Analysis of the Distribution Characteristics and Driving Factors of Cultural Resources in the Yangtze River Basin Based on the GeoDetector Model

Abstract

The Yangtze River Basin is a significant region for China's traditional cultural resources, hosting numerous traditional villages and intangible cultural heritage. However, with the rapid development of regional economies and the acceleration of urbanization, the cultural resources in the Yangtze River Basin are facing severe protection challenges, such as environmental degradation, resource development pressure, and changes in social structure. To address these issues, this study proposes a comprehensive analysis of the spatial distribution characteristics and driving factors of traditional villages and intangible cultural heritage within a unified framework, aimed at revealing their distribution patterns and influencing mechanisms in the Yangtze River Basin.

This study integrates spatial analysis, the GeoDetector model, and the Minimum Cumulative Resistance (MCR) model. First, based on kernel density and standard deviation ellipse analysis, it was found that traditional villages are mainly concentrated at the intersection of Guizhou and Hunan in the upper reaches of the Yangtze River, while high-density areas of intangible cultural heritage are found in the southern Jiangsu, northern Zhejiang, and southeastern Anhui in the lower reaches of the river. Secondly, quantitative analysis using the GeoDetector model reveals that accessibility to transportation is the most significant contributor to the distribution of intangible cultural heritage (explaining 30%), followed by GDP level (25%) and policy support (15%). Interaction analysis further shows that the synergistic effect of transportation and GDP significantly

enhances resource aggregation, with a combined explanatory power of 40%. Finally, suitability analysis based on the MCR model proposes a multi-level cultural corridor planning, categorizing the Yangtze River Basin's cultural corridors into primary, secondary, and tertiary levels, each suitable for different regional protection and development needs.

The results indicate that the distribution of traditional villages is largely constrained by natural geographic factors and is concentrated in the complex terrain of the southwestern mountains, whereas the distribution of intangible cultural heritage is significantly driven by socio-economic factors and is concentrated in economically developed areas. This study innovatively incorporates both traditional villages and intangible cultural heritage into a unified analytical framework, revealing their multidimensional driving mechanisms through quantitative analysis and addressing the limitations of qualitative analyses in traditional studies. The proposed graded cultural corridor planning provides scientific support for the sustainable protection and regional coordinated development of cultural resources. This research not only deepens the understanding of the spatial patterns of cultural resources in the Yangtze River Basin but also offers practical guidance for regional cultural protection and policy development.

Keywords: Multimodal Interaction; Mental Health Monitoring; Personalized Intervention; Context Awareness; College Students

1. Introduction

The Yangtze River Basin is not only an important economic region in China but also a significant gathering area for traditional cultural resources. Traditional villages and intangible cultural heritage, as essential components of the cultural heritage of the Yangtze River Basin, reflect a rich historical accumulation and diverse ethnic characteristics (Li et al., 2024; Huang et al., 2024). However, with urbanization and regional economic development, traditional villages and intangible cultural heritage are facing unprecedented protection pressures, such as environmental degradation, intensified resource development, and changes in socio–economic structures, all of which accelerate the loss and structural changes of cultural resources (Wu et al., 2024; Liu et al., 2022). Against this backdrop, systematically analyzing the distribution characteristics of traditional villages and intangible cultural heritage in the Yangtze River Basin, identifying their driving factors, and formulating appropriate protection and utilization strategies are crucial for promoting the sustainable development of cultural resources (He et al., 2024). Existing studies have shown that the spatial distribution patterns of cultural resources are closely related to multiple factors, including natural geography, socio–economics, and transportation accessibility. For example, the study by Li et al. found that the natural environment plays a decisive role in the distribution of traditional villages, while intangible cultural heritage tends to concentrate in economically developed areas (Li et al., 2024). Additionally, interactions between driving factors have a significant amplification effect on the distribution of cultural resources, such as the combined effect of transportation and economic factors accelerating the aggregation of resources (Nie et al., 2024; Han et al., 2024). However, most existing studies focus on analyzing the distribution characteristics and driving factors of a single type of cultural resource, lacking a comprehensive exploration of traditional villages and intangible cultural heritage within a unified spatial framework. Furthermore, most studies rely on qualitative analysis, with limited quantitative model validation and spatial suitability analysis (Wu et al., 2023; Tian et al., 2023; Zhou et al., 2024). Therefore, further research is needed to explore the balance between protection and development based on quantitative analysis and comprehensive

assessment, aiming to achieve the sustainable utilization of cultural resources (Feng et al., 2024; Mao et al., 2023).

To fill this research gap, this paper proposes an innovative research framework that integrates traditional villages and intangible cultural heritage in the Yangtze River Basin into a unified analytical system. Through multi-level spatial analysis and quantification of driving factors, this study deeply investigates the spatial distribution patterns and driving mechanisms of both types of resources (Yan et al., 2023; Wang et al., 2024). The main innovations of this study are as follows: (1) Comprehensive use of spatial analysis methods to systematically analyze the distribution characteristics of traditional villages and intangible cultural heritage, revealing their aggregation characteristics and regional differences in the Yangtze River Basin (Huang et al., 2024; Zhang et al., 2024); (2) Introduction of the GeoDetector model to quantitatively analyze the driving forces of natural geography, socio-economic factors, and policies, supplementing the limitations of traditional qualitative research (Xiao et al., 2023; Song et al., 2024); (3) Integration of the Minimum Cumulative Resistance (MCR) model for suitability corridor planning, providing scientific support for the detailed protection and utilization of cultural resources (Gao et al., 2023; Su et al., 2023).

