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INFLUENCING FACTORS IN SPATIAL OPTIMIZATION OF RURAL SETTLEMENTS IN SOUTHWEST FUJIAN GUIDED BY ECOLOGICAL WISDOM

Jie Tian[1], Nur Huzeima Mohd Hussain[2*], Helmi Hamzah[3], Suzanah Abdullah[4]

[1] Department of Built Environment Studies and Technology, College of Built Environment, Universiti Teknologi MARA, Perak Branch, Malaysia
College of Fine Arts & Design, Minjiang University, China
Email: 2160@mju.edu.cn
[2] Department of Built Environment Studies and Technology, College of Built Environment, Universiti Teknologi MARA, Perak Branch, Malaysia
Email: nurhu154@uitm.edu.my
[3] Department of Built Environment Studies and Technology, College of Built Environment, Universiti Teknologi MARA, Perak Branch, Malaysia
Email: helmi692@uitm.edu.my
[4] Department of Built Environment Studies and Technology, College of Built Environment, Universiti Teknologi MARA, Perak Branch, Malaysia
Email: suzan156@uitm.edu.my
[*] Corresponding Author

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Abstract:

Under the current backdrop of the simultaneous advancement of ecological civilization construction and rural revitalization, optimizing the spatial layout of rural settlements in mountainous and wetland complex areas under ecological constraints has become a particularly urgent issue that requires everyone's attention and emphasis. This article takes the southwestern part of Fujian Province as an example to systematically review the research on ecological wisdom and the spatial evolution of rural settlements. This paper employs literature review, text analysis, and policy analysis to identify and synthesize the key factors influencing the optimization of rural settlement spatial patterns under ecological wisdom, from five dimensions: natural environment, transportation and accessibility, socio-economic conditions, historical culture, and policy governance. The research shows that the natural environment is the ecological foundation for the evolution of settlements and their disaster resistance capacity. The social and economic factors and transportation together have shaped the "mountain-valley - road-village" beaded pattern, as well as the evolutionary path where agglomeration and contraction coexist. Historical and cultural factors, through the Tulou settlements and clan networks, have maintained the continuity of the settlement

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forms and preserved local characteristics. Under the territorial spatial planning system and the ecological civilization agenda, policies and governance have reshaped the logic of spatial regulation and control. This research summarizes a set of influencing factors for the spatial optimization of rural settlements in mountainous wetland complex areas, providing a reference for related research and planning applications.

Keywords:

Influencing Factors, Ecological Wisdom, Spatial Optimization, Southwest Fujian

Introduction

Rural settlements are actually a spatial outcome formed after a long period of interaction between humans and the land. They play a fundamental role in agricultural production and people's living conditions, and also play a very crucial role in ecological processes, cultural inheritance, and social governance. In the context of the continuous advancement of global urbanization and the increasingly fierce regional competition, the intensity of changes in rural land use and land cover has been constantly rising. In some areas, there has been a disorderly expansion of construction land outward, compression of ecological space, and fragmentation of settlements. These problems have severely restricted the sustainable development of rural areas (Li et al., 2021; Zhang et al., 2025).

In China, with the continuous advancement of the rural revitalization strategy and the gradual establishment of the national spatial planning system, the spatial evolution of rural settlements no longer develops naturally and spontaneously as before. Instead, it is gradually moving towards institutionalized regulation achieved through overall planning and classified guidance. Following the implementation of the “Three Zones and Three Lines” system, instruments such as ecological conservation red lines, permanent basic farmland protection, and urban development boundaries have imposed rigid constraints on rural spatial governance, necessitating the reorientation of development pathways under ecological security requirements. The terrain in the southwestern part of Fujian Province is highly diverse, featuring mountains, hills and river valleys. In recent years, due to the continuous expansion of the coastal economic belt, the increase in resource development activities and the rapid growth of rural tourism, the spatial pattern of rural settlements in this area has undergone significant changes. In some local areas, there has emerged a phenomenon where both the concentrated expansion of the built-up area and the hollowing out of the periphery have occurred simultaneously, which has exerted great pressure on the mountain wetland ecosystem. From the perspective of the knowledge spectrum, Western theories such as ecological wisdom, social ecosystems, and adaptive governance help elucidate the coupling relationships among people, land, and institutions. Meanwhile, traditional Chinese ecological wisdom embodied in concepts like “harmony between heaven and humanity,” “adapting to local conditions,” and “settling with mountains behind and water in front” has long influenced rural settlement site selection and spatial patterns (Li et al., 2024). Existing research either focuses on the cultural and symbolic significance of traditional ecological wisdom or analyzes the geometric characteristics and drivers of settlement spatial forms, with a lack of systematic integration between the two. Particularly in complex mountainous regions like Southwest Fujian, how to systematically examine the multidimensional factors influencing rural settlement spatial

