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Abstract. Landscape ecology is a new interdisciplinary subject that has developed rapidly in recent years and is the focus of current research on resources, environment and ecology. Landscape ecology relies on the theoretical framework of ecology, absorbs the essence of modern geography and systems science, and studies the type composition, structure (spatial pattern), function (ecological process) and evolution (spatial dynamics) of landscape units and their ecology. A comprehensive discipline that interacts with the learning process. This paper briefly introduces the development history of landscape ecology in China, summarizes the progress of landscape ecology research, briefly analyses the problems existing in landscape ecology research in China, and forecasts the research direction of landscape ecology.

1. Introduction

Landscape ecology is an interdisciplinary subject between geography and ecology. It is based on the landscape, through the exchange of energy flow, material flow, information flow and species flow on the surface of the earth, to study the spatial structure, internal functions and the relationship between the various parts of the landscape. In short, landscape ecology is a correlation analysis that represents the natural bio-integration of units in different regions. Its strength lies in concentrating the essence of geography and ecology, overcoming the weaknesses of both, combining the horizontal methods of geospatial research spatial interaction with the vertical methods of ecological research functions to explore spatial heterogeneity. Development and dynamics, the impact of spatial heterogeneity on biotic and abiotic processes and the management of spatial heterogeneity. China's landscape ecology started later than European and American countries, but it has developed rapidly in recent years. This study summarizes the research results and existing problems of landscape ecology in China, and looks forward to its future development direction.

2. Development of landscape ecology

Although the concept of landscape ecology has only been sixty years old, it has shown its vitality and has attracted the attention of ecologists all over the world. Landscape ecology is a relatively young and widely used branch of ecology, derived from geoscience, economic science, ecological science, and systems science. It is a natural extension of traditional ecological research to macro and spatial

development. Although its theoretical paradigm and disciplinary system have not yet been finalized, it can comprehensively study and analyze ecosystems in practice and spatial scales. Ecological methods are provided in ecological landscape design, landscape geochemical analysis and zoning, ecological construction and ecological engineering planning. Landscape ecology emphasizes the interaction of landscape pattern and ecological process on different scales. The change of landscape pattern is influenced by both biotic and abiotic factors, reflecting the spatial distribution of landscape elements and the changing trend of time, and affecting the corresponding ecological process. Land use/cover change is an important determinant of landscape pattern change, and its impact on landscape structure, function and change has become a hot issue in landscape ecology research. In recent years, famous ecologists such as Wu Yegang, Li Habin, Mark Ming and Fu Bojie have done a lot of work to promote the development of landscape ecology in China.

3. Research progress

3.1. Basic theoretical research

The basic theoretical research of landscape ecology is the premise and cornerstone of landscape ecology development, and it is the key to understanding and applying landscape ecology. In 1991, according to the theory of related disciplines, Xiao Yining proposed seven theoretical foundations of landscape ecology, which are of great significance to the establishment and improvement of the basic theories and systems of landscape ecology [1]. In recent years, scholars have also carried out a lot of research on the theoretical significance and application of major problems such as landscape heterogeneity, landscape connectivity, ecological scale and scale conversion. For example, Zhao Yutao et al. conducted a comprehensive review of landscape heterogeneity and proposed a new perspective [2]. Cai Bofeng reorganized the multi-scale spatial analysis method based on spatial type variables and numerical variables [3]. Fu Wei et al. introduced the theoretical basis, evaluation methods, applications and main conclusions of ecological connectivity, and prospected the future research direction of ecological connectivity in landscape ecology to promote the further development of ecological connectivity research [4].

3.2. Methodological study

The landscape ecology research method is the means and guarantee for promoting the development of landscape ecology theory and ensuring the effective application of landscape ecology. The Methodology of Landscape Ecology is one of the focuses of Chinese landscape ecology research, but at present, there is no landscape ecology major in China. Landscape ecology is only a research and work area of some scholars, which also shows that it has become a profession in China and has a lot of room for development.

