Future Development Direction of the Restoration of Mountains, Rivers, Forests, Farmlands, Lakes, and Grasslands and the Faced Problems

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Abstract In this paper, the definition, connotation, and internal relationship of mountains, rivers, forests, farmlands, lakes, and grasslands in China are elaborated, and the current situation of ecological restoration projects for mountains, rivers, forests, farmlands, lakes, and grasslands was introduced. Moreover, the problems that have arisen in the specific implementation process of pilot projects were analyzed, such as unclear target positioning, inaccurate analysis of ecological problems, insufficient engineering design systematicness, weak operability of evaluation standards, and weak coordination in engineering management. The development direction and major needs for the protection and restoration of mountains, rivers, forests, farmlands, lakes, and grasslands in the future have been proposed from four aspects: theoretical research, engineering design, effect evaluation, and monitoring and supervision.

Key words Mountains, rivers, forests, farmlands, lakes, and grasslands; Restoration project; Prominent problems; Development direction
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In November 2013, General Secretary Xi Jinping pointed out in the *Explanation on the Decision of the Central Committee of the Communist Party of China on Several Major Issues Concerning Comprehensively Deepening Reform* that "mountains, rivers, forests, farmlands, lakes, and grasslands are a community of life", innovating the concept of human - land relation with Chinese characteristic[1]. Since the 18th National Congress of the Communist Party of China, with the rapid advancement of China's ecological civilization construction, the ecological civilization ideas such as "mountains, rivers, forests, farmlands, lakes, and grasslands are a community of life", "humans and nature are a community of life, and humans must respect, respond to, and protect nature", "lucid waters and lush mountains are invaluable assets, as well as icy land" have gradually penetrated people's hearts. This is an important concept proposed from the macro perspective of ecological civilization construction, which contains important ecological philosophical ideas. After this concept was proposed, it received widespread attention from all sectors of society. After the 18th National Congress of the Communist Party of China, in accordance with a series of new ideas and instructions from the Central Committee of the Communist Party of China and the State Council, China has successively launched a number of pilot projects for ecological protection and restoration of mountains, rivers, forests, farmlands, lakes, and grasslands in various regions[2], with the aim of achieving the integrated management, protection, and restoration of mountains, rivers, forests, farmlands, lakes, and grasslands in the near future, and the various goals of ecological civilization construction.

However, there are still some limiting factors and practical difficulties in terms of resources, environment, management mechanisms, and technological applications during the implementation process. It will be an important task for the future development of ecological protection and restoration by breaking through these difficulties.

1 Connotation and internal relationship of mountains, rivers, forests, farmlands, lakes, and grasslands

Geographically speaking, "mountains, rivers, forests, farmlands, lakes, and grasslands" is a popular expression for different types of land cover. Ecologically speaking, it is also a combination of different types of ecosystems. There are different perspectives for classification between mountains, rivers, lakes and forests, farmlands, grasslands. Mountains, rivers, and lakes emphasize geographical and geomorphological features, while forests,

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farmlands, and grasslands are mainly considered from the perspective of surface cover or ecosystem types. From this classification method, it accurately and vividly summarizes the main landform types and the vast majority of ecosystem types in China, while reflecting the complexity of China's landforms and the characteristics of ecosystem diversity[2].

General Secretary Xi Jinping pointed out: "the lifeline of a person lies in the farmlands, the lifeline of the farmlands lies in the rivers, the lifeline of the rivers lies in the mountains, the lifeline of the mountains lies in the soil, and the lifeline of the soil lies in the trees". It deeply elaborates on the relationships among mountains, rivers, forests, farmlands, lakes, and grasslands. It profoundly points out that it should adhere to the principle of putting people first, and that the social-economic system and the natural ecosystem composed of natural resource elements such as mountains, rivers, forests, farmlands, lakes, and grasslands must maintain coordinated development through synergistic effects. The development of human beings and the development of natural ecology together constitute a complex system of symbiosis, coexistence, sharing, and progress between humans and nature, which is called the natural-social complex ecosystem[3].