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optimization under the ecological civilization paradigm, guided by ecological wisdom, remains an issue requiring further exploration (Song & Kim, 2025). Therefore, this study takes southwestern Fujian as a case reference and adopts an ecological wisdom perspective to examine five key factors influencing rural settlement spatial optimization: natural environment, transportation and accessibility, socioeconomic conditions, historical and cultural heritage, and policy and governance (Li, Zhou, & Tao, 2024).

Western Traditional Ecological Wisdom Perspectives

Western research on "Ecological wisdom" has evolved from early ethnographic observations of human-land interactions to a mature, policy-relevant paradigm that explicitly connects values, knowledge, and action. Norwegian philosopher Arne Næss first proposed the concept of "ecological wisdom" based on his ecocentric philosophy, combining the word's roots with the Ancient Greek word for "ecology". In a 1973 essay in Inquiry, Arne Næss introduced ecosophy as "a philosophy of ecological harmony or equilibrium." According to this view, ecosophy is understood as a normative form of wisdom that integrates ethical principles, regulatory structures, value hierarchies, and theoretical insights. In this context, wisdom is not limited to scientific explanation or prediction, but also serves as a foundation for policymaking and practical guidance (Naess, 2017).

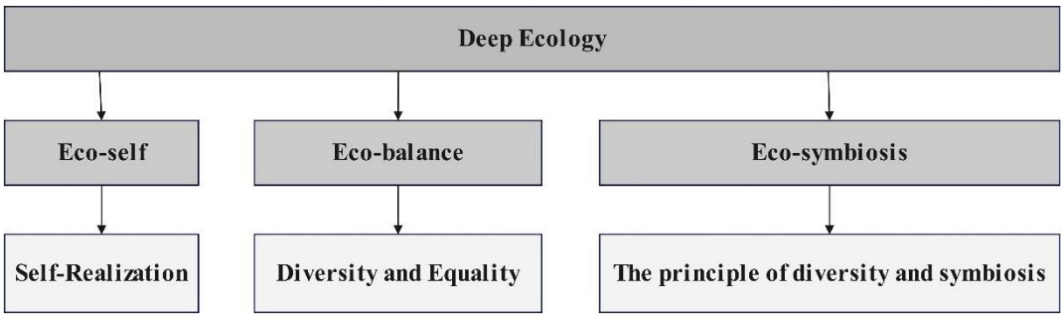

Figure 1: Deep Ecology Framework

(Source: Naess, 2017)

Building on this ethical turn, the Ecological Wisdom corpus reconstructs eco-wisdom as a unity of Næss's eco-philosophy (value-ethical orientation) and practical rationality. This unity is conceptualised as ecological practical wisdom, the "supreme art of moral improvisation" in ecological practice. The concept emphasises that ecological wisdom is both normative and actionable, enabling judgment and action to be integrated into specific planning and design contexts. In his research, he proposed a working definition: ecological wisdom is the ethics, knowledge, ability, and resilience to do the right thing in the planning, design, and management of social-ecological systems. Consequently, the author distilled several principles and approaches through cross-traditional examples. This synthesis was operationalised through four widely cited principles: reverence for nature, sustained relevance, holism, and practicality. These principles were distilled from a comparative review of China, Europe, and America and are evidenced in time-honored projects and effective policy instruments (Yang et al., 2019).