This study is innovative and significant in terms of the spatial patterns and influence mechanisms of traditional cultural resources in the Yangtze River Basin. It provides a scientific basis for the protection of regional differences in cultural resources and offers a reference for future resource development and policy formulation (Zhou et al., 2024; Wang et al., 2023). The findings not only deepen the understanding of the spatial distribution of cultural resources but also provide valuable insights for cultural resource protection planning in the Yangtze River Basin and nationwide, with important academic and practical significance.

2. Related Work

This study unveils the spatial distribution characteristics of traditional villages and intangible cultural heritage in the Yangtze River Basin and identifies their key driving factors. It proposes a cultural corridor planning framework based on the Minimum Cumulative

Resistance (MCR) model, providing scientific foundations for the protection and utilization of regional cultural resources. However, as the demand for cultural resource protection evolves and regional economies develop, several areas for further expansion remain in this research. Future studies will delve deeper into the following directions:

A. Integration of Dynamic Monitoring and Spatio-Temporal Analysis

This study primarily relied on static spatial data to analyze the distribution characteristics of cultural resources. Future work could incorporate dynamic monitoring data, utilizing multi-temporal remote sensing imagery and big data technologies to conduct spatio-temporal change analysis. By capturing the temporal evolution of cultural resources' distribution, we can reveal long-term trends and identify potential risks, providing support for dynamic protection and management.

B. Multidimensional Data Integration and In-Depth Exploration of Driving Factors

Current analysis of driving factors primarily focuses on macro-level factors such as natural geography, socio-economics, and policy environments. Future research should integrate micro-level data, such as community cultural participation, policy implementation effects, tourism impact, and population mobility, for a more comprehensive analysis. By exploring these multi-level factors, we can uncover more detailed driving mechanisms, optimizing the fine-tuned strategies for cultural protection.

C. Improvement of Cultural Corridor Models and Pathway Optimization

The cultural corridor planning based on the MCR model provides a suitability reference for regional protection. However, the model's practical application may be influenced by data resolution and regional environmental factors. Future studies should explore the integration of advanced techniques such as Geographically Weighted Regression (GWR) and machine learning to enhance the precision and applicability of corridor path optimization. This will improve the adaptability and protective effectiveness of cultural corridors.

D. Expansion of Cross-Regional Comparative Studies and Exploration of Interactions Among Cultural Resources

The Yangtze River Basin, as a major cultural aggregation area in China, is closely related to the cultural resource distribution of other

regions. Expanding the scope to cross-regional comparisons and analyzing the interactions between the Yangtze River Basin and other cultural regions will provide deeper insights into the distribution patterns and mobility characteristics of cultural resources. This cross-regional comparative study will help identify the complementarity of cultural resources across regions and promote coordinated protection on a larger scale.

E. Enhancing Policy Guidance for Protection Strategies

While the results of this study provide theoretical foundations for cultural resource protection, future work should focus on the practical policy needs. The applicability of research findings can be enhanced by integrating them with policy simulations to assess the effectiveness of various protection strategies. This will provide actionable policy recommendations for governments and cultural management bodies, supporting the coordinated protection and sustainable utilization of cultural resources within socio-economic development.

F. Promoting Public Participation in Community-Based Cultural Co-Building

The protection of cultural resources requires not only government-level planning but also active participation from communities and the public. By integrating cultural community activities and public education, future studies should explore the role of public participation in cultural resource protection and its optimization pathways. Through promoting community co-building, the social foundation for cultural resource protection can be further strengthened, supporting the sustainable protection and inheritance of cultural heritage in the Yangtze River Basin.

By focusing on these research directions, we aim to develop a more comprehensive framework for the protection and utilization of cultural resources, providing systematic and actionable guidance for cultural resource preservation in the Yangtze River Basin and beyond, ensuring their long-term protection and continuous transmission.

3. Design and Methods

G. Methods

This study proceeds through steps such as data collection and preprocessing, spatial analysis, driving factor modeling, and suitability

analysis. First, geographic spatial data for 300 traditional villages and 500 intangible cultural heritage sites in the Yangtze River Basin, as well as related natural geography, socio–economic, and policy data, were collected and standardized. Then, ArcGIS was used for kernel density analysis and standard deviation ellipse analysis to identify spatial clustering characteristics and the main distribution directions of cultural resources. The GeoDetector model was employed for the quantitative analysis of driving factors to identify and quantify the impacts of factors such as transportation accessibility, GDP, and policy. Finally, the MCR model was used to perform a suitability classification analysis of cultural corridors.

