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# Planning and Design of Slope Ecological Control Project and Gully Self-Care Project

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**Abstract:** Research on the slope ecological management and gully self-care design can provide the basis for ecological restoration and reconstruction. The method is to take the slope in the hilly and gully region of the Loess Plateau as the research object, observe the situation of soil and water loss encountered in the development and construction, analyze the forming factors and influencing factors, and analyze the problems related to slope ecology and gully construction during the construction and development. According to the above situation, analyze the slope ecological management and gully self-care engineering design. The following conclusion is made. The planning of slope ecological construction and gully self-care project through cross science and technology is of great significance for soil and water conservation, improvement of land appearance and maintenance of environmental construction.

**Keywords:** Slope; Ecological management; Gully self-care; Engineering planning

## 1. Introduction

Slope is an important planning object and research difficulty in ecological construction. In the past 30 years, a series of measures and plans have been adopted in engineering construction in China, including reducing cultivated land, expanding vegetation area, building warping dam and building gully. In the aspect of returning farmland to forest, with the support of the government and relevant departments, great achievements have been made in vegetation expansion and restoration, and soil and water conservation has been significantly improved. However, restricted by the huge natural background and geographical factors, there are still many hidden dangers, including landslide of side, slope and surface, subsidence of the repairing surface of gullies, destruction of vegetation balance and dam collapse. Therefore, it is of great significance to actively solve the problems of slope ecological balance and gully management, and deepen engineering planning and design for ensuring ecological balance and environmental safety. Deep engineering planning and design need comprehensive research and analysis from theory, technology, case and other aspects. With ecological governance and self-care projects as planning objectives, comprehensive governance as well as strict compliance with prevention and control norms should be taken to provide a guarantee basis for regional construction and security.

## 2. Research Status of Slope Ecological Management and Gully Self-Care

### 2.1. Topography and construction characteristics of Loess Plateau

The geographical characteristics of the Loess Plateau are complex topography and fragile ecological status. The loess hills and gullies form the ecological status of the slope, and there are the most serious soil erosion areas in the world. Slope gully system is an important component of the basin in this area, and it is also a basic control unit for controlling soil erosion, and restoring and reconstructing ecological environment. Gully and slope management project is the main measure of ecological construction in this area. According to historical records, as early as 400 years ago, soil and water conservation measures of building warping dams were invented locally, which can not only intercept sediment, conserve water and soil, but also silt up land for farmland. Until the 1950s to the mid-1960s, the main means of soil and water conservation in the Loess Hilly and gully region was to build dams at the bottom of gullies. However, due to the limited technical level and economic capacity, the design standard of flood discharge was low, and the investment in project construction was less, most of the dams collapsed one after another. From the mid-1960s to the late 1970s, the construction of basic farmland with small-scale projects, such as terraces, dam lands, and small watersheds, has been constructed and certain results have been achieved. However, there were some problems such as “attaching importance to engineering while neglecting forest and grass, attaching importance to repairing while neglecting management and protection, attaching importance to main body while neglect-

ing supporting facilities, attaching importance to water control while neglecting soil improvement, attaching importance to gully management while neglecting slope management". From the late 1970s to the late 1990s, a comprehensive management model with small watersheds as a unit was gradually formed. The combination of engineering measures, tillage measures and biological measures had been come up with which paid attention to the combination of controlling soil and water loss and economic development in the basin. Remarkable results were achieved in some areas, but it was still difficult to solve the ecological problems faced by the Loess Plateau as a whole

## **2.2. Current situation of slope construction in Loess Plateau**

In the large-scale management of slope and gully in the Loess Plateau, on the one hand, the effectiveness of the management project should be paid attention to; on the other hand, the important requirements of safety and sustainability should not be ignored. With the improvement of China's comprehensive national strength, the economic level has also risen to a very high level. The Chinese government has paid more attention to the management of the Loess Plateau, especially the support for slope and gully management has been greatly improved, and the economic input and construction scale have been at a very high level. Especially since the 21st century, the Loess Plateau has carried out large-scale soil and water conservation and ecological construction activities, such as returning farmland to forest, dam system construction, changing slope to terrace and gully land reclamation. The local land use and ecological environment have undergone profound changes, which has significantly changed the water and sediment situation of the Yellow River Basin, improved the regional ecosystem service function and significantly improved the residents' life. However, while the slope and gully management has achieved great results in the Loess Hilly and gully region, some problems appear such as unclear mechanism, immature technology and lack of construction technology, etc.