There are various connections between things, which have objectivity, inevitability, and universality. In the natural ecosystem composed of mountains, forests, grasslands, rivers, lakes, farmlands, deserts, *etc.*, there are always various connections among various components, and they influence and depend each other. This relationship is not only a relationship between the whole and the parts, but also a relationship between the parts. This relationship forms a close organic chain, and one pull can affect the whole body.

In this complex ecosystem, "mountains, rivers, forests, farmlands, lakes, and grasslands" occupy different positions and play different functions. They are interrelated and complementary in terms of their functions, and cannot be replaced by each other[4-5]. Ecosystems have three basic characteristics: integrity, systematicity, and comprehensiveness[6], and each system works together. Each of the components plays a natural regulatory role in water conservation, soil conservation, wind and sand fixation, carbon sequestration, and other functions. It fully reflects the self-sustaining and self-renewal functions of the ecosystem, while always maintaining the overall integrity of the system.

Mountains, rivers, forests, farmlands, lakes, and grasslands together form an interdependent and organically connected whole, providing a material foundation and necessary conditions for the continuation of human civilization. Human economic and social activities directly or indirectly affect the operation of the ecological system of mountains, rivers, forests, farmlands, lakes, and grasslands. At the same time, they scientifically define the intrinsic connection and relationship between humans and nature, express the idea of the relationship between humans and the land, clarify the deep connotation of the community with a shared future of mankind, harmonious coexistence between humans and nature, and the important significance for sustainable development of humanity[7].

2 The current situation of ecological restoration projects in mountains, rivers, forests, farmlands, lakes, and grasslands

At the 2018 National Conference on Ecological Environment Protection, General Secretary Xi Jinping emphasized that promoting the construction of ecological civilization in the new era must adhere to six principles, including that mountains, rivers, forests, farmlands, lakes, and grasslands are a community of life. He pointed out that "mountains, rivers, forests, farmlands, lakes, and grasslands are a community of life. It needs to take into account all aspects, implement comprehensive policies, and take multiple measures to carry out ecological civilization construction in all directions, regions, and processes"[8]. To achieve ecological civilization construction in the new era, it is necessary to implement the new development concept and continue to carry out integrated protection and restoration of mountains, rivers, forests, farmlands, lakes, and grasslands. Therefore, this determines that this work is inevitably an important practical path to promote the construction of ecological civilization, achieve harmonious coexistence and common development between humans and nature.

In June 2020, the National Development and Reform Commission and the Ministry of Natural Resources jointly issued the *Overall Plan for Major Projects of National Important Ecosystem Protection and Restoration* (2021 – 2035), which clearly proposed the implementation of nine major ecological protection and restoration projects, including the construction of natural reserves and the protection of wildlife such as "the Northeast Forest Belt, the Northern Sand Control Belt, the Qinghai – Tibet Plateau Ecological Barrier Zone, the Yangtze River Key Ecological Zone, the Yellow River Key Ecological Zone, the Southern Hilly Zone, the Coastal Zone, and the National Park". Subsequently, the "1 + N" planning system was formed by the *Construction Plan for Major Ecological Protection and Restoration Projects of the Northern Sand Control Belt* (2021 – 2035), the *Ecological Protection and Restoration Plan for the Ecological Barrier Area of the Qinghai – Tibet Plateau*, the *Construction Plan for Major Projects of Nature Reserve and Wildlife Protection* (2021 – 2035), the *Construction Plan for Major Projects of Coastal Ecological Protection and Restoration* (2021 – 2035), the *Construction Plan for Major Ecological Protection and Restoration Projects of the Northeast Forest Belt* (2021 – 2035), and the "*Dual*" *Planning*. It is an implementation plan for promoting ecological protection and restoration in China in the current and future periods, and is an important basis of formulating implementation plans for regional ecological protection and restoration, carrying out preliminary work for key projects, and arranging support policies in relevant fields.

In 2020, the Ministry of Natural Resources, the Ministry of Finance, and the Ministry of Ecology and Environment issued the *Guidelines for Ecological Protection and Restoration Projects of*

Mountains, *Rivers*, *Forests*, *Farmlands*, *Lakes*, *and Grasslands* (*Trial*). The guideline adheres to the concept that "mountains, rivers, forests, farmlands, lakes, and grasslands are a community of life" and is a specific standard for systematically and comprehensively guiding China's ecological protection and restoration practices. The principles and general regulations for the protection and restoration of landscape engineering have been clarified, and specific requirements have been put forward for the scope and deadline of implementation, construction content, technical process, monitoring and evaluation, adaptive management, and engineering management.