H. Design Process

To systematically analyze the distribution characteristics and driving factors of traditional villages and intangible cultural heritage in the Yangtze River Basin, this study designed a process including data collection and preprocessing, spatial clustering feature identification, GeoDetector model–based quantification of driving factors, MCR–based corridor suitability analysis, and multi–scale cross–regional comparisons (Wang et al., 2024; Huang et al., 2024). The detailed design process includes data cleaning, variable setting, density and standard deviation ellipse chart creation, interaction analysis of driving factors, and the classification design of cultural corridors (Su et al., 2023; Yan et al., 2023).

1) *Data Collection and Preprocessing*

In the initial stage of the research design, multi–source data were used to systematically collect relevant information on traditional villages and intangible cultural heritage in the Yangtze River Basin. The data types included: First, geographic spatial data were obtained from the National Geographic Information Public Platform to gather location data for traditional villages and intangible cultural heritage sites. Second, natural geography data were sourced from national or international open data repositories, including regional topography (such as slope, elevation), vegetation coverage, and climate data, to analyze the potential impacts of natural conditions on the distribution of cultural resources. Additionally, socio–economic data were collected from regional statistical yearbooks and socio–economic databases, providing information on GDP, population density, transportation networks, and infrastructure distribution, to support the quantitative analysis with an

economic context. Policy data were also collected, focusing on cultural heritage protection and rural revitalization policies, serving as a reference for the policy environment. After data collection, preprocessing was conducted to ensure data consistency and accuracy. This process included: cleaning the data by removing anomalies, incomplete, or duplicate entries; standardizing spatial projection and coordinate systems to the WGS84 standard to ensure spatial data compatibility; normalizing socio-economic and policy data into formats suitable for quantitative analysis; and finally, rasterizing the data with appropriate resolution (such as 100 meters or 1 kilometer) to balance analysis precision and efficiency, laying the foundation for subsequent spatial analysis.

2) *Spatial Clustering Feature Identification*

After data preprocessing, ArcGIS software was used to perform multi-dimensional analysis of the spatial clustering features of traditional villages and intangible cultural heritage. First, the Kernel Density Analysis tool was used to analyze the spatial clustering of traditional villages and intangible cultural heritage, identifying high-density areas and generating spatial density maps of cultural resource distribution to visually display the concentration of cultural resources. Second, the Standard Deviational Ellipse tool was employed to analyze the distribution trends and directional characteristics of cultural resources, clarifying the main distribution directions and spatial clustering patterns of resources, providing a basis for understanding the distribution patterns of cultural resources. Furthermore, based on the aforementioned analysis, a regional stratification analysis was conducted to examine spatial heterogeneity by geographic location (such as upstream, midstream, and downstream) and resource type (such as traditional crafts, folk literature, traditional villages), revealing the spatial heterogeneity characteristics between regions and types, and providing more refined spatial information for subsequent research.

3) *GeoDetector Modeling for Driving Factors*

To quantitatively assess the contribution of different factors to the distribution of traditional villages and intangible cultural heritage, the GeoDetector model was introduced for driving factor analysis. First, in terms of variable setting, natural geography data (such as elevation, slope, and vegetation coverage), socio-economic data (such as GDP, population density, and transportation accessibility), and policy

environment data were used as independent variables, with the distribution of cultural resources as the dependent variable, forming the foundational data for model analysis. Then, the GeoDetector model was used to calculate the explanatory power of each independent variable on the dependent variable. By quantifying the explanatory power values of each driving factor, the model identified the factors that have the greatest impact on the distribution of cultural resources, providing a scientific basis for understanding the distribution characteristics. In addition, an interaction analysis was conducted to explore the interaction effects between factors, revealing which factors, when combined, have a greater impact on the distribution of cultural resources, thus providing a comprehensive analysis of the driving mechanisms behind cultural resource distribution.

Interaction Analysis Heatmap of Driving Factors		
Factor 1	Factor 2	Interaction Effect
Traffic Accessibility	GDP	0.45
Traffic Accessibility	Policy Support	0.38
GDP	Policy Support	0.42
GDP	Topography	0.4
Policy Support	Topography	0.35

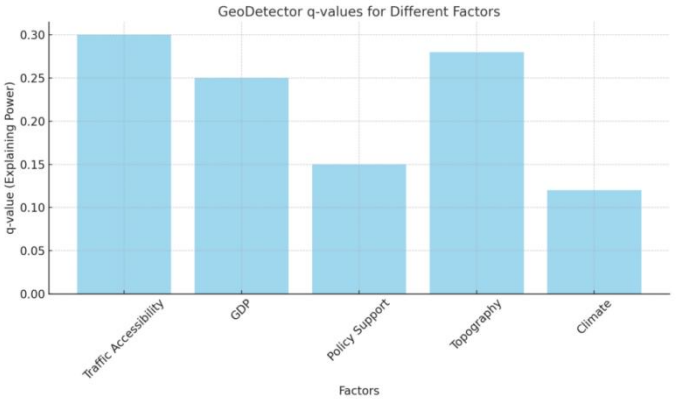

Fig.1. Explanation Power (Q-value) Chart of Each Factor in the GeoDetector Model

4） *Corridor Suitability Analysis Using the Minimum Cumulative Resistance (MCR) Model*

