

A Review of Research on the Evolution of Village Morphology and Landscape Pattern Optimization along Rivers Based on GIS: A Case Study of the Dong Ethnic Group in Sanjiang

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Abstract: This study employs Geographic Information System (GIS) technology and principles of landscape ecology to investigate the morphological evolution and landscape pattern optimization of riverside villages. Focusing on the Sanjiang Dong ethnic region, the research encompasses various stages, including data collection, processing, and spatial data analysis, along with the application of landscape metric calculations and simulation models. The paper primarily analyzes the historical land use patterns, current landscape structure, and their impacts on the ecological environment and socio-economic aspects in the Sanjiang Dong area. Based on the findings, a comprehensive GIS-based landscape pattern optimization model is proposed, integrating ecological, socio-economic, and cultural factors to guide the sustainable development of riverside villages. Through quantitative analysis, the study reveals the evolutionary patterns of landscape in riverside villages, providing scientific insights for policy formulation and practical applications.

1. Introduction

Villages along rivers refer to traditional villages distributed along rivers and are an important part of China's rural culture, boasting rich historical, cultural, ecological, and socio-economic values. This study adopts GIS-based landscape pattern analysis, a method that utilizes Geographic Information System (GIS) technology and principles of landscape ecology to quantitatively describe, evaluate, and simulate the spatial distribution and dynamic changes of land. This method reveals the laws and mechanisms of morphological evolution in riverside villages. Taking the Dong ethnic group in Sanjiang as the case study area and applying the GIS-based landscape pattern analysis, this study explores the land-use changes and evolution characteristics of the landscape pattern of the Sanjiang Dong ethnic group and its ecological and social effects. It also establishes a GIS-based landscape pattern optimization model, proposing future landscape pattern optimization plans and suggestions for Chengyang Baizhai, providing references for the sustainable development of villages along rivers.

2. Domestic and International Research Review

International Academic History and Research Trends on GIS-Based Evolution and Landscape Pattern Optimization of Villages along Rivers International research on GIS-based evolution and landscape pattern optimization of villages along rivers mainly focuses on the following areas.

Landscape pattern analysis of villages along rivers and their ecological effects. The main viewpoints include using GIS and remote sensing technology for quantitative analysis of the landscape pattern, revealing spatial distribution characteristics, landscape type composition, landscape structural indicators [1][2], and using principles and methods of landscape ecology to assess the value of landscape ecological services, risks, and safety, exploring their roles and impacts on soil and water conservation, flood regulation, and biodiversity conservation [3].

Research on landscape pattern optimization and planning design of villages along rivers. The main viewpoints are constructing landscape pattern optimization models based on multi-objective planning

and multi-criteria decision-making, considering various factors such as ecology, economy, and society, and proposing optimal or suboptimal landscape pattern schemes[4][5], and based on concepts like rural revitalization and sustainable development, proposing planning and design principles and strategies for villages along rivers, emphasizing the protection of natural resources and cultural heritage, and promoting functional transformation and industrial upgrading [6].

Theoretical and technical development of GIS-based landscape pattern analysis methods. Main viewpoints include GIS as an effective tool for landscape pattern analysis, supporting multi-scale, multi-source, and multi-dimensional landscape information processing[7], landscape pattern analysis methods including landscape index analysis, pattern optimization, and simulation, reflecting landscape structure, function, and dynamics from different perspectives [2] , and the need for continuous improvement and innovation of GIS-based landscape pattern analysis methods to adapt to different types and levels of landscape research requirements, considering factors like spatial heterogeneity, scale effects, and uncertainty[8][9].

Application examples of GIS-based landscape pattern analysis methods in the morphological evolution and optimization of villages along rivers. Main viewpoints include using GIS and remote sensing technology to monitor and evaluate land-use changes in villages along rivers, revealing their spatio-temporal characteristics and driving mechanisms[11][12], using GIS and multi-objective planning technology to optimize landscape patterns, balancing the needs of ecological protection and social development, and enhancing the ecological efficiency and aesthetic value of landscapes[21], and using GIS and system dynamics technology to simulate and predict landscape patterns, analyzing landscape change trends and influencing factors under different scenarios, providing a scientific basis for decision-making [13][14].

3. Current Status of Domestic Research

Domestic research on GIS-based evolution and landscape pattern optimization of villages along rivers is relatively less, mainly focusing on the following aspects.