3.2.1. Data acquisition and processing method. At present, satellite remote sensing image is the main data source, and 3S technology has become a trend of landscape ecology. On the one hand, it is limited by the parameters of the sensor and the revisiting ability, and on the other hand, it is limited by weather conditions such as cloud occlusion, making it difficult to obtain images conforming to the research phase or research accuracy. The current common approach is to integrate existing data. The quantity and quality have been greatly improved, mainly in the spatial resolution significantly improved, and the value of image information is improved; the orbiting satellites form a constellation system, which greatly improves the revisiting ability; the hyperspectral is toward hyperspectral development. With the advancement of China's aviation industry, domestic remote sensing satellites have also achieved rapid development. Remote sensing (RS), geographic information system (GIS) and global positioning system (GPS) are widely used in the study of landscape patterns in different categories and scales. The three are also called 3S technologies. China's landscape ecologists mainly apply remote sensing to three aspects: 1 vegetation and land use classification; 2 quantification of ecosystem and landscape features, spatial pattern, vegetation structure, habitat characteristics and biomass calculation of different scale

patches; Landscape dynamics research, temporal and spatial changes in land use, vegetation dynamics, community succession, and human activities. The application of GIS in landscape ecology mainly includes: analysing the landscape spatial pattern and its changes; determining the spatial correlation of different environmental and biological characteristics; determining the size, shape adjacency and connectivity of the patch; analysing the landscape Direction and flux of energy, matter and biological flow; image output of landscape ecological variables; simulation of landscape ecological processes. The application of GPS in landscape ecology mainly focuses on the following aspects: monitoring the movement of animal activities; making thematic maps; positioning and ground correction of aerial photos and satellite remote sensing images. In short, 3S technology has greatly changed the research methods of landscape ecology, providing an extremely effective research tool for landscape ecology, and gradually becoming an indispensable means of data collection, storage, processing and analysis.

3.2.2. Landscape information extraction method. In remote sensing image information extraction and landscape classification, past studies have mostly used the supervised classification of human-computer interaction. It is a pixel-oriented classification method that ignores the spatial correlation between pixels and cannot avoid "homologous and homogeneous". The occurrence of foreign matter is suitable for medium and low resolution images. The object-oriented classification method is based on the determination of various spectral and topographic texture features of the classification object, and extracts the feature information from the layer by item, which is more suitable for high-resolution images. Classification is usually combined with qualitative and quantitative, and the original image is segmented on multiple scales by calculating various normalized indices, supplemented by different band weights. For example, Cao Bao used the object-oriented method to classify the landscape in Beijing, which greatly improved the accuracy and overcome the “salt and salt effect” caused by the high-resolution image information of the high-resolution image [5]. Ma Shudong et al. based on the decision tree algorithm in Hainan, through the construction of improved water and land index WLI, general vegetation index VIUPD, Qiao shrub index GSI and other object-oriented landscape information extraction, also achieved higher precision than traditional supervised classification [6].

3.2.3. Application of spatial statistical analysis. In the statistical analysis of the landscape pattern, the spatial data are not independent of each other, and do not meet the requirements of random variables, and cannot be subjected to large-scale repeatable tests, so the application is limited. Spatial analysis statistics are different from mathematical index-based pattern index analysis, which mainly reflects spatial correlation and variation, so it can be used to study the spatial correlation of landscape composition, plaque properties and parameters, landscape pattern tropism, and pattern. Scale effects, patterns and process interactions have strong application prospects [7]. At present, many studies have begun to focus on the use of geostatistical analysis methods such as geostatistics and wavelet analysis to explore the intrinsic relationship and ecological significance of urban landscape patterns.