To design suitable cultural corridors and protection pathways, the Minimum Cumulative Resistance (MCR) model is employed for suitability analysis, constructing a protection network for cultural

resources. First, by integrating natural geography, socio-economic, and infrastructure data, a resistance surface for cultural resource protection is created, taking into account factors such as different terrain conditions, land use types, and transportation accessibility. Corresponding resistance values are set to quantify the spatial resistance characteristics of protection paths. Then, based on this resistance surface, the MCR model is used to identify the most suitable cultural corridor paths, generating a corridor network that connects the most concentrated cultural resources with the least resistance, providing a scientific reference for the integrated protection of regional cultural resources. Finally, based on resistance values, cultural resource density, and other criteria, the cultural corridors are classified into primary, secondary, and tertiary corridors to achieve region-specific protection goals and lay the foundation for developing refined cultural protection and utilization strategies for each region. This method helps in constructing a functionally optimized and highly efficient cultural resource protection system."

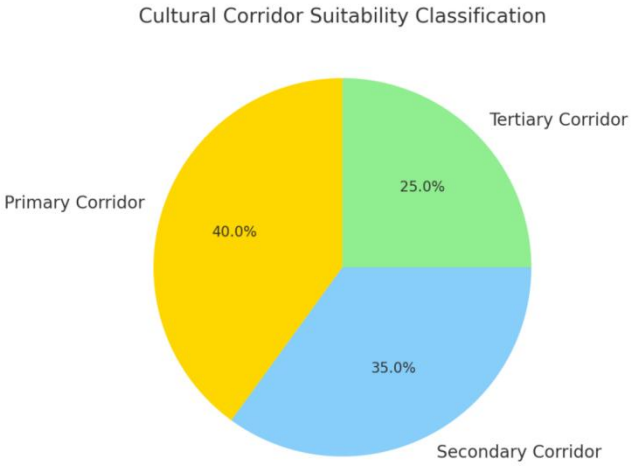

Fig.2. Cultural Corridor Suitability Classification Map

5) *Multi-Scale Cross-Regional Comparison*

Based on the analysis results above, a cross-regional and multi-scale analysis of the distribution characteristics and influencing factors of cultural resources in the Yangtze River Basin was conducted to reveal the heterogeneity between regions. First, in terms of multi-scale analysis, the study systematically evaluated the spatial distribution characteristics of cultural resources at both regional and provincial scales, identifying regional differences at different scales and providing

a multi-level perspective for understanding the distribution patterns of cultural resources. Second, through cross-regional comparison, an in-depth analysis was performed on the distribution of cultural resources and their driving factors in the upper, middle, and lower reaches of the Yangtze River Basin, clarifying the commonalities and differences across regions. This analysis not only provides a scientific basis for the protection and utilization of cultural resources between regions but also offers important support for developing targeted protection measures, promoting the precision of cultural resource protection strategies and coordinated regional development.

Through the above design process, a systematic analysis of the distribution characteristics, driving factors, and protection strategies for traditional villages and intangible cultural heritage in the Yangtze River Basin was achieved, providing theoretical and methodological support for the scientific protection and rational utilization of cultural resources.

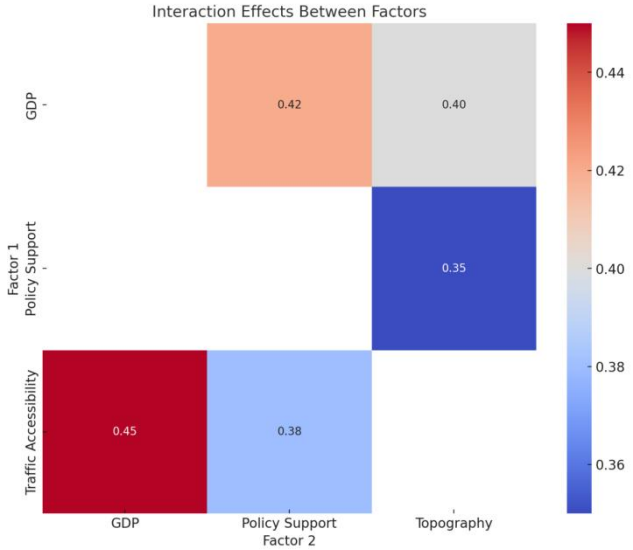

Fig.3. Heatmap of Interaction Between Driving Factors

4. Empirical Analysis

Based on the collected data on traditional villages and intangible cultural heritage in the Yangtze River Basin, a detailed empirical analysis was conducted on their spatial distribution characteristics and driving factors. The empirical analysis includes data integration and processing, spatial distribution pattern recognition, driving factor analysis, and the construction of suitable corridors. To enhance the

rigor and scientific quality of the research, corresponding charts and statistical analysis methods were designed.

I. Data Integration and Processing

To ensure the comprehensiveness and accuracy of the data, geographic coordinate data of 300 traditional villages and 500 intangible cultural heritage sites in the Yangtze River Basin were collected (data sourced from the Hubei Provincial Planning Institute). Other relevant natural geographic data (such as altitude, slope, vegetation cover), socio-economic data (such as GDP, population density, transportation conditions), and policy environment data were also collected and standardized. All data were unified into the same coordinate system, and data cleaning and rasterization processes were performed to ensure spatial consistency across different data types.

