

Research on Ecological Restoration Zoning of Land and Space: A Case Study of Shandong Province

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ABSTRACT

The key to the preparation and implementation of land space planning in the zoning of land space ecological protection and restoration is also the premise and basis for scientific and efficient land space ecological protection and restoration. Based on the natural geographical characteristics, dominant ecological service functions and prominent ecological problems in the study area, this paper takes Shandong Province as an example, and studies the ecological restoration zoning on the basis of the main functional zoning, so as to evaluate the ecological service capacity of the region, and establishes three levels of ecological restoration zoning. Shandong Province was divided into 6 first-level districts, 7 second-level sub-regions and 11 third-level districts, which basically clarified the geographical characteristics of regional space and the leading role of ecology in Shandong Province, identified the key areas of ecological restoration, and put forward suggestions for the development of land space governance.

KEYWORDS

land space; ecological restoration; Partition; Shandong Province

Ecosystems have important functions such as producing food, regulating climate, and maintaining water and soil, and the rapid changes in society and rapid economic development have brought about increasing population and rapid urbanization, but also caused certain negative impacts on ecosystems^[1]. Ecological restoration is a research that emerged in Europe and the United States in the early 20th century, which first focused on the protection of natural resources such as mountains, forests, and grasslands. Ecological restoration of land and space is the process of gradually improving, restoring and reconstructing damaged or degraded or completely damaged ecosystems by using natural or man-made means. With the increasing intensity of human development and the continuous deterioration of the global climate and environment, the protection and restoration of ecosystems has gradually attracted the general attention of all countries in the world, and the objects of ecological protection and restoration have gradually covered the land space represented by "mountains, rivers, forests, fields, lakes and grasses"^[2]. At present, ecological restoration is in a stage of rapid advancement, and the restoration of degraded ecosystems has become the focus of territorial and spatial governance. Ecological restoration of land and space is an important way to ensure the sustainable supply of ecosystem services, and comprehensive spatial analysis and planning for key protection and restoration are the key to the ecological restoration of land and space.

Under the concept of following the concept of life community of mountains, rivers, forests, fields, lakes, grasslands and sands, carrying out ecological restoration of land space is to improve the

spatial policy expression of regional ecosystem pattern, and carrying out ecological restoration of land space in the whole basin, all elements and in all directions has become an important way to strengthen the health and safety of land space ecosystem and promote the construction of ecological civilization in the new era of China.

1 Introduction to the study area and data sources

1.1 Introduction to the study area

Shandong Province is located on the east coast of China, located in the lower reaches of the Yellow River, there are two major areas in the territory of the peninsula and the inland, the Shandong Peninsula stretches out from the Bohai Sea and the Yellow Sea, and the Liaodong Peninsula is far away; The inland area is adjacent to Hebei Province in the northwest, Henan Province in the southwest, Anhui and Jiangsu Province in the south, and is located between 34° 22.9'-38° 24.01'N latitude and 114° 47.5'-122° 42.3'E longitude. The topography of Shandong Province is complex and diverse, which can be roughly divided into 9 landform types, including low mountains, hills, terraces, basins, plains, etc. Among them, the plain area accounts for 65.56% of the total area of the province, mainly distributed in the northwest and southwest of Shandong. The marine resources are abundant, and the economic development level of the marine aquaculture industry is relatively high; The land resources are diversified, which is characterized by high reclamation rate and few reserve resources. The physical geographical pattern presents the characteristics of "three mountains" (Mount Tai, Yimeng Mountain, Kunyu Mountains), "Three Plains" (Yellow Flood Plain in northwest Shandong, sedimentary plain in southwest Shandong, and alluvial plain in front of Jiaoji Mountain), "one island" (Miaodao Islands), "two seas" (Bohai Sea and Yellow Sea), "two rivers" (Yellow River and Grand Canal) and "two lakes" (Nansi Lake and Dongping Lake).

1.2 Data Sources

Socio-economic data, population, industrial structure and GDP are mainly derived from the data of the statistical department, which are mainly from the Shandong Statistical Yearbook and the Shandong Bureau of Statistics, and various chart resources are mainly from the Third Land Survey Database of Shandong Province (2019), the Forest Land Change Survey Database of Shandong Province (2018), the Second Wetland Survey Database of Shandong Province (2013) and the Land Use Change Survey Database of Shandong Province.