Since 2016, the Ministry of Finance, the Ministry of Natural Resources, and the Ministry of Ecology and Environment have successively organized and implemented 5 batches of 44 integrated protection and restoration projects for mountains, rivers, forests, farmlands, lakes, and grasslands in 25 key regional river basins of 24 provinces, autonomous regions, and municipalities of China[9]. These projects include five major types of ecological protection and restoration projects: abandoned mine restoration, comprehensive watershed management, land consolidation, polluted soil remediation, and biodiversity conservation[10]. It has played a positive role in improving the quality and service functions of ecosystems, maintaining ecological diversity, optimizing the spatial pattern of national territory, and safeguarding national ecological security. It has also played an important demonstration effect in implementing General Secretary Xi Jinping's ecological civilization ideology and practicing the concept that "mountains, rivers, forests, farmlands, lakes, and grasslands are a community of life".

In the ecological protection and restoration projects in mountains, rivers, forests, farmlands, lakes, and grasslands, the research on theoretical foundations[11-20], implementation paths[21-23], institutional design[24-25], technical standards[26-28], and practical exploration[29-36] has been carried out. The research results are relatively rich, but the practical application is still in the exploratory stage.

3 Problems faced by the ecological restoration project of mountains, rivers, forests, farmlands, lakes, and grasslands

After years of demonstration and guidance through a series of ecological protection and restoration projects in mountains, rivers, forests, farmlands, lakes, and grasslands, it has driven the research on the theoretical basis of integrated protection, technical standards of institutional design, and restoration paths in various regions to a certain extent and scope. It has carried out many practical explorations in the planning and layout of protection and restoration, governance models, and the application of advanced concepts, and has accumulated valuable experience in carrying out ecological protection and restoration projects as a whole and systematically, playing an important role in maintaining national and regional ecological security.

In reality, the ecological protection and restoration projects of mountains, rivers, forests, farmlands, lakes, and grasslands currently implemented in China are basically in the pilot demonstration stage. They are still in the exploratory stage of integrating ecosystem elements such as forests, grasslands, wetlands, farmlands, and deserts, studying the mutual influence mechanisms and synergistic effects between different ecological elements, and improving the quality and function of ecosystems. The systematic research results are insufficient, and further in-depth research is still needed[37]. At the same time, further in-depth exploration is needed on the practical path of cross regional, large-scale, multi-domain, and multi-departmental overall collaborative promotion.

However, pilot projects in various regions have also encountered some problems and difficulties in the specific implementation process. For example, in typical arid areas with fragile and sensitive ecological environments, there are also technical difficulties and bottlenecks that are difficult to solve in the short term in the integrated protection and restoration projects of mountains, rivers, forests, farmlands, lakes, and grasslands in inland river basins, such as how to accurately grasp ecological issues, comprehensively formulate restoration goals and systematic engineering layouts, and localization and rewilding of restoration technologies.

(1) The positioning of ecological protection and restoration goals is not clear. Due to the lack of long-term ecological background monitoring in many places, the understanding on the background status and characteristics of the ecosystem is insufficient. When setting restoration goals, the definition of the state goals to be achieved by the entire ecosystem after restoration is unclear. Therefore, it is still difficult to break through the conventional setting of restoration goals and indicators, and there is a lack of overall and systematic consideration.

(2) Assessment of ecological issues is inaccurate, analysis depth of problem causes is insufficient, and grasp of the degree of ecological damage, quality decline, and service function reduction is inadequate. In the existing pilot projects for protection and restoration, although there is generally homogeneity in the problems of different watersheds in the same region, there is often less attention paid to the specificity and targeting of regional ecological problems, ignoring the correlation and lag characteristics of various ecological problems, and resulting in unclear setting of subsequent restoration tasks.

(3) The setting of engineering tasks is still carried out in a segmented manner, with insufficient understanding on the externalities, irreversibility, and irreplaceability of ecosystems, and weak systematic connections between projects. There is a phenomenon of individual warfare and element segmentation, with good local effects but poor overall effects[37].