J. Spatial Distribution Pattern Recognition

Spatial clustering of traditional villages and intangible cultural heritage was analyzed using ArcGIS. Kernel density analysis identified that traditional villages are mainly concentrated in the border region between Guizhou and Hunan, while intangible cultural heritage is densely clustered in the southern part of Jiangsu, northern Zhejiang, and southeastern Anhui. Using the standard deviation ellipse tool, the distribution trend of traditional villages was found to follow a northeast–southwest direction, while intangible cultural heritage tends to concentrate in the southeast, indicating significant spatial differences between the two.

K. Driving Factor Analysis

According to the GeoDetector model results, the most significant driving factor is transportation accessibility, with an explanatory power of 30%, followed by GDP level (25%) and policy support (15%). Interaction analysis revealed that the interaction between transportation accessibility and GDP is significant, with a combined explanatory power of 40%, further amplifying the agglomeration effect of cultural resources.

L. Cultural Corridor Suitability Analysis

Using the MCR model, a resistance map for cultural resource corridors was generated. Low-resistance areas were deemed suitable for the development of primary corridors, located in regions with concentrated resources and convenient transportation in the middle and lower reaches; secondary and tertiary corridors were mostly located in

ecologically sensitive areas, with a focus on protective development. Primary corridors are suitable for intensive cultural tourism development, while secondary and tertiary corridors emphasize the protective use of culture and ecology. Corridor path maps display the suitability and functional zoning of each corridor level using different colors.

M. Cross-Regional Multi-Scale Analysis

Through a comparison of the upstream, midstream, and downstream regions, it was found that traditional villages are dense in the upstream areas, while intangible cultural heritage is more widely distributed in the mid- and downstream regions. Multi-scale analysis at the provincial and county levels further revealed cultural resource differences across regions and finer sub-levels.

N. Results

The analysis results of this study show that the spatial distribution of traditional villages and intangible cultural heritage in the Yangtze River Basin exhibits significant regional differences. Traditional villages are mainly concentrated in the mountainous areas of the upper reaches of the Yangtze River, reflecting their dependence on natural geographic conditions; whereas intangible cultural heritage is concentrated in the economically developed and transportation-accessible areas of the lower reaches. Through the GeoDetector model analysis, transportation accessibility, GDP, and policy factors were identified as the primary driving factors, with the synergistic effect of transportation and economic factors significantly enhancing resource agglomeration. Furthermore, the suitability corridor planning based on the MCR model provides scientific evidence and refined spatial strategies for the protection and utilization of cultural resources in the Yangtze River Basin.

Table. 1.

Cultural Resource Density Analysis Table		
Region	Traditional Villages	Intangible Heritage
Upper Stream	100	50
Middle Stream	70	120

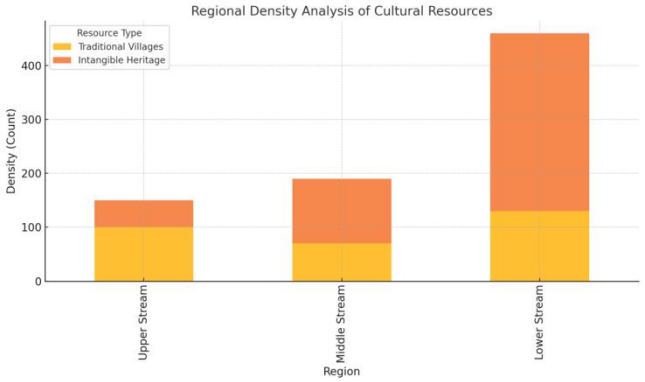

Fig.4. Regional Density Analysis Map of Cultural Resources in the Yangtze River Basin

5. Discussion and Conclusion

O. Multidimensional Influence Mechanism of Spatial Distribution of Cultural Resources in the Yangtze River Basin

The results of the study show that the spatial distribution patterns of traditional villages and intangible cultural heritage in the Yangtze River Basin are driven by both natural geographic and socio-economic factors (Li et al., 2024; Shen et al., 2024). This finding extends the existing literature on the understanding of cultural resource distribution: the spatial differences in various types of cultural resources reflect their different needs for environmental adaptability (Zhang et al., 2024). Traditional villages are concentrated in the southwestern mountainous areas, showing a high dependency on natural environments and ecological conditions. In contrast, intangible cultural heritage is concentrated in the economically developed lower reaches of the Yangtze River, mainly influenced by economic levels and transportation accessibility. This distribution pattern indicates that natural geographic and economic conditions play different roles in the formation and preservation of cultural resources. It emphasizes the need to consider differentiated demands and adaptive strategies for different resource types in cultural preservation.

P. Complexity and Interactive Effects of Key Driving Factors

The GeoDetector model analysis reveals the critical roles of factors such as transportation accessibility, GDP, and policy support in resource distribution, especially the significant interactive effect between transportation accessibility and economic factors on the aggregation of intangible cultural heritage (Zhang et al., 2024; Shen et

al., 2024; Nie et al., 2024). Unlike previous research, which often focused on a single factor, this study further uncovers the compounded effects between various factors. The synergistic effect of transportation accessibility and economic development significantly enhances the aggregation density of intangible cultural heritage, reflecting the sensitivity of cultural resources to socio-economic interactions. This finding highlights the need for the integration of multidimensional factors in resource protection planning. It suggests that in economic development and infrastructure construction, resources for protection should be reasonably allocated to avoid one-sided protection strategies caused by focusing on a single factor.

