully exerted to ensure that multiple entities fulfill their duties and minimize the safety risks of warping dams. During this process, it is necessary to strengthen publicity and education for the masses. Village radio broadcasts, self-media communication, and other methods can be used to popularize knowledge about the construction, management, and protection of warping dams among local people. This will enhance their awareness of management, protection, and supervision, and create a good atmosphere where "everyone participates in management and protection, and everyone supervises management and protection".

4.4. Improve monitoring and early warning to realize joint efforts of "real-time monitoring" and "risk prevention and control"

To address problems in monitoring and early warning, the construction of warping dam projects in the Loess Plateau should continuously improve the monitoring and early warning mechanism. First, it is necessary to optimize the layout design of monitoring points to ensure full coverage. On this basis, digital technologies should be actively introduced to improve the timeliness and flexibility of monitoring and early warning. At the same time, modern digital platforms should be used to realize real-time sharing of warping dam monitoring and early warning information. This can avoid the problem of information silos that existed in previous manual monitoring and early warning [15]. Second, it is important to improve monitoring indicators and focus on comprehensive project benefit evaluation. For example, comprehensive monitoring and analysis should be conducted on local soil and water conservation, agricultural economic development, and other aspects. This will form a comprehensive monitoring report and lay an information foundation for the optimization and improvement of warping dam project construction.

Furthermore, it is necessary to optimize and upgrade the early warning system and early warning plans. For instance, a digital automatic early warning system can be introduced to monitor the operation status of warping dam projects in real time. An intelligent analysis system can be adopted to conduct intelligent analysis of monitoring data, detect potential risks in a timely manner, and then carry out effective handling and response.

In addition, it is also necessary to design and improve emergency plans, formulate early warning mechanisms for various emergencies and risks, clarify relevant handling procedures and main responsibilities, and regularly organize multiple entities to carry out emergency drills. This can comprehensively improve the coordination effect of various entities in risk prevention and control and effectively reduce the incidence of risk problems.

5. Conclusion

In general, there are certain practical problems in the construction of warping dam projects in the Loess Plateau area in the new era. In this regard, while scientifically analyzing these problems, we should constantly use new methods and countermeasures to improve the scientificity and effectiveness of warping dam project construction. This will enable warping dam projects to better play their roles and values, and lay a solid foundation for the realization of harmonious coexistence between humans and nature in the Loess Plateau area.

Disclosure statement

The author declares no conflict of interest.

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