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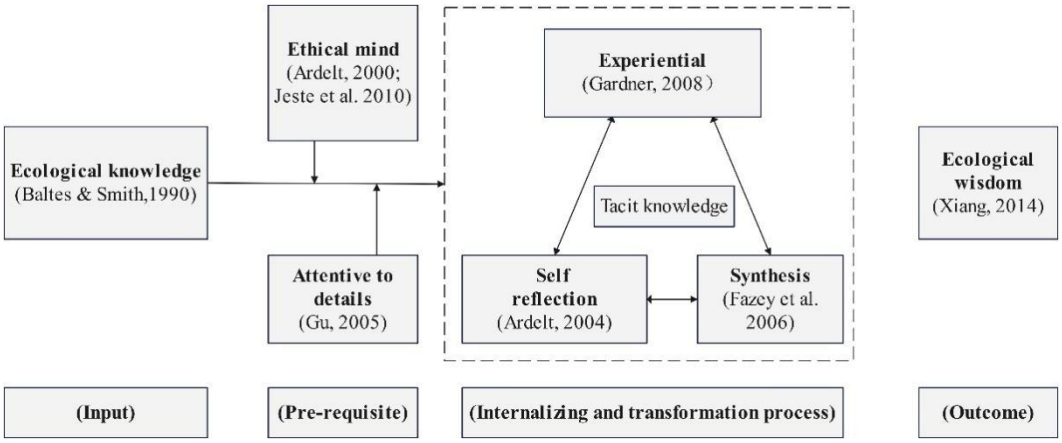

Figure 2: Conceptual Model of Ecological Knowledge to Ecological Wisdom Transformation Process at the Individual Level, Ecological Wisdom: Theory and Practice

(Source: Yang et al., 2019)

Beginning in the late 1980s, Fikret Berkes and his colleagues systematised Traditional Ecological Knowledge (TEK) as a "knowledge-practice-belief" complex. This encompasses local experiences, resource management systems, social institutions, and worldviews, transforming place-based observations into transferable analytical frameworks for management and conservation (Berkes et al., 2000).

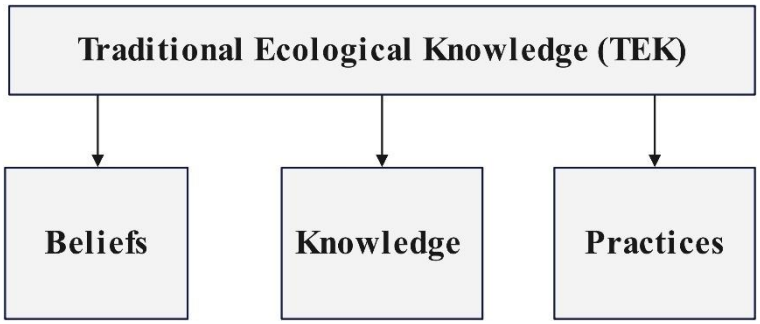

Figure 3: Traditional Ecological Knowledge (TEK) Framework

(Source: Berkes et al., 2000)

Foreign scholars have primarily studied the unique traditional ecological wisdom of indigenous peoples in South Asia, East Africa, South Oceania, the Americas, the Caribbean, Arabia, and other regions, and have begun to focus on the relationship between traditional culture and the local environment. A researcher studied how farmers in the Makanya watershed in Kilimanjaro, Tanzania, used traditional knowledge to identify potential sites for rainwater collection (Ngonyani et al., 2024). Studies have shown that rainfall patterns in semi-arid regions are highly variable in space and time. Over the centuries, people who depend entirely on rainwater have developed indigenous wisdom and techniques for harvesting it. These traditional catchment systems are adapted to local lifestyles, local institutional patterns, and local social systems. A researcher believes that the role of traditional ecological wisdom in providing basic data should be emphasised (Rani et al., 2025).

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The evolution of Western ecological wisdom has formed a thread: (1) from descriptive observation, (2) the framing of TEK, (3) the integration of ecological philosophy and practical rationality, (4) an actionable framework from knowledge to wisdom, and (5) policy uptake and co-production of evidence. This path aligns with the emphasis of EcoWISE: ecological wisdom must be ethically grounded, contextually informed, and policy-driven, transforming local ecological understanding into tools for governance and supporting the sustainable evolution of rural and urban spaces.