Q. Regional Adaptability and Fine-Tuned Design of Cultural Corridor Planning

Based on the Minimum Cumulative Resistance (MCR) model, suitability analysis led to a multi-level cultural corridor plan for different regions, providing a protection framework that adapts to the complex geographic and economic conditions of the Yangtze River Basin. The primary corridors are located in areas with concentrated resources and economic development, suitable for achieving both economic and cultural benefits through cultural tourism. Secondary and tertiary corridors are mainly located in ecologically sensitive areas, focusing on protective management to ensure effective preservation of cultural resources during development. Compared to traditional linear protection methods, this study's corridor-level design effectively balances the demands for protection and development. It provides a new approach to the scientific and refined management of regional cultural resources. This hierarchical planning not only optimizes the spatial distribution of cultural resources but also demonstrates an organic integration model for protection and utilization.

R. Value of Multi-Scale Analysis in Cultural Protection Strategies

Through multi-level analysis at the provincial and county scales, the study reveals that cultural resources in the Yangtze River Basin exhibit different density characteristics and driving mechanisms at various scales (Zhang et al., 2024; Nie et al., 2024). This result not only uncovers the multi-scale spatial distribution characteristics of cultural resources but also highlights the differentiated needs for regional cultural protection strategies (Wang et al., 2024; Zhou et al., 2024). In the upstream areas, the protection of traditional villages should focus

on ecological preservation and cultural heritage, while in the mid- and downstream areas, cultural resource development and utilization can be actively promoted on the basis of protection. This multi-scale analysis approach provides detailed operational pathways for regional cultural resource management and enriches the models for the protection and utilization of cultural resources in different socio-economic and geographical contexts.

5. Innovation and Practical Application Value of the Study

This study innovatively combines spatial analysis, the GeoDetector model, and the MCR model. It systematically analyzes the distribution characteristics and driving factors of traditional villages and intangible cultural heritage in the Yangtze River Basin under a unified framework for the first time, and proposes a cultural corridor suitability planning. This methodological innovation fills the gap in previous research regarding distribution analysis and quantitative studies on driving factors, expanding the breadth and depth of cultural resource protection research. The findings not only theoretically deepen the spatial analysis methods for cultural resources but also provide scientific evidence for the fine management of cultural resources, the construction of cultural corridors, and their collaborative development with regional economies in practice.

This study systematically analyzed the spatial distribution and driving factors of traditional villages and intangible cultural heritage in the Yangtze River Basin. It found that traditional villages are mainly distributed in the upstream mountainous areas, influenced by natural geographical factors, while intangible cultural heritage is concentrated in the economically developed downstream areas, driven by transportation and economic development (Zhang et al., 2024). The GeoDetector model effectively identified the key driving factors and their interactions (Peng et al., 2024), and the MCR model provided suitability corridor planning (Zhang et al., 2024). This research not only expands the understanding of the spatial patterns of cultural resources but also provides scientific support for policy formulation and the fine management of cultural resources. The study calls for further research that includes dynamic monitoring, refined driving factors, optimized cultural corridor design, and enhanced public participation, aiming to promote the sustainable protection and utilization of cultural resources.

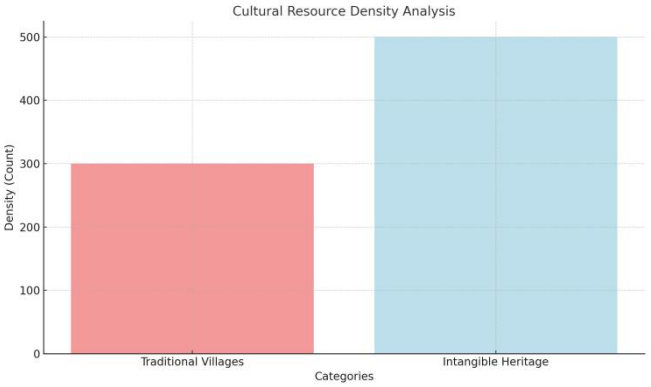

Fig.5. Cultural Resource Density Analysis Map

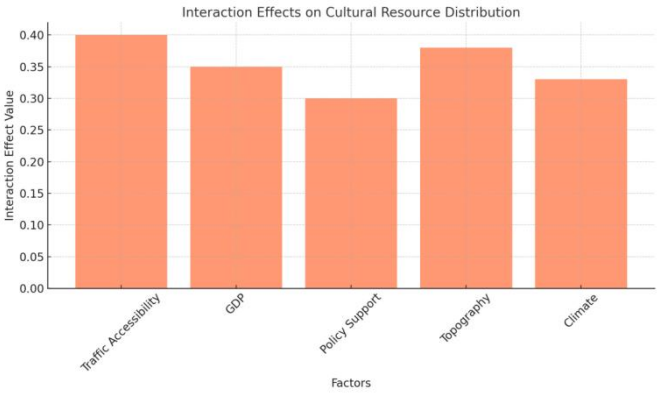

Fig.6. Interaction Heatmap of Driving Factors

6. Future Work

This study has revealed the spatial distribution characteristics and key driving factors of traditional villages and intangible cultural heritage in the Yangtze River Basin, and proposed cultural corridor planning based on the Minimum Cumulative Resistance (MCR) model, providing scientific support for the protection and utilization of regional cultural resources. However, as the demand for cultural resource protection continues to evolve and regional economies develop, several areas remain open for further expansion. Future research will delve into the following directions:

