

Original Article



Integration of Ecology and Culture into the Rural Leisure Tourism Industry: A Spatial Coupling Analysis of Sustainable Regional Growth Mechanisms

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Abstract:

Due to increased global economic integration and the in-depth implementation of ecological civilization, environmental protection and sustainable development have become a global focus. The rural leisure tourism industry bridges the natural environment and human activities. It promotes the greening of the regional economy and the transformation of ecological values.

This study uses a research framework of ecology-culture-industry integration. Geographic information system (GIS) and spatial coupling analyses are conducted to analyze the integration of ecological resources, regional culture, and the rural leisure tourism industry and its effect on the industry's sustainable development. The current conditions and the interaction between ecological resources and regional culture are systematically analyzed by conducting an empirical investigation of the agro-pastoral ecotone in northern China.

The results show that ecological resources and the material and spiritual values of regional culture improve the competitiveness of rural leisure tourism and its ability to attract visitors. Optimizing the allocation of ecological resources, considering regional cultural characteristics, and promoting industrial integration and innovation improve the competitiveness and sustainable development of the rural leisure tourism industry.

Keywords: Ecosystem services; GIS; Industry integration; Regional culture; spatial coupling method; Rural tourism

1. Introduction

Due to significant global environmental change and increased awareness of environmental protection, sustainable development has become a core issue. Environmental protection is required to maintain the ecological balance of the earth's ecosystems and ensure socioeconomic development. The value of ecological resources has been increasingly recognized, and its effect on sustainable development has been analyzed (Clements et al., 2024a). Rural areas have

abundant environmental and cultural resources, representing unique advantages and potential for developing the leisure tourism industry, a new type of agricultural industry. This industry has improved rural economic prosperity and contributed to healthy ecosystem development. It provides economic benefits to rural areas, increasing the value of ecosystem services while promoting environmental protection and cultural inheritance (Xu et al., 2022).

International scholars have increasingly focused on the rural leisure tourism industry. Research has shown that rural tourism promotes a return to nature and improves rural economic development. Due to globalization and informatization, rural tourism has become more diverse and personalized. The rise of smart tourism has provided new ideas and methods for the innovation of rural tourism (Hussain *et al.*, 2023). Scholars have discussed the value of rural tourism from different perspectives, including economic, cultural, ecological, and tourists' perceived values (Stokowski *et al.*, 2021). At the micro level, research has focused on the impact of rural tourism on farmers and the ability to protect the environment and culture of local communities. At the macro level, researchers have analyzed the role of rural tourism in rural revitalization strategies and the sustainable development of the regional economy (Rosalina *et al.*, 2021). Some studies have considered the integration of ecology and culture (Ahern *et al.*, 2014; Macdonald and

King, 2018) and rural tourism and regional culture (Dai *et al.*, 2023; Gocer *et al.*, 2024), whereas others have analyzed how tourists' experiences can be improved through innovative tourism products and services (Chen *et al.*, 2023; Chen *et al.*, 2023). However, there is insufficient research on the high-quality and sustainable development of the rural leisure tourism industry. In particular, the integration of ecological resources, regional culture, and industrial integration requires further research. This study aims to fill this gap. It proposes innovative integration strategies and recommendations by analyzing the status quo, potential, and mechanism of integrating ecological resources and regional culture in the rural leisure tourism industry (Fig. 1). The results provide a theoretical basis and practical guidance for the sustainable development of the rural leisure tourism industry and the implementation of ecological civilization in rural areas to achieve sustainable development goals (Kowarik, 2023).