Figure 4 illustrates the conceptual framework of Western Traditional Ecological Wisdom, composed of three interrelated dimensions: Knowledge Foundation, Ethical-Value Structure, and Practical Rationality.

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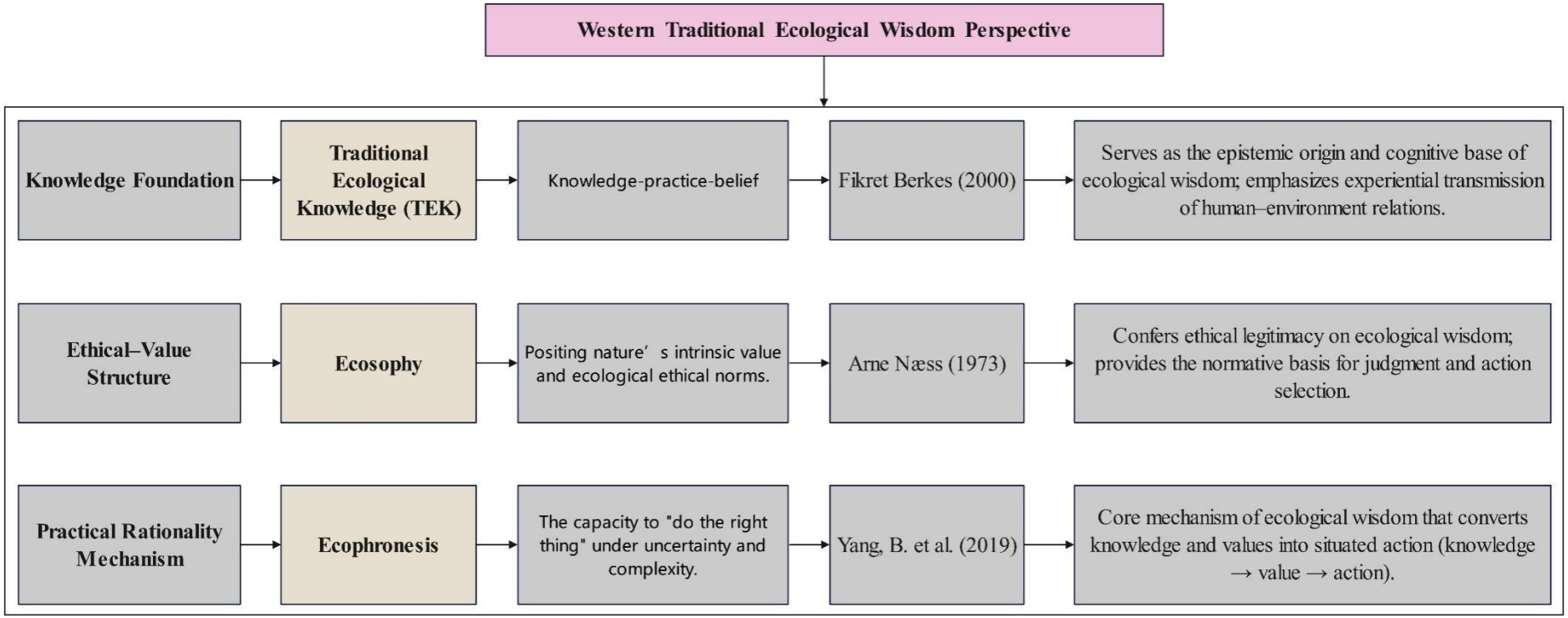

Figure 4: Western Traditional Ecological Wisdom Perspective

(Source: Author)

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Research Area

Location

Southwest Fujian is located in southeastern China, near the Tropic of Cancer, which includes Nanjing County, Pinghe County, Yongding District, and Xinluo District. The region lies in a subtropical oceanic monsoon climate zone, characterised by mild humidity, abundant rainfall, short, mild winters, and not extremely hot summers. The average annual temperature ranges from 20 to 22.5°C, annual precipitation is around 1800 mm, evaporation is about 1500 mm, sunshine duration is 1700-2000 hours, and rainfall is concentrated from June to November. Relative humidity averages 80%, with a mean annual wind speed of 1.1 m/s and a maximum of 13.8 m/s.