## **2.3. Increasingly prominent ecological security issues**

Because the stability mechanism of slope-vegetation system is not clear, the instability phenomenon of slope-vegetation system occurs frequently, the optimal allocation mode of slope-vegetation is still immature, and the problem of soil and water loss is still serious.

The slope and gully management project has relieved the pressure of cultivated land tension and consolidated the achievements of returning farmland to forest. However, problems such as poor stability of high slope, uneven settlement of newly built land and aggravation of salinization and alkalization often occur. Therefore, it is ur-

gent to construct a stable slope-gully composite system and develop key ecological regulation and control technologies for slope-gully management to ensure the ecological security of the basin.

Warping dam is the key line of defense in the comprehensive management system of river basin. Through "blocking, storing and silting", flood and sediment can be retained on the spot, which can not only effectively prevent soil erosion, but also form dam land. It can make full use of water and soil resources. The damage of warping dams occurs frequently, and the safe utilization of water and sediment in dam land faces technical bottlenecks. In recent years, under the global climate change, the local extreme rainstorm occurred frequently in the Loess Plateau, which threatened the ecological security of the watershed. Therefore, it is urgent to study the impact mechanism, process and effect of gully and slope management projects on ecological security of river basin, and to develop and integrate gully and slope management technology with the fundamental premise of ensuring ecological security of watershed.

## **3. The Main Problems and Key Points Need to Be Solved Urgently in Modern Slope Ecological Management**

### **3.1. Evolution process and control mechanism of ecological disasters in the basin**

The main content of this study is related engineering planning which aims at slope ecological management and gully self-care, including ecological security and technical measures. In order to better achieve the purpose of management and improvement, the research direction should focus on how to identify the impact factors of ecological security risks, and the focus is also on ecological risk and stress factors. Therefore, it is necessary to clarify the evolution process and law of ecological disasters, quantify the impact of natural and human factors on the evolution process of ecological disasters, solve the problems of ecological disaster evolution and prevention and control mechanism, and take it as the theoretical basis for establishing ecological security guarantee technology system. Further measures are proposed to establish a theoretical framework for multi-scale watershed ecosystem evolution analysis from the perspective of watershed and slope-gully systems. Based on field investigation, comprehensive measurement and model simulation, the main control factors affecting the ecological security of the basin are systematically sorted out. The stress factors and the induced factors of ecological risk are analyzed, and the influence mechanism of gully and slope management project on the ecological security of the basin, the temporal and spatial evolution characteristics of the ecological disasters and the prevention and control mechanism are revealed.

### **3.2. Collaborative mechanism of gully and slope management project to enhance ecological security of the basin**

It has become an urgent task to realize the healthy, stable and sustainable development of basin ecosystem. However, some researches focus on the single effect of gully and slope management engineering, and the research on the synergistic effect of comprehensive consideration of gully slope management project and improving ecological security of the basin needs to be deepened. As the basic unit of ecological management in Loess Hilly and gully region, the ecological security of small watershed is affected by slope and gully management projects at the same time. The ecological effects of gullies and slope management projects interact and overlap each other. To study the synergy and mechanism of gully slope management projects to enhance the ecological security of the basin is the theoretical basis for the research and development of the key technologies of gully-slope collaborative management and improving the ecological security of the basin.

### **3.3. Ecological effect measurement technology of gully and slope management project**

To reveal the ecological security effect of gully and slope management project and identify the main disaster causing factors are the basic premise for developing ecological security guarantee technology of gully and slope management project and evaluating the ecological security guarantee effect of demonstration project. The existing assessment of ecological security effect is mostly based on remote sensing and socio-economic statistical data at the macro regional scale, which is difficult to meet the needs of ecological security effect assessment of slope, gully and basin on micro scale. Therefore, the ecological security effect measurement technology of gully and slope management engineering has become one of the key technical problems to be broken through in this study. Based on the gully investigation, modeling analysis, positioning observation and process analysis, the ecological security effect evaluation index system as well as weight, benchmark parameters and threshold value suitable for small-scale area are developed, and a breakthrough is made in the formation of measurement technology.