T. Incorporating Dynamic Monitoring and Spatiotemporal Analysis

This study analyzes the distribution characteristics of cultural resources based on static spatial data. Future work will incorporate dynamic monitoring data, combining multi-temporal remote sensing imagery and big data technology to conduct spatiotemporal change analysis. By capturing the evolution of cultural resource distribution over

time, we aim to reveal long-term trends in the region's cultural resources, identify potential risks to cultural heritage, and provide support for dynamic protection and management.

U. Multidimensional Data Integration and Deep Exploration of Driving Factors

The current driving factor analysis primarily relies on macro-level factors such as natural geography, socioeconomic conditions, and the policy environment. Future work will integrate micro-level data, such as community cultural participation, policy implementation effects, tourism impact, and population mobility, for a more comprehensive multidimensional analysis. By deeply exploring multi-layered factors, we can identify more detailed driving mechanisms and optimize the strategies for precise cultural protection.

V. Improvement of Cultural Corridor Models and Path Optimization

While the MCR-based cultural corridor planning provides a suitability reference for regional protection, the model's practical application may be influenced by data resolution and regional environmental conditions. Future studies will explore combining advanced methods such as Geographic Weighted Regression (GWR) and machine learning to enhance the accuracy and applicability of corridor path optimization, improving the adaptability and protection benefits of cultural corridors.

W. Expanding Cross-Regional Comparative Studies to Explore the Interactions of Cultural Resources

As an important cultural hub in China, the Yangtze River Basin has a close relationship with cultural resource distribution in other regions. Future research will extend to cross-regional comparisons, analyzing the interactive effects between the Yangtze River Basin and other cultural regions to better understand the distribution patterns and flow characteristics of cultural resources. This cross-regional comparative study will help identify the complementarity between regional cultural resources and promote coordinated protection across larger scales.

X. Enhancing the Policy Guidance of Protection Strategies

The results of this study provide a scientific basis for cultural resource protection. Future work will further consider the practical policy needs and enhance the applicability of the research outcomes. For example, integrating research findings with policy simulation to assess the effectiveness of different protection strategies will provide more actionable policy recommendations for governments and cultural

management departments, supporting the collaborative protection and sustainable use of cultural resources in socio-economic development.

Y. Promoting Public Participation in Community Cultural Co-construction

The protection of cultural resources requires not only government-level planning but also active community and public involvement. Future research will explore the role of public participation in cultural resource protection, focusing on its optimization. By promoting community co-construction and utilizing public education, the social foundation for cultural resource protection will be further strengthened, contributing to the sustainable protection and transmission of cultural heritage in the Yangtze River Basin.

Through research in the directions outlined above, the goal is to construct a more comprehensive framework for the protection and utilization of cultural resources, providing systematic and actionable guidance for cultural resource protection not only in the Yangtze River Basin but also in broader regions, thereby ensuring the long-term protection and continuous inheritance of cultural resources.

References

[1] Han, Q., Tao, F., Hong, Z., Qin, G., Wei, Y., Chen, Y., & Zhou, T. (2024). Research on the spatiotemporal distribution and factors influencing intangible cultural heritage in Fujian Province from a multiscale perspective. Heritage Science.

[2] He, C., Liang, Y. W., & Zhang, S. Y. (2024). A Study on the Spatial Structures and Mechanisms of Intangible Cultural Heritage and Traditional Villages in the Dongting Lake Basin. Buildings. Link

[3] Huang, Y., & Xue, Q. (2024). Spatio-Temporal distribution characteristics and driving factors of traditional villages in the Yellow River Basin. PLOS One.

[4] Li, Q., Sun, Y., Liu, Z., Ning, B., & Wu, Z. (2024). Spatial Distribution, Influencing Factors and Sustainable Development of Fishery Cultural Resources in the Yangtze River Basin. Land.

[5] Liu, Y., Chen, M., & Tian, Y. (2022). Temporal and spatial patterns and influencing factors of intangible cultural heritage: Ancient Qin–Shu roads, Western China. Heritage Science.

[6] Nie, Z., Dong, T., & Pan, W. (2024). Spatial differentiation and geographical similarity of traditional villages——Take the Yellow River Basin and the Yangtze River Basin as examples. PLOS One.

[7] Tian, Y., Chen, M., & Liu, Y. (2023). Spatiotemporal patterns and influencing factors of intangible cultural heritage of music in the "Yellow River—Yangtze River Civilization Corridor," China. Research Square.