Table1: Location And Climate Overview of Southwest Fujian

Region	Area (km^2)	Administrative division	Administrative division/°	Mean annual precipitation/mm
Nanjing County	(1962).	Eleven towns	21.4	1821.1
Pinghe County	2328.6	10 towns, 5 townships	21	1712.5
Yongding District	2216.3	10 towns, 14 townships	20.1	1663.8
Xinluo District	2685.4	7 streets, 13 towns	16-20	1500-1900

Source: (Nanjing County, Pinghe County, Yongding District, Xinluo District Official government website, 2024)

Table 1 summarises the basic climatic and geographical characteristics of four regions in southwestern Fujian (Nanjing County, Pinghe County, Yongding District, and Xinluo District) in terms of geographic area, number of administrative divisions, and average annual precipitation. The table shows that these regions are located in the subtropical marine monsoon climate zone, with generally abundant annual precipitation (approximately 1500-1821 mm), though there are slight variations between regions.In terms of spatial attributes, Silla District has the largest area, reaching 2,685.4 square kilometers. The administrative density here is relatively low, and the precipitation is at a moderate level, approximately between 1,500 and 1,900 millimeters. The terrain is very wide, and the climate is characterized by being humid and stable. Yongding covers an area of 2,216.3 square kilometers, while Pinghe has an area of 2,328.6 square kilometers. In terms of area size, they are relatively similar. Regarding the density of administrative units, there are approximately 20 units per degree. There are also certain similarities in precipitation. The precipitation in Yongding is 1,663.8 millimeters, and that in Pinghe is 1,712.5 millimeters. From these aspects, it can be reflected that they have similar geographical and climatic conditions. Nanjing County has the smallest area, only 1,962 square kilometers. However, its administrative density is the highest, reaching 21.4 units per degree, and its annual precipitation is also the highest, at 1,821.1 millimeters. In Nanjing County, the way land is utilized is highly intensive and the water resource conditions are particularly good. These geographical and climatic factors combined form a very crucial background, which can help us understand the distribution of rural settlements in southwestern Fujian and the process of their spatial evolution. Typically, regions with higher precipitation and higher administrative density, such as Nanjing County, tend to support denser, more complex settlement structures. At the same time, areas with broader terrain and moderate

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rainfall, like Xinluo, are more likely to exhibit dispersed and adaptive spatial patterns. These variations influence the location and density of settlements, as well as the resilience and sustainability of spatial configurations under long-term ecological and socio-economic transformations.

Topographic And Hydrological

Fujian topography itself is very complex. In the process of geomorphic development, the regional fault block as a whole uplifted. The central and western Minxi mountain belt (Xianxia Ridge, Wuyi Mountain) and Minzhong mountain belt (Jiufeng - Dai Yun - Boping Mountain range) feature longitudinal lines that extend many branches in all directions, forming criss-cross peaks. From the perspective of terrain, the Southwest of Fujian lies between the two mountain belts in the west and the middle of Fujian, as well as the eastern coastal area. The region features considerable relief, with high elevations in the north and low elevations in the south, and a mix of high hills, low hills, and plains in the east. The middle mountain and low mountain constitute the dominant landform types in this area, with combined coverage accounting for the majority of the total land area. The mountain belt in western Fujian is the birthplace of many rivers, including the Jiulong River, the largest river in southern Fujian, and the Hanjiang River, the largest in eastern Guangdong, both of which originate in this region. The plain includes the valley plain and the intermountain basin valley plain, accounting for the whole area. Therefore, this area is known as "eight mountains, one water, and one field".

The terrain of the southwestern part of Fujian Province is mainly composed of mountains and hills. Generally speaking, it presents a pattern of highlands in the northwest and lowlands in the southeast. Under the influence of such topography and elevation, a distinctive composite landform structure composed of mountains, basins and river valleys has been formed. The region is dominated by the foothills of Wuyi Mountain, with undulating terrain and limited flat land resources. Settlements are primarily distributed in river valleys, gentle slopes, and small basins. In terms of water systems, the Jiulong River system is the main one, featuring a tree-like distribution and numerous tributaries, such as Longjin Creek and Meizhou River, which run through various counties and districts, providing the basic conditions for agricultural irrigation and village site selection. Overall, the relationship between the terrain and the water system has significantly affected the distribution form of the villages, resulting in a diverse settlement spatial pattern characterised by river belts and basin concentrations (Figure 1).