2 The connotation of ecological restoration zoning

The zoning study of territorial space ecological restoration aims to ensure the health of territorial spatial ecosystems, and promotes the integrated protection and collaborative management of regional ecosystems and social economy from a holistic and systematic perspective, which is of great theoretical and practical significance for the implementation of national ecological civilization construction and the promotion of territorial spatial ecological restoration^[3]. At present, the academic research on the zoning of ecological restoration of land space can be roughly divided into two categories: quantitative and qualitative. From the perspective of quantitative zoning, the ecological security pattern and the matching of supply and demand of ecosystem services are the main ones^[2]. From the perspective of qualitative zoning, it is guided by ecological issues, based on the concepts of "ecological regional unit" and "regional complex", and is a task for the comprehensive implementation of the outline of territorial spatial planning, the preparation and

implementation of territorial spatial planning, the determination of key ecological restoration areas, and the determination of the goals, tasks, key areas, and key projects of comprehensive territorial management and ecological restoration^[4].

On the whole, ecological restoration zoning is centered on regional differentiation, spatial differentiation and ecological zoning, and accurate identification of key areas of ecological restoration is the basis for scientifically formulating the zoning of ecological restoration in land and space. Theoretically, the zoning of land space ecological restoration should be combined with the local natural geographical conditions, leading ecological service functions and core ecological issues. The regional physical geographical characteristics and differentiation law are the macro scales that affect the spatial distribution of dominant ecological service functions, and whether the ecological functions can be effectively improved will directly depend on the threats of human activities to ecological functions and whether ecological problems can be effectively managed. Logically, the natural geographical conditions, the dominant ecological functions, and the core ecological problems correspond to the environmental background, goal orientation, and governance objects of ecological restoration, and the natural site conditions and core ecological problems jointly determine the distribution state and change trend of the dominant ecological functions. Therefore, based on the specific natural environment background, systematically identifying the ecological stress space under the action of human disturbance and ecological sensitivity is an effective way to identify the key areas of ecological restoration.

3 Zoning ideas and indicators

3.1 Zoning ideas for ecological restoration

Firstly, based on the theories of ecosystem, landscape ecology, human-land relationship and main functional area, the structure and main function of provincial ecosystem services were determined from the perspective of supply, regulation, cultural and support functions of ecosystem services. Secondly, the supply-demand relationship of climate, soil, and vegetation was organically combined with the role of activities on the ecosystem, and the supply-demand balance of ecosystem services in the region was measured, and the spatiotemporal matching law of ecosystem services in the region was clarified, and the spatial characterization was carried out on this basis^[5]. Thirdly, through the evaluation of different types of ecosystem services, the key factors affecting their role were identified, and the degree of adjustment of each factor was determined through the diagnosis and analysis of each factor. Fourthly, on the basis of the development and protection model, the corresponding ecological restoration zones are divided according to the main causes and constraints of the mismatch between resource supply and demand in each region. When the zoning structure is poor and the function is impaired, the ecological restoration of the sub-district or sub-region is carried out, the ecological restoration goals and the priority of cities, counties, towns and towns are clarified, and the overall coordination is carried out.

Based on a comprehensive analysis of the supply-demand relationship between ecosystem service supply, regulation, culture and support, this paper identifies the areas with a low degree of supply-demand matching, identifies and identifies the main obstacle factors, and then delineates the ecological restoration zones and proposes relevant countermeasures.

3.2 Technical methods of ecological restoration zoning

The selection of the zoning index system of ecological restoration should reflect the regional natural geographical conditions, the spatial differentiation of ecological functions, and the main

ecological problems, so that it can fully reflect the characteristics of the regional ecological environment and the law of natural differentiation. Due to the diversification of regional development goals, social needs, and land use patterns, there are regional spatial diversity in different regions, and there are significant regional differences^[6] (Table 1).

The first-level zoning takes the natural background characteristics of the region as the core, and the mountains, rivers, forests, fields, lakes and grasses as the basic units, highlighting the basic functions of the natural geographical pattern in land ecological restoration. According to the geomorphological characteristics of Shandong Province, Shandong Province is in the third tier of China's topographic ladder, and the terrain types are very complex, and the coastline is long and tortuous, which affects the local economic and social development and ecological protection. Therefore, based on the actual situation of Shandong Province, four indicators of altitude, topographic relief, vegetation type and coastline were selected as the first-level zoning indicators of ecological restoration.

The second-level zoning focuses on the dominant ecological service function of the region, and serves as the basic basis for the ecological restoration goal of improving the ecosystem service function. Ecosystem services refer to the natural environmental conditions and utilities that are formed and maintained by ecosystems and ecological processes^[7]. By studying the driving factors of ecosystem services in Shandong Province, the key factors that cause the decline of local ecosystem services are identified, and the productivity of ecosystems, such as forests, cultivated land, and water bodies is increased^[8].

The third-level zoning is the specific implementation unit of ecological restoration, which studies the sensitive problems of the ecological environment that evolve from nature and the pressure of ecological environment deterioration caused by human interference. These problems have greatly affected the objects and measures of ecological restoration. In view of the characteristics of the ecological environment and the existing ecological damage in Shandong Province, two indicators, namely air pollution and ecological water replenishment, were selected as the third-level zoning indicators of ecological restoration.