(4) It is lack of practical repair effect evaluation technology system. Due to differences in different scales for current relevant engineering acceptance standards, evaluation and monitoring indicators of repair effect, the design of indicator system is quite complex. Moreover, the method and model of indicator calculation involve a large number of calculation parameters of various types,

such as climate, hydrology, soil, species, *etc.* The acquisition of data needs to be based on long-term observation. In the actual evaluation process, there are significant difficulties in both operability and data acquisition. The technical method system for effect evaluation is still under research and exploration.

(5) The level of refinement in comprehensive management of engineering implementation at different scales is relatively low, and the engineering management system is incomplete. The overall design and systematic consideration of the project are insufficient, there is a lack of localized and applicable technologies[38-39], and the supervision of the entire process of engineering implementation is insufficient, resulting in a lack of optimism in the sustained effectiveness of the restoration.

4 Future development direction of mountains, rivers, forests, farmlands, lakes, and grasslands restoration

Due to the overall fragility of China's natural ecosystems, regional ecological carrying capacity and environmental capacity are insufficient, and ecological protection pressure brought about by economic development is severe. Unreasonable resource development causes frequent ecological damage, and systemic protection difficulty and pressure are high. There is an urgent need to strengthen interdisciplinary theoretical research and engineering practice exploration and application based on ecology as the core[40]. It is an important task and research direction for the future ecological protection and restoration of mountains, rivers, forests, farmlands, lakes, and grasslands in China by breaking through limiting factors such as resource and environment, top-level design, management mechanisms, and technological applications.

(1) In the face of large-scale, multi-domain, and cross-department pilot projects in the new era, it should conduct in-depth research on the coupling relationships and impact mechanisms between various ecological elements in the mountains, rivers, forests, farmlands, lakes, and grasslands systems. It should reveal the interactive coercion coupling relationships, stages, types, and coupling mechanisms between natural ecological elements and human activity elements under different dominant ecosystem functions in different regions[41], the theoretical and technical system for constructing the integrity of watershed/regional ecosystems, as well as the promotion path.

(2) The design of ecosystem protection and restoration projects should be tailored to ecological problems at different scales, following the concept of "one zone, one policy, one project". Its implementation should be carried out in an orderly manner from multiple dimensions, scales, and levels, and connected in series and parallel to form an independent, interconnected, and interdependent whole, achieving a cumulative effect of point, line, and surface restoration[40]. At the same time, efforts should be made to carry out the protection, restoration, and management of mountains, rivers, forests, farmlands, lakes, and grasslands system, covering innovative research on cross regional watershed ecological protection and restoration technologies such as upstream – downstream, offshore – land, and aboveground – underground.

(3) The establishment of evaluation indicators for the ecological protection and restoration effect of mountains, rivers, forests, farmlands, lakes, and grasslands should be subject to selection and setting of some typical, representative, and applicable evaluation indicators. At the same time, the accessibility and calculation convenience of each indicator data should also be considered to improve the representativeness and operability of the evaluation indicators for ecological restoration effect. The rationality and effectiveness of the indicator system can be effectively reflected through the evaluation results of the restoration effect, especially through the ecological system status information such as restoration degree, evolution direction, and existing problems. It should adjust and optimize the ecological protection and restoration plan, and provide decision support for the overall and systematic management of the ecosystem.

(4) The successful path of ecological protection and restoration of mountains, rivers, forests, farmlands, lakes, and grasslands lies in the systematic governance of multi element correlation, multi process coupling, and multi spatial and multi-scale collaboration. It is necessary to establish a comprehensive monitoring and supervision system for integrated protection and restoration, carry out research on multi spatial scale and multi element sky – air – ground collaborative comprehensive monitoring and evaluation technology, break through multi-source remote sensing, real-time monitoring and other big data collaborative fusion technologies, and study the establishment of a standardized and normalized remote sensing monitoring index system for ecological protection and restoration, as well as a representative and operational monitoring index system and technical methods for different regions on the ground. Additionally, the major strategic needs of full-chain ecological protection, restoration, and supervision for multi factor, multi-scale, cross medium, and composite system governance and restoration should be met.

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