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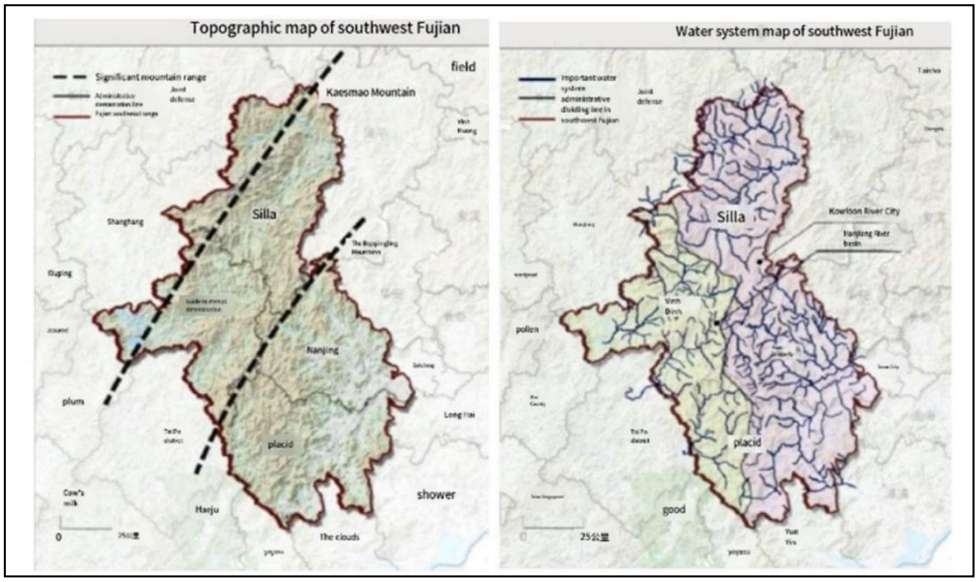

Figure 5: Physical And Geographical Environment in Southwest Fujian
(Source: NGCC http://www.ngcc.cn)

Methodology

Literature Research

This research adopts the literature review method to systematically sort out the achievements at home and abroad in the fields of ecological wisdom, the evolution of rural settlement spatial forms, rural development and rural governance, etc. It focuses on sorting out the common analytical dimensions and types of influencing factors in the existing research on rural settlement spatial forms, and identifies the key elements that frequently occur, such as natural environment, transportation, social economy, historical culture and policies. At the same time, pay attention to the key issues and practical experiences discussed in the optimization and governance of rural Spaces in ecologically sensitive areas such as mountains, hills and wetlands. On this basis, through concept comparison and classification, the relevant factors scattered in different studies are systematically integrated to initially construct five major influence dimensions: natural environment, transportation, social economy, historical culture, and policy. The conceptual boundaries of each dimension are clarified to provide a theoretical basis for subsequent analysis.

Text and Policy Analysis

Based on literature research, this study further adopts text analysis methods to systematically sort out and cross-read the planning and policy documents closely related to the spatial development of rural areas in southwestern Fujian. These mainly include the overall planning of territorial space, documents related to the rural revitalization strategy, documents on ecological civilization construction, as well as institutional documents on the protection of traditional villages and cultural heritage. The text analysis mainly focuses on three levels: First, sort out the principle-based requirements and bottom-line constraints regarding ecological protection, spatial control, and rural construction in the policy text, and identify the institutional expressions corresponding to the dimension of the natural environment; Second, analyze the overall guiding ideas in the document regarding the rural spatial pattern, industrial layout, infrastructure and public services, and reveal the allocation logic at the institutional level in dimensions such as social economy, transportation and accessibility. Thirdly, it examines the

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ways and limitations of the institutional level in absorbing traditional culture, local ecological knowledge and community participation, and explores the coupling relationship and potential tension between historical and cultural factors and policy and governance factors.