3.3. Landscape pattern research

Landscape pattern analysis is the main research tool in landscape ecology. It is helpful to understand the ecological process in space. It is also the basis for studying the potential driving force of landscape pattern or identifying various ecological environment problems at the landscape level and designing countermeasures. The research focuses on suburban landscapes, agricultural landscapes, forest landscapes, arid landscapes and wetland landscapes. For example, Zeng Hui et al. conducted a spatial analysis of the urbanization process and its constraints; Liu Haijiang used the Hunshandake Sandy Land in Inner Mongolia as an example to analyze the landscape changes of damaged sandy ecosystems [8]; Yuan Li et al. Study on the evolution of land use landscape pattern in Long Wetland [9]. The landscape pattern index is a commonly used method for landscape pattern analysis. It can provide a simple and effective quantitative information for landscape ecology research by providing a high degree of overview of the composition and spatial structure of landscape mosaics. However, there is a high correlation between most landscape pattern indices, and the interpretation of the index needs to be based

on different pattern characteristics and the variation of the index with the pattern, especially the nonlinearity often existing between the pattern index and the type components. Relationships bring difficulties to the interpretation of the index.

3.4. Landscape ecological evaluation and planning design

Through the landscape ecological evaluation, it is possible to have a comprehensive understanding of the landscape conditions, the sensitivity of the local landscape system, the level of interference and the level of its interference status, and the pattern of productivity levels, so that the landscape ecological planning can be relied upon and law-abiding. It is also a necessary foundation for landscape science management. Chinese scholars have done a lot of work in landscape ecological evaluation, and the research scope is also very broad, including rural landscapes and urban landscapes; there are also natural landscapes and artificial landscapes. Landscape ecological planning is mainly applied to the landscape ecological planning of cities, rural areas, scenic areas and forests. The landscape ecological design types include the multi-layered Sangji fish pond system, the harmonious symbiosis of agroforestry, the comprehensive utilization of the agro-forestry three-dimensional landscape design, and the recycling of the courtyard landscape ecological design. At present, the scientific basis of landscape ecological planning and design has been increasingly valued, and it has begun to advocate the effective construction of a bridge between basic research and planning and design, so that scientific research results can be more applied to practice. At the same time, landscape ecological planning design considers the relationship between landscape pattern and ecological process and landscape ecological function, and enhances the scientific nature of planning and design results.

4. Currently Problem

Landscape ecology in China has developed rapidly and the research results have been fruitful. However, in general, China's landscape ecology research still lags behind Europe and North America. It is more about the introduction and application of theories and methods in Europe and North America. It is basically in the state of imitation and tracking, and its originality is insufficient. The main problems in landscape ecology in China are as follows: (1) Abuse and misuse of landscape pattern index. The landscape index has certain limitations, and its ecological significance research is not clear enough. (2) There are relatively few studies on the relationship between landscape pattern and ecological process. (3) "3S" data processing reliability and accuracy are not enough. The wide application of 3S technology provides great convenience for the study of landscape ecology, but the accuracy and accuracy of the data need to be improved. (4) The discipline is weak and the characteristics are not clear enough. Studies with strong interdisciplinary focus are mostly on landscape management, cultural landscapes and rural landscapes, which are closely related to humans, while the core aspects of landscape ecology are less involved in more than two disciplines. (5) Research methods need to be innovated. China's landscape ecology theory and landscape ecology schools need to be established.

5. Research outlook

China's landscape ecology should be deeply rooted in this fertile land of China, and establish a unique landscape ecology school that is in line with my many national conditions. The development of landscape ecology has formed a discipline that relies on 3S technology and integrates natural, social and economic aspects. At present, the research on the relationship between landscape pattern and ecological process, the environmental impact of landscape dynamic evolution, and the landscape scale effect are still not deep enough. In the analysis of a large number of landscape patterns, the use of its own limited landscape index causes the pattern and ecological process. The splitting is just a bunch of complicated data, which does not play a role in explaining and solving various ecological problems. At the same time as the new technology and new theories continue to emerge, it is more necessary to think about whether it has any value to the core issues of landscape ecology, whether it can help solve real problems and avoid falling into a strange circle similar to the abuse of landscape pattern index. China's landscape ecology should focus on artificial-natural landscapes, focusing on landscape ecological construction at

the landscape and regional scales, adhering to the openness of landscape ecology, and being good at taking nutrition from relevant disciplines, especially using RS. New methods and techniques for GIS and spatial simulation models, and strengthening landscape ecology in the environment, land use change and planning, urbanization and regional sustainable development, climate change and its effects, ecosystem restoration and biodiversity conservation, land The application of degradation processes and governance, and the development of harmony with nature.