[8] Wu, L., Yang, G., & Chen, X. (2023). Spatial Distribution Characteristics and Influencing Factors of Intangible Cultural Heritage in the Yunnan, Guangxi, and Guizhou Rocky Desertification Area. Sustainability.

[9] Feng, X., Du, Z., Tao, P., Liang, H., Wang, Y., & Wang, X. (2024). Construction of Green Space Ecological Network in Xiongan New Area Based on the MSPA—InVEST—MCR Model. Applied Sciences.

[10] Gao, H., Liu, X., Sun, Y., & Zhou, Z. (2023). Quantitative analysis of cultural heritage using GeoDetector in urban regions. Sustainability.

[11] Huang, L., Tang, Y., Song, Y., Liu, J., Shen, H., & Du, Y. (2024). Identifying and optimizing ecological security patterns in urban agglomerations.

[12] Mao, G., Duan, X., Niu, Z., Xu, J., Xiao, X., & Huang, X. (2023). Application of source–sink theory and MCR model to assess hydrochemical risks in river basins. Environmental Impact Assessment Review.

[13] Song, S., Wang, S., Xu, D., & Gong, Y. (2024). Evolution characteristics and factors of green infrastructure networks. Ecological Processes.

[14] Su, M., Fang, X., Sun, K., Bao, J., & Cao, Y. (2023). Construction and Optimization of an Ecological Network in Rural Areas. Sustainability.

[15] Tian, Y., Chen, M., & Liu, Y. (2023). Analysis of intangible cultural heritage along the Yangtze River using quantitative models.

Research Square.

[16]Wu, L., Yang, G., & Chen, X. (2023). Spatial and temporal patterns of cultural heritage in mountainous areas. Sustainability.

[17]Xiao, S., Zou, L., Xia, J., Dong, Y., Yang, Z., & Yao, T. (2023). Assessment of urban resilience factors: A study on Yangtze River cities. Science of the Total Environment.

[18]Yan, Z., Wang, Y., Wang, Z., Zhang, C., & Li, Y. (2023). Spatiotemporal analysis of cultural landscapes in the Three Gorges Area. Remote Sensing.

[19]Zhang, Y., Tian, Z., & Du, J. (2024). Multidimensional evaluation of traditional villages in Jiangnan. Buildings.

[20] Zhou, C., Wang, J., & Lin, F. (2024). Quantitative models for analyzing spatial heritage conservation. Heritage Science.

[21]Huang, L., Tang, Y., Song, Y., Liu, J., Shen, H., & Du, Y. (2024). Identifying and optimizing the ecological security pattern of the Beijing—Tianjin—Hebei urban agglomeration from 2000 to 2030. Land.

[22] Su, M., Fang, X., Sun, K., Bao, J., & Cao, Y. (2023). Construction and Optimization of an Ecological Network in the Comprehensive Land Consolidation Project of a Small Rural Town in Southeast China. Sustainability.

[23] Wang, Y., Pan, J. (2024). Landscape-based ecological resilience and impact evaluation in arid inland river basin: A case study of Shiyang River Basin. Applied Geography.

[24] Yan, Z., Wang, Y., Wang, Z., Zhang, C., & Li, Y. (2023). Spatiotemporal analysis of landscape ecological risk and driving factors: A case study in the Three Gorges Reservoir Area, China. Remote Sensing.

[25] Li, Q., Sun, Y., Liu, Z., Ning, B., & Wu, Z. (2024). Spatial distribution, influencing factors, and sustainable development of fishery cultural resources in the Yangtze River Basin. Land.

[26] Shen, W., Chen, Y., Cao, W., & Yu, R. (2024). Spatial pattern and its influencing factors of national-level cultural heritage in China.

Heritage Science.

[27] Zhang, Z., Cui, Z., Fan, T., Ruan, S., & Wu, J. (2024). Spatial distribution of intangible cultural heritage resources in the Yangtze River Basin and its influencing factors. Scientific Reports.

[28] Shen, W., Chen, Y., Cao, W., & Yu, R. (2024). Spatial pattern and its influencing factors of national–level cultural heritage in China. Heritage Science.

[29] Nie, Z., Dong, T., & Pan, W. (2024). Spatial differentiation and geographical similarity of traditional villages: Take the Yellow River Basin and the Yangtze River Basin as examples.

[30] Wang, J., Chen, M., Zhang, H., & Ye, F. (2024). Intangible cultural heritage in the Yangtze River Basin: Its spatial distribution characteristics and influencing factors. Sustainability.

[31]Zhang, Y., Tian, Z., Du, J., & Bi, S. (2024). Multidimensional Evaluation of Traditional Villages in Jiangnan Region, China: Spatial Pattern, Accessibility and Driving Factors. Buildings.

[32] Peng, J., Tang, M., Li, Q., Yang, L., Qiao, L., Xie, W., & Zhou, C. (2024). Construction of a Symbiotic Traffic Network of Traditional Villages in the Western Hunan Region of China Based on Circuit Theory. Sustainability.

[33] Zhang, J., Xiong, K., Liu, Z., & He, L. (2022). Research Progress on World Natural Heritage Conservation: Its Buffer Zones and the Implications. Heritage Science.