Result

Influencing Factors of Spatial Optimization in Rural Settlements

Natural environmental factors include four factors. In the topographic factors, the analysis focuses on the natural terrain, including elevation, slope, and aspect, which influence the settlement's morphological characteristics. Ecological wisdom emphasises that human settlements should be harmonious with the surrounding terrain. This principle clearly stipulates that construction activities should be carried out without causing disturbance to the environment. There is a mutual influence between terrain and human settlements. This interaction is crucial for maintaining ecological balance and reducing the possibility of natural disasters. Human settlements need to be coordinated with natural terrain. And ensure that the landscape is intact. This is done to minimize energy consumption during building construction and human habitation. Studies have shown that terrain can affect natural layout and socio-economic activities (Palmer, 2022; Yang et al., 2022). Climate variables examine various aspects of the weather, such as temperature changes, snow conditions, and water variations. This is to assess the extent to which these factors affect the agricultural labor force pattern and the spatial preferences of rural residents.

This article assesses hydrological factors to determine whether water sources exist, such as rivers, lakes, and other types of water resources, and examines how this water sources affect the site selection of residential areas and their subsequent development. Ecological wisdom is reflected in traditional practices, which particularly focus on water extraction. At the same time, efforts will also be made to minimize the ecological disturbance to the water source. Residential areas will balance the situations of water intake channels and water quality protection based on flood risks. Ecological wisdom methods emphasize that the location of residential areas should meet human needs, and also rely on concepts such as riverbank buffering and sustainable water management practices to protect water resources (Radaei et al., 2021).

When considering soil type and quality variables in this article, aspects such as agricultural productivity, soil fertility, and the survival of settlements are all taken into account. Ecological wisdom generally adopts some agricultural practices that can cultivate healthy soil and prevent soil degradation, such as crop rotation, organic fertilization, and terraced field construction. Traditionally, it has often been used by people to maintain soil fertility and prevent soil erosion at the same time (Homeshwari-Devi et al., 2024).

The traffic factor actually encompasses two distinct aspects: traffic roads and connectivity. The factor of traffic roads can reflect the impact of different roads on the accessibility and connectivity of villages. Roads play a crucial role in connecting settlements with other markets, services, and communities. This is also crucial for the development and prosperity of the settlement. Ecological wisdom emphasizes the construction and maintenance of roads that cause the least damage to the environment. By adopting such an approach, sustainable development can be supported and the needs of rural communities can also be met (Wu et al., 2021).

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The connectivity variable mentioned in this article is used to examine the degree of integration of the road network, which includes the accessibility of public transportation options, the convenience of means of transportation such as buses and trains, and the distance between settlements and large cities. When interconnection reaches a relatively high level, it can promote economic growth. It can also give people the opportunity to access a wide variety of services. Strengthening the integration between urban and rural areas is also achievable. However, this development approach of interconnection and intercommunication will also bring some problems, such as possible overdevelopment and possible environmental deterioration. From the perspective of ecological wisdom, combining connectivity with sustainability can make rural areas more suitable for living in terms of the environment and prevent people from feeling that they are not suitable to live there (Zhang et al., 2023).

The influence of socio-economic factors is influenced by four key factors, namely population size and density, business activities, infrastructure level and land ownership pattern. The population size and density factors mainly examine the changes in population size and density, such as population structure, distribution, density and mobility patterns. How do they influence the spatial form of rural settlements? Ecological wisdom proposes to strike a balance between population growth and environmental protection, promoting settlement plans that neither overcrowding the area nor depleting resources (Ma et al., 2022; Romanchuk et al., 2024). From the perspective of ecological wisdom, the key lies in keeping the population size consistent with the local environmental carrying capacity to avoid the degradation of natural resources. Business activity variables reflect the impact of macroeconomic indicators such as gross domestic product and per capita income on the spatial formation and development dynamics of rural residential areas. Existing industrial types also have an impact on the development and sustainability of rural residential areas. Integrating ecological wisdom essentially means supporting economic activities that can protect the environment while reducing resource consumption. Research indicates that the ecological wisdom approach needs to support economic activities that are beneficial to both community and environmental health (Merrell et al., 2022). In terms of infrastructure level factors, existing high-quality public service facilities should be taken into account for instance, aspects such as communication networks, medical facilities, and educational facilities. All of these facilities play a key role in the development and long-term sustainability of rural settlements. In such circumstances, ecological wisdom aims to create infrastructure that is beneficial to humanity without harming nature (Du & Jiao, 2023). The perspective of ecological wisdom particularly emphasizes the use of green infrastructure and sustainable technologies to promote rural development.