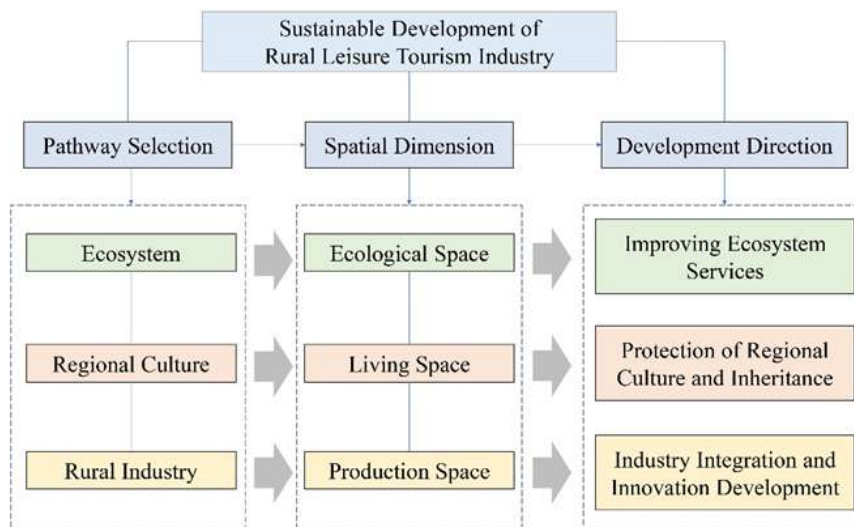


Fig. 1 Research framework of ecology-culture-industry-oriented rural leisure tourism industry

2 Research Area and Methods

2.1 Research Area

The research area is Fuxin City in Liaoning Province, which is located in the Liaohe Plain at the southern edge of the Horqin Sandy Region. Fuxin City is located in the sandy region and has rich natural resources and diverse ecosystems (Fig. 2). The area around Fuxin City includes plains, hills, mountains, rivers, lakes, grasslands, and aeolian landforms, providing divers natural

conditions for this study. Fuxin City has a long historical and cultural heritage and is known as "The hometown of Jade loong - The origin of civilization". In addition to the Zhahai culture, the region has mining areas (agate mining), hot springs, and other regional characteristics that provide unique cultural resources for this study. The Fuxin municipal government has a strong green development strategy focused on environmental protection. The region is prone to desertification. Many measures have been

implemented to mitigate it, such as planting shrubs, installing sand barriers, and planting species resistant to cold weather and drought. The

area has become a model for mitigating desertification in China.

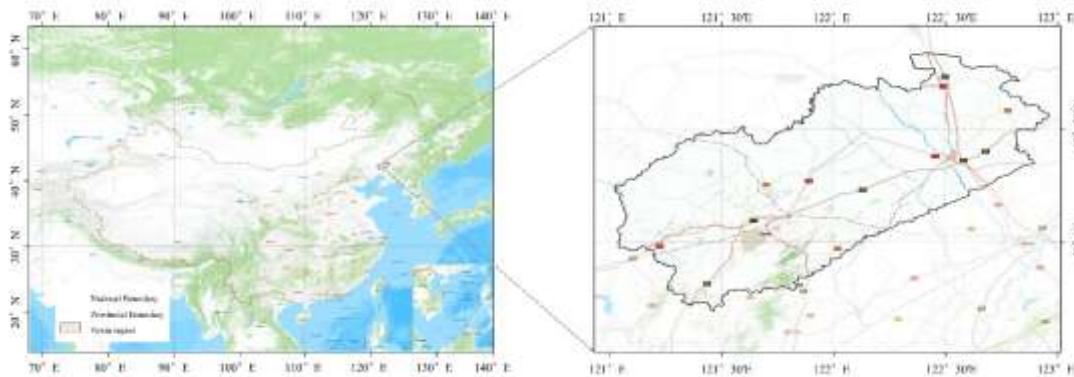


Figure 2 Research area location

Fuxin City's natural conditions, cultural resources, and environmental management experiences provide a good example for analyzing the rural leisure tourism industry. We conduct a systematic analysis to assess the impact of integrating ecosystem services and regional culture into the rural leisure tourism industry to ensure the industry's sustainable development.

2.2 Research Methods

2.2.1 Spatial Analysis and Assessment of Ecosystem Services

Spatial analysis of ecosystem services: A spatial analysis of ecosystem services was conducted for visualization and quantitative analysis. An ecosystem is a complex network of biological communities and their physical environment (Clements *et al.*, 2024b). Ecological resources are the basis of an ecosystem (Deng *et al.*, 2024), and ecosystem services are the benefits humans receive from ecosystems (Li *et al.*, 2023). Ecological products refers to the economic value of ecological resources and ecosystem services in economic and social activities (Ben *et al.*, 2024; Song and Du, 2024). Environmental protection refers to measures and policies to maintain and restore the integrity, stability, and functionality of an ecosystem (Khaddour *et al.*, 2024). These related concepts provide the basis for environmental protection and sustainable development (Li *et al.*, 2022). We mapped the services of different types of ecosystems.