3.1. Land use change research

Studies on land-use changes and driving mechanisms in the Sanjiang Dong ethnic group and surrounding areas. Main viewpoints include monitoring and analyzing land-use changes in the Sanjiang Dong ethnic group and surrounding areas using GIS and remote sensing technology, finding that the main land use types in the area are arable land, forest land, and construction land, with a decreasing trend in arable land, fluctuating changes in forest land, and an increasing trend in construction land[15][16].and using the Logistic regression model and the driving force-state-response framework to analyze the driving mechanisms of land-use changes in the area, suggesting that these changes are primarily influenced by both natural and human factors, with human factors playing a dominant role, such as population growth, economic development, and policy intervention[17][18].

3.2. Theoretical and technological development

Theoretical and technical development of GIS-based landscape pattern analysis methods. Main viewpoints include GIS as a powerful landscape pattern analysis platform, integrating various data sources and analysis models, supporting multi-level, multi-angle, and multi-dimensional landscape information processing [19], landscape pattern analysis methods including landscape index analysis, landscape pattern optimization, and simulation, able to reflect the structure, function, and dynamics of landscapes from different perspectives[20], and the need for continuous improvement and innovation of GIS-based landscape pattern analysis methods to meet the research needs of different types and levels of landscapes, considering factors like spatial heterogeneity, scale effects, and uncertainty [17][21][22].

3.3. Application example

Theoretical and technical development of GIS-based landscape pattern analysis methods. Main

viewpoints include GIS as a powerful landscape pattern analysis platform, integrating various data sources and analysis models, supporting multi-level, multi-angle, and multi-dimensional landscape information processing [9][10], landscape pattern analysis methods including landscape index analysis, landscape pattern optimization, and simulation, able to reflect the structure, function, and dynamics of landscapes from different perspectives [1][6], and the need for continuous improvement and innovation of GIS-based landscape pattern analysis methods to meet the research needs of different types and levels of landscapes, considering factors like spatial heterogeneity, scale effects, and uncertainty [1][5][4].



Figure 1: GIS landscape data analysis workflow.

4. Research inadequacies

In summary, there have been many achievements in the academic field both domestically and internationally regarding the research on GIS-based evolution and landscape pattern optimization of villages along rivers. However, there are still some deficiencies.

4.1. Single and lack of system

Current research is mostly based on single or a few cases, lacking systematic, comparative, and comprehensive studies of landscape patterns in villages along rivers, making it difficult to reveal the general laws and regional differences. For instance, landscape patterns in villages along rivers in different geographical areas, river types, and development stages might have different characteristics

and issues, necessitating cross-regional, cross-scale, and cross-type comparative analyses to identify commonalities and individualities, and propose universal and targeted suggestions.

4.2. Lack of dynamic prediction

Most studies are based on static or short-term data, lacking research on the dynamic changes and future predictions of landscape patterns in villages along rivers, making it difficult to reflect the evolution process and trends [15].

4.3. Lack of landscape quality analysis

Most studies are quantitative or spatial analyses, lacking in quality or functional analysis of landscape patterns in villages along rivers, making it difficult to evaluate their impact and value on the ecological environment, socio-economy, and cultural history [18].

4.4. Lack of model analysis

Current research involves single or simplistic methods or models, lacking in multi-method or complex model analyses of landscape patterns in villages along rivers, making it difficult to consider the multi-dimensionality, multi-level, and multi-scale characteristics and issues of these landscapes.

5. Conclusion

This study uses GIS-based landscape pattern analysis methods to optimize the landscape pattern of the Sanjiang Dong ethnic group, mainly considering three objectives: protecting the ecological environment, promoting socio-economic development, and enhancing the aesthetic value of the landscape. It balances various interests and needs, providing references for the sustainable development of Chengyang Baizhai. It is recommended that in the future development of the Sanjiang Dong ethnic group, the following principles should be followed.

We need to respect the laws of nature and cultural traditions, and protect the ecological environment and historical culture of the villages along the river in Chengyang Bazhai; adapt to the needs of economic and social development, and promote the industrial transformation and community vitality of the villages along the river; and focus on the aesthetics of the landscape and humanistic care, and enhance the tourism attractiveness of the villages along the river and the well-being of the residents therein.

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