References

[1] Xiao Duning. Landscape Ecology-Theory, Method and Application [M]. Beijing: China Forestry Publishing House, 1991.
[2] Zhao Yu-tao, YU Xin-xiao, GUAN Wen-bin. Review of landscape heterogeneity research [J]. Chinese Journal of Applied Ecology, 2002, 13 (4): 496 - 500.
[3] Cai Bofeng, Yu Wei. Scale analysis method in landscape ecology [J]. Chinese Journal of Ecology, 2008 (5): 2279 - 2287.
[4] Fu Wei, Liu Shiliang, Cui Baoshan. Research progress on ecological connectivity in landscape ecology [J]. Chinese Journal of Ecology, 2009 (11): 6174 - 6182.
[5] Cao Bao, Qin Qiming, Ma Haijian, et al. Application of Object-Oriented Method in SPOT-5 Remote Sensing Image Classification-Taking Haidian District of Beijing as an Example [J]. Geography and Geo-Information Science, 2006, 22 (2): 46 - 49.
[6] Wang Shudong, Zhang Lifu, Chen Xiaoping, et al. Model and method for extracting tropical fine land information based on Landsat TM - taking Hainan Island as an example [J]. Journal of Ecology, 2012, 32 (22): 7036 ~ 7044.
[7] Yu Lin. Statistical ecology [M]. Beijing: China Forestry Publishing House, 2009.
[8] Zeng Hui, Jiang Zikai. Study on Landscape Structure in the Process of Rapid Urbanization in Longhua District of Shenzhen City: Analysis of Urban Construction Land Structure and Heterogeneity [J]. Chinese Journal of Applied Ecology, 2000, 11 (4): 567 - 572.
[9] Liu Hai-jiang, CHENG Wei-ming, LONG En.Analysis of Landscape Changes of Damaged Sandy Land Ecosystem-Taking the Hunshandake Sandy Land in Inner Mongolia as an Example [J]. Chinese Journal of Plant Ecology, 2007 (6): 1063 - 1072.
[10] Yuan Li, Zhao Yusen, Gong Wenfeng, et al. Study on the landscape pattern evolution of Zhalong wetland land use based on RS and GIS [J]. Soil and Water Conservation Research, 2008 (3): 49 - 53.
[11] Li Xiuzhen, Xiao Yining. Discussion on the landscape ecology of the city [M] Yan Xiaoning. Progress in landscape ecology research. Changsha: Hunan Science and Technology Press, 1999.
[12] Feng Xuehua. Main Soil Types and Utilization of Ecological Landscape Forest in Shenzhen City [J]. Forestry Science and Technology Development, 2001, 15 (3): 16 - 18.
[13] Wang Ranghui, Yu Qianlong, Li Fengying, Huang Qing, Li Jin, Lin Yi, Xue Ying, Xu Xiaofang. Methods and Case Analysis of Landscape Ecology Research in Arid Areas [J]. Journal of Arid Land Resources and Environment, 2006, 03: 16 - 20.
[14] Chen Yulin, Tang Tengfang. Application and Research Progress of Landscape Ecology [J]. Economic Forest Research, 2003, 02: 54 - 57.
[15] Zeng Hui, Xia Jie, Zhang Lei. The status quo and development trend of urban landscape ecology research [J]. Geography Science, 2003, 04: 484 - 492.
[16] Bai Jiangli, Peng Daoli, Yan Xiaohong, Zheng Xiaoxian. Current Status and Prospects of Forest Landscape Ecology Research [J]. Journal of Ecology, 2005, 08: 943 - 947.