Geographic Information System (GIS) data: We used GIS data, including terrain, landforms, water

and transportation networks, and remote sensing data on land cover types to perform spatial analysis of ecosystem services.

2.2.2 Mapping and Evaluation of Regional Cultural Resources

Mapping of regional cultural resources: We used qualitative and quantitative methods to assess regional cultural resources. Since regional culture is an abstract concept, we determined the attributes of cultural resources to perform spatial analysis. The data were obtained from field investigations.

We considered three aspects of integrating cultural and tourism resources: the goal, the consistency of characteristics, and the coupling of effects.

Regional cultural resource assessment: GIS analysis was used to map cultural and tourism resources and to quantify them. The spatial distribution of cultural tourism resources was analyzed.

3. Results and Discussion

3.1 Analysis of Ecosystem Services and Regional Culture

3.1.1 Distribution of Ecosystem Services

From distinct GIS data analyses presented in Fig. 3, it is evident that the ecosystem services are the benefits humans receive from ecosystems, such as forest, shrub, grassland, wetland, and farmland ecosystems.

Forest ecosystems are primarily located in mountainous and hilly areas in this study area.

Forests have high biodiversity and serve as carbon sinks to mitigate climate change. Fuxin City has large forest areas, primarily broad-leaved forests, that are crucial for soil and water conservation and providing ecological services (Fig. 3b).

Shrub ecosystems are located in semi-arid regions. They have high biodiversity and drought tolerance. Broad-leaved shrubs are dominant. They provide different ecological functions in ecological transition zones and shelter for various wild animals (Fig. 3c).

Grassland ecosystems are dominant in the ecotone between agricultural and shrubland ecosystems. They are critical for mitigating wind erosion and

soil and water conservation. A high vegetation cover reduces the adverse effects of sandstorms and improves soil fertility, ensuring regional ecological balance (Fig. 3d).

Wetland ecosystems regulate the regional climate, ensure high water quality, and provide species habitat. The protection and restoration of wetland ecosystems are required for regional ecological security (Fig. 3e).

Farmland ecosystems provide agricultural products and protect biodiversity and soil health if appropriate agricultural practices, such as crop rotation and intercropping, are utilized (Fig. 3f).

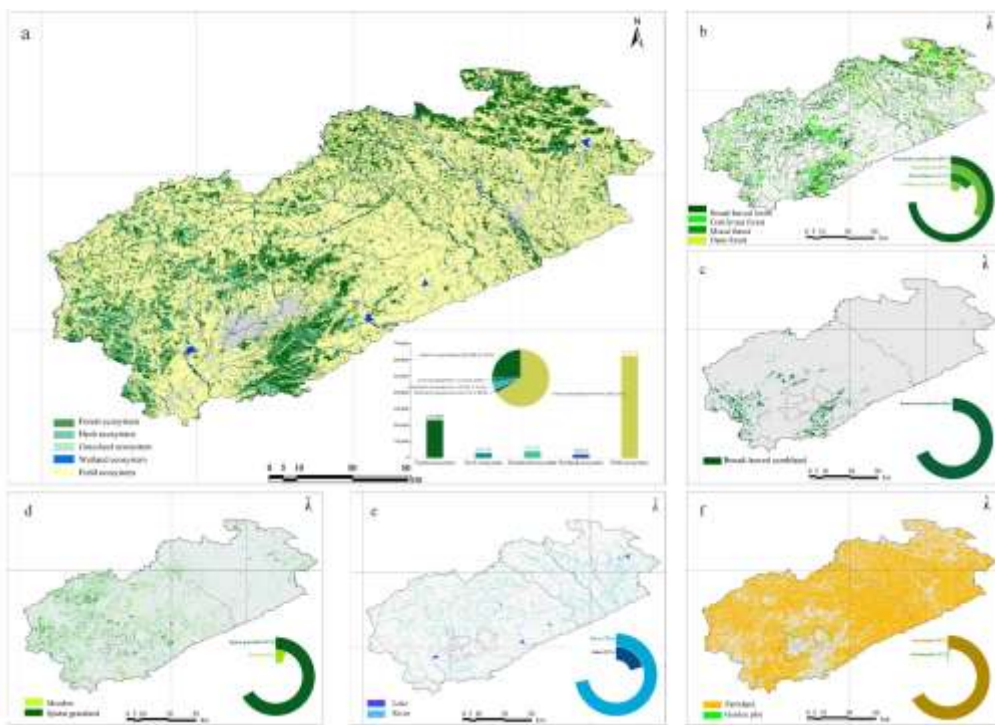


Fig. 3 Ecosystem type distribution map (a) General map of ecosystems (b) Forest ecosystem (c) Shrub ecosystem (d) Grass-land ecosystem (e) Wetland ecosystem (f) Farmland ecosystem