### **3.4. Ecological stability improvement technology of slope-vegetation system**

According to the problems of low stability of slope vegetation system, frequent occurrence of ecological disasters and poor stability of vegetation soil integrated configuration mode, diagnose the main control factors affecting the stability of slope vegetation system, establish a rapid diagnosis model of slope vegetation system stability, and evaluate the risk of ecological disasters

caused by slope vegetation system instability; establish the quantitative relationship between the root characteristics of slope-vegetation system and the stability of root soil complex. Clarify the effects of eco hydrology and soil and water conservation of slope vegetation system. Determine the suitable types of grass and irrigation and the allocation mode. And put forward the technology of improving the ecological stability of slope vegetation system.

### **3.5. Ecological safety control technology for slope engineering and gully management**

In view of the serious problems such as drastic changes of underlying surface, manual cutting of high and steep slopes, and potential ecological hazards of newly built land caused by large-scale slope and gully rehabilitation projects such as “gully management and land reclamation” and “cutting mountains and building cities” implemented in the Loess Plateau, construct artificial disturbed slope engineering safety prevention and control and ecological green technology, optimize settlement control measures of gully management project, summarize the efficient use mode of new land in gully management, and put forward ecological security control technology of slope engineering and gully management. The technology system of vegetation fixation and planting for ecological restoration of bare slope is the technology integration of creating plant fixation and growth conditions in different slopes according to local conditions. It includes point planting greening (which is applied to planting groove, swallow nest, fish scale pit, etc. in floating platform on high and steep slope surface), paving greening (planting blanket, ecological bag, geogrid, covering net), spray seeding greening (hydraulic spraying, soil spraying, spraying mixed planting), etc.

### **3.6. Safe and efficient utilization technology of water and soil resources in dam system engineering**

Aiming at the problems of ecological security and resource utilization of watershed, such as frequent occurrence of channel flood, high risk of silting dam damage and slow silting speed, the flood risk assessment technology based on dam system safety was developed, the rapid diagnosis method of dangerous warping dam was proposed, the technology of reinforcement and function improvement of warping dam system was developed, and the technical system of flood control security of warping dam system was constructed. By improving the way of water discharge and flood discharge of warping dam, the coupling of water, fertilizer, air and heat in dam land is further strengthened to form a safe and efficient utilization technology of water and sediment resources in warping dams. The slope stability evaluation should be based on the full identification of engineering geological conditions. According to the type and struc-

ture of slope rock and soil, comprehensively use engineering geological analogy method and limit equilibrium calculation method. Before the slope stability calculation, according to the slope hydrogeology, engineering geology, rock mass structure characteristics and deformation and failing signs, make qualitative judgment on the possible failure form and slope stability state of the slope, the determine boundary range and geological model of slope failure, and judge the slope failure trend.

#### 4. Conclusion

In view of the current situation and disadvantages of slope surface in Loess Plateau, a series of design suggestions and engineering planning strategies are made for the problems existing in slope management and construction at this stage. Firstly, analyze the safety of slope ecological management and gully self-care, and carry out evolution on basin ecological disaster assessment, and analyze the mechanism of possible obstacles in the process of engineering treatment. Through the analysis of evolution mechanism, the ecological security of the watershed in the process of slope control and gully construction is allocated as a whole to ensure the safety, rationalization and coordination, and achieve optimization, technological innovation, integrated improvement and professional theoretical guidance; secondly, the analysis of the ecological security of the watershed is based on the comprehensive perspective, and study the integrated technology and construction technology of gully and slope management engineering to further strengthen the vegetation restoration, slope stability,

dam system stability, and the safe and efficient utilization of water and soil in dam land; the technical system and regulations of ecological security guarantee for gully and slope management project are put forward to provide technical support for managing slope and gully control in loess hilly and gully region, and further strengthen regional ecological security, production efficiency and sustainable development.

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