Table 1 Zoning index system of land and space ecological restoration in Shandong Province

partition	Criterion layer	Specific metrics
Level 1 partitioning	Physical geographical conditions	Elevation, topographic relief, vegetation type, coastline
Secondary partitions	Dominate ecological functions	Water conservation, soil conservation, biodiversity conservation, habitat quality
Three-level zoning	Ecologically sensitive issues	Air pollution problems, ecological water replenishment

4 Partition results

4.1 Results

The main ecological and environmental problems of land use in Shandong Province were divided into different regions. In the process of division, there is a certain degree of overlap between the two divisions^[9-11], for example, the overlap between the ecological restoration of water resources protection and the ecological restoration of ecological protection, the overlap between ecological restoration and the improvement of human settlements, and the ecological restoration of comprehensive land management, etc., can retain multiple dominant ecological functions according to the actual situation. The main ecological and environmental problems in Shandong

Province should be divided into different regions, and the demarcation of the three districts should be adapted to the regional social and economic conditions and development plans, and priority should be given to the rectification of key areas throughout the province. According to the regional index system, Shandong Province was divided into 6 regions, 7 sub-regions and 11 restoration areas (Table 2).

Table 2 Results of the first and second level zoning of land and space ecological restoration in Shandong Province

Level 1 partitioning	Secondary partitions
Ecological restoration area of soil and water conservation and water conservation in central and southern Shandong	Key area of ecological restoration in the mountainous and hilly areas of central and southern Shandong
	Key areas of ecological restoration along the Yellow River
	Key areas for ecological restoration along the Grand Canal
Soil and Water Conservation Ecological Restoration Area in Ludong Low Mountains and Hills	Key area of ecological restoration of low mountains and hills in eastern Ludong
Lubei Coastal Biodiversity Reserve	Key areas for the protection and restoration of the Yellow River Delta
	Key areas of ecological restoration along the Yellow River
Comprehensive land management area of sedimentary plain in southwest Shandong	Key areas for the treatment of coal mining subsidence in southwest Shandong
	Key areas of ecological restoration along the Yellow River
	Key areas for ecological restoration along the Grand Canal
Habitat improvement area of the Yellow Flood Plain in northwest Shandong	Key areas for ecological restoration along the Grand Canal
	Key areas of ecological restoration along the Yellow River
Island Ecological Restoration Area in the sea area	Key areas for ecological restoration in coastal waters

According to the overall pattern of "two screens, three belts, three plains and one sea" of the topography and landform of Shandong Province, the first-level sub-district is divided into six major regions, namely, the ecological restoration area of soil and water conservation and water conservation in central and southern Shandong, the ecological restoration area of soil and water conservation in the low mountains and hills of eastern Shandong, the coastal biodiversity reserve of northern Shandong, the comprehensive land management area of the sedimentary plain of southwest Shandong, the habitat improvement area of the Yellow Flood Plain in northwest Shandong, and the ecological restoration area of sea islands^[12]. The second-level zoning is divided into 7 sub-regions on the basis of the first-level zoning combined with the dominant ecological service function of the region. The third-level zoning is divided into 11 sub-districts on the basis of the second-level zoning and combined with outstanding ecological problems.

4.2 Analysis of results

For the soil and water conservation and water conservation ecological restoration areas in southwest Shandong and the ecological restoration areas of soil and water conservation in the low mountains and hills of eastern Shandong, ecological slope protection and vegetation restoration, soil conservation, vegetation greening, enclosure and protection projects, the construction of small

reservoirs, ponds and dams, and grain mills should be implemented according to local conditions, and the soil erosion caused by human activities should be strictly controlled, so as to build an ecologically clean small watershed. build Qilong Bay into a high-standard area of national soil and water conservation demonstration base; For the ecological restoration along the Yellow River, the Yellow River Delta wetland ecological restoration project can be implemented to restore wetland vegetation and natural features, strengthen biodiversity conservation and habitat restoration, promote land greening in the Yellow River Delta, create a high-level ecological barrier, implement soil salinization control projects, and improve site conditions. Ecological restoration along the Grand Canal can be achieved by promoting the construction of the riverside ecological corridor and implementing land greening along the Grand Canal, strengthening the construction of shelterbelt systems in villages and towns along the canal, vigorously developing waterfront ecological space, expanding green space, and protecting and restoring wetland ecosystems. The ecological restoration of coastal waters should focus on improving the quality and function of the ecological environment, carry out comprehensive management, create a "blue bay", implement the restoration project of the golden coastline, restore the natural attributes and landscape of the coast, and carry out ecological restoration according to the island's policies, so as to improve the quality and stability of the island ecosystem.

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