3.1.2 Spatial Distribution of Regional Cultural Characteristics

The regional cultural characteristics show significant historical hierarchy and ethnic diversity (Soja, 2009). The geographical distribution of regional cultural characteristics affects the ability to attract tourists, the diversity of tourism products, and the integration of cultural

and tourism resources (Nijkamp and Abreu, 2020). As a city with a long history in northern China, Fuxin City's cultural characteristics are deeply influenced by different historical periods, resulting in different cultures represented by the Zhahai culture, ethnic culture and agate culture (Table 1). A unique spatial distribution is observed, resulting in hot spots for the integrated development of culture and tourism (Fig. 4).

Table 1 Spatial distribution pattern of typical regional culture in Fuxin City

Serial number	Culture Category	Peculiarity	Embodiment Form	Spatial Distribution
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1	Zhahai Culture	The site of the earliest ancient village in the northern China, and the unearthed jade and loong-shaped artifacts, mark the important position of Fuxin in the origin of Chinese civilization.	Zha Hai cultural site	Fuxin Mongolian Autonomous County, east of Fuxin City
2	National Culture	National culture, especially Mongolian culture, is characterized by its distinctive nomadic characteristics and various national festivals.	Mongolian culture, Aobao meet, Mongolian Zhen pie, etc	Fuxin Mongolian autonomous County
3	Mining Culture	The mining culture and industrial heritage bear witness the history of Fuxin as an energy base.	Haizhou strip mine	Mining area of Fuxin City
4	Agate Culture	Agate culture, as a name card of Fuxin, is not only the inheritance of agate craft, but also an important place for the exchange of agate culture.	Shijiazi agate town	Shijiazi agate town of Fuxin Mongolian Autonomous County
5	Liao Culture	Liao cultural relics are all over Fuxin City, especially the historical role of Liao Dynasty hinterland and Khitan cradle, which adds a strong historical and cultural atmosphere to the city.	Liao ancient city, ancient pagoda, ancient tomb, etc	Fuxin Mongolian autonomous County

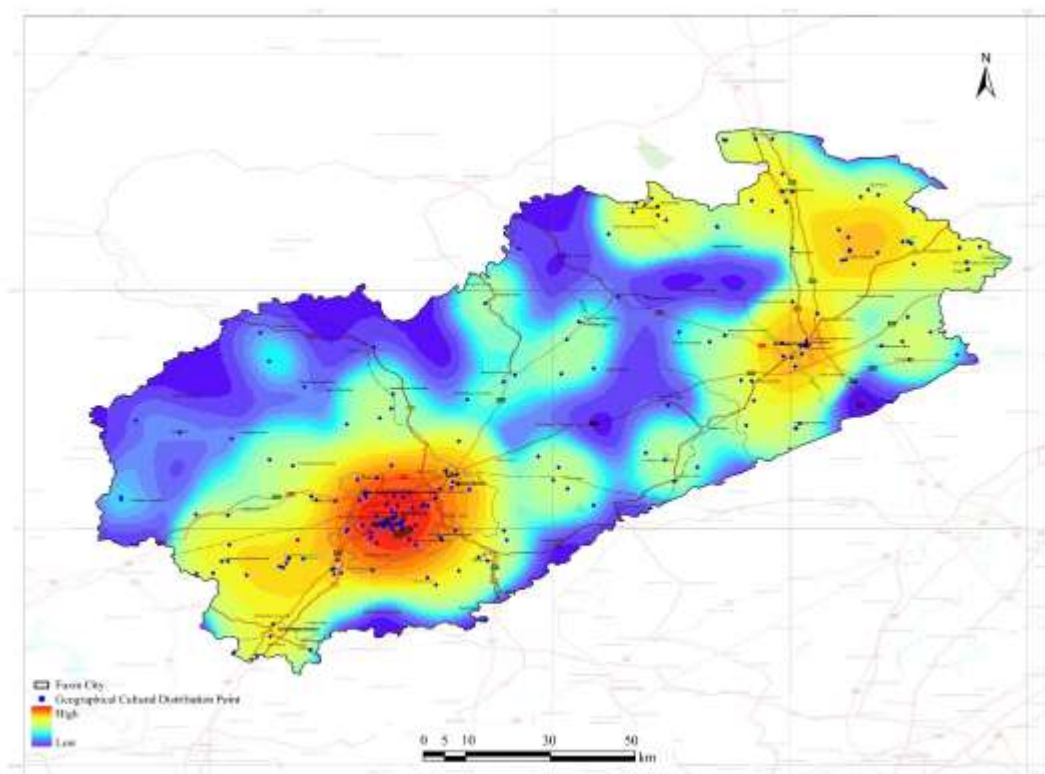


Figure 4 Heat map of regional cultural resource distribution

A resource evaluation system of cultural and tourism integration was developed to combine the abstract attributes of regional culture with the spatial distribution of resources to evaluate the

correlation, structure, function, and market development potential of resources. We found 261 cultural tourism resources in Fuxin city in 4 main categories, 10 sub-categories, and 34 types. The

cultural tourism resource types in Liaoning Province, where Fuxin City is located, were divided into 5 categories, 18 sub-categories, and 81 types, accounting for 80% of the categories, 55.6% of the subcategories, and 42% of the types. The types of cultural tourism resources in Fuxin City covered most of the categories in the standard system of Liaoning Province, but the coverage of the types was less than 50%.

Many cultural heritage resources exist in Fuxin City, with many immovable cultural relics with

profound historical and cultural significance. These intangible cultural relics have unique local characteristics and scientific values. The buildings and core facilities provide diverse cultural and recreational activities to improve cultural tourism. Human activities and cultural symbols represent the region's unique cultural charm (Table 2). Fuxin City has many cultural tourism resources, but there is room for further expansion and improvement to integrate cultural tourism resources.

Table 2 Four types of cultural and tourism integration resources in Fuxin City

Resource type	Liaoning Province Basic type	Fuxin City			
		Basic type	Proportion of the province (%)	Number of cells	Proportion of the city (%)
Material cultural relics	17	6	35.3	41	15.7
Intangible cultural relics	15	4	26.7	28	10.7
Functional buildings and core facilities	31	19	61.3	165	63.2
Human activities and cultural identifiers	7	5	71.4	27	10.4
Total	70	34	48.6	261	100

3.1.3 Interaction of Ecological and Regional Cultural Resources

A. The Role of Ecological Resources in Regional Culture

The results show that the ecological resources contribute to regional culture at multiple levels (Fig. 5). High biodiversity is critical in agricultural and grassland ecosystems. Local ethnic festivals and traditional handicrafts are diverse.

Biodiversity and cultural diversity: Biodiversity is important for regional culture. It supports the local

food chain and agricultural development and affects the living habits and cultural traditions of locals.

Natural landscapes and cultural identity: Natural landscapes, such as river wetlands and forest meadows, are important parts of the ecosystem, cultural identity, and cultural inheritance.

Ecosystem services and cultural values: Ecosystem services, such as water conservation and climate regulation, have direct and indirect impacts on regional cultural activities, such as festivals and folk arts.



Figure 5 Interaction mechanism of ecology, culture and industry

B. Effect of Ecological Resources on Regional Culture

The results show that ecological resources affect regional culture, and cultural factors are critical to environmental protection and sustainable development (Fig. 5). Regional culture enhances people's understanding of the value of environmental resources and provides practical strategies for the protection and wise use of environmental resources (Gatzweiler et al., 2024).

Cultural cognition and ecological values: The regional culture is based on respecting and protecting natural resources. This cultural recognition is reflected in the protection of natural landscapes, the maintenance of biodiversity, and the high evaluation of ecosystem services and functions. The ecological wisdom in cultural traditions and belief systems provides local residents a way of life in harmony with nature.

Cultural practices and environmental protection: Many traditional practices in regional culture, such as rotational grazing and seasonal farming, positively affect natural resources. The regional culture values respecting and protecting nature. These traditional practices coincide with the

modern concept of environmental protection and ensure the sustainable use of natural resources.

Integration of cultural industry and eco-tourism: The development of regional cultural resources, such as the agate and national culture, combined with eco-tourism, provides a new strategy for protecting and utilizing natural resources. Developing and promoting cultural products enriches the tourism experience and ensures the protection of natural resources.

C. Interaction between Ecological Resources and Regional Culture

The results in Fig. 6, obtained from former analytic graphs of GIS data and spatial distribution of regional cultural resource, show a significant spatial coupling relationship between ecosystem services and regional cultural resources. The distribution of cultural tourism resources at the intersection of forest, wetland, and farmland ecosystems is highly consistent with the ecosystem's diversity. This coupling relationship provides a unique combination of resources for developing the rural leisure tourism industry and promoting eco-tourism.

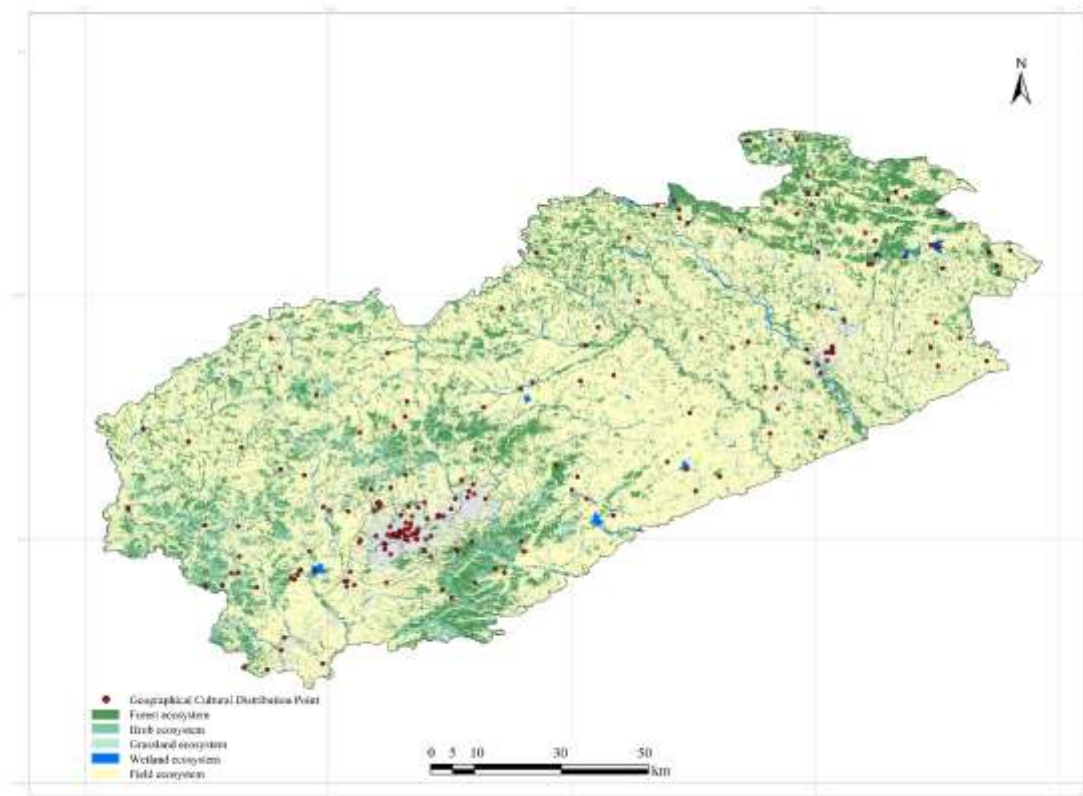


Fig. 6 Spatial coupling of ecosystem services and regional culture

Cultural value mapping of ecological resources: The cultural value of ecological resources in the regional culture was mapped. Forest and wetland ecosystems provide ecosystem services, are important components of the local national culture, and have significant cultural and historical value.

Effect of regional culture on environmental protection: The environmental protection concepts and practices in the regional culture, such as respect for and the protection of grassland ecosystems, are critical in the protection and sustainable use of natural resources. These cultural practices contribute to biodiversity preservation and provide a unique appeal for ecotourism.

Development of tourism products integrating ecology and culture: Due to the spatial coupling relationship between ecological resources and regional culture, creative design can be used to integrate ecological resources and cultural elements into tourism products, such as ecotourism routes, cultural experience activities, and ecological education projects. These elements attract more tourists and enhance the added value of the tourism industry.

Spatial coupling analysis can be used to integrate natural resources and regional culture to strengthen environmental protection and cultural inheritance. This strategy vitalizes the rural leisure tourism industry and ensures the coordinated development of ecosystems, culture, and economy.

3.2 Strategies for the Sustainable Development of the Rural Leisure Tourism Industry

In the current context of global emphasis on sustainability and the growing recognition of the unique value of rural areas, it is imperative to adopt a comprehensive approach that takes into account the intricate relationship between ecosystem services and regional culture. By conducting an in-depth analysis of these two crucial aspects, we can formulate and propose a set of moderate and well-thought-out strategies aimed at ensuring the sustainable development of the rural leisure tourism industry. These strategies, as depicted in Fig. 7, encompass three key dimensions: the improvement of ecosystem services, the protection and inheritance of regional culture, and the integration and innovative development of various industries within the rural tourism sector. Each of these dimensions plays a vital role in shaping a balanced and sustainable

rural tourism landscape that not only preserves the natural and cultural heritage of rural areas but also

promotes economic growth and social well-being for local communities.

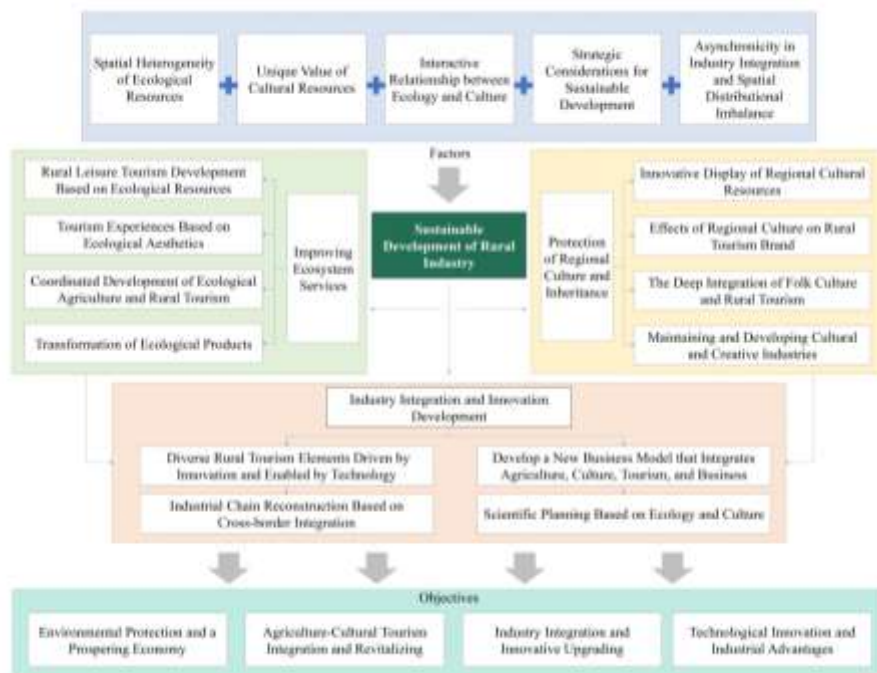


Figure 7 Correlation mechanism of sustainable development of rural leisure tourism industry

Conclusions

This work used GIS data and spatial coupling analysis to assess the integration of ecosystem services and regional culture into the rural leisure tourism industry in Fuxin City. It was found that ecosystem services and regional cultural resources had positive effects on the high-quality development of the rural leisure tourism industry. The following conclusions were drawn:

The ecosystem services showed significant spatial heterogeneity, providing diverse natural resources for the rural leisure tourism industry. The rich and unique regional cultural resources substantially improved the quality of the rural leisure tourism industry. The complex interaction between ecological resources and regional culture resulted in trade-offs and coordination at different scales. The balance between environmental protection and cultural inheritance should be considered in the sustainable development of the rural leisure tourism industry to ensure harmony between economic and social development and environmental protection.

The development levels of ecological resources, regional culture, and the rural leisure tourism industry differed significantly, showing substantial

differences in the spatial distribution. Due to its market-oriented operation, the cultural tourism industry is well developed. In contrast, the tourism potential of the agricultural industry is less developed, exhibiting agglomeration and regional differentiation.

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