The Land Ownership Model variable assesses the effect of land ownership models such as land scale, land fragmentation, and land ownership systems on the spatial organisation and sustainability of rural settlements. Ecological Wisdom means land is treated well. Hence, it has not been used up too much and is shared fairly (Muchová & Raškovič, 2020). The ecological wisdom method considers following the practices of environmental guardians and promoting social fairness to be superior to them.

Three socioeconomic structures were present: the community structure, the cultural practice, and the cultural heritage. The Community Structure dimension explores how customary practices concerning buildings and villages guide the spatial allocation and siting of these elements. Community Structure shows the shared identity of a settlement and is formed by historical building ways and styles. Architectural style and village layout are closely tied to

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ecological wisdom, as conventional design typically prioritises harmony with nature, energy efficiency, and unity among people (Barrientos et al., 2021). The researcher needs to focus on the aspects that contribute to these elements being beneficial for the sustainability of a village and its cultural survival.

In terms of historical and cultural factors, this variable mainly examines how folk culture, local traditions and community structure influence the creation of the surrounding space of people's living places. Cultural customs encompass elements such as rituals, festivals, and collective activities. These diverse cultural customs, when combined, collectively constitute the unique identity characteristics of a settlement and also form a bond among people. In fact, these cultural customs contain ecological wisdom, which can promote the practice of sustainable agricultural development (Öz & Timur, 2024). It can help us manage resources and also enable us to live together as a community in a special way. In the context of continuous modernization and environmental changes, the protection of cultural customs is a very crucial issue. Cultural heritage factors involve the preservation of old buildings, various structures and cultural landscapes in rural settlements. Cultural heritage plays a key role in maintaining the historical continuity and identity of a community. Ecological wisdom is reflected in the emphasis on balanced development and conservation, which enables our culture to be preserved and passed down to future generations for use.

Policy and regulatory factors mainly consist of three parts: land policy, development planning, and governance quality. The spatial form of rural areas is to a considerable extent influenced by land regulations, which are used to manage the utilization of land resources, ownership, and transfer matters. Among them, there is land use planning. And the reasonable transfer of land use, that is, allocation, as well as land transfer policies, land expropriation and compensation policies. The design and specific implementation of policies will have a significant impact on the development of rural areas. The key point to focus on is whether land policies will promote the sustainable development of rural areas or hinder it. Development planning, also referred to as a policy package plan, primarily encompasses various rural development policies, including rural reform policies, agricultural policies, and infrastructure development. Strategic spatial planning instruments facilitate the coordinated development of rural areas, promoting equitable and enduring growth in accordance with overarching economic strategies (Peng et al., 2023).

Characteristics of the Influencing Factors of Spatial Form in Southwestern Fujian Natural Environment

The terrain in the southwestern part of Fujian Province is highly undulating and has drastic slope changes. Most settlements choose gentle slopes to avoid steep ones and are distributed along river valleys, plateaus and gentle slopes. The abundant and seasonal precipitation makes it necessary to strike a balance between convenient water access and flood safety when choosing a location for the village, thus forming a layout logic of "being close to water but not sinking into it". Soil and vegetation conditions indirectly shape a complex pattern of "mountain - forest - field - water - village" through paths such as agricultural production, ecological stability and soil and water conservation. As a result, the natural environment has become the primary ecological foundation for the evolution of rural settlements. From the perspective of topographic conditions, altitude, elevation zone and slope are the primary constraints determining the distribution of settlements (Yang et al., 2022).

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The slope and direction further refine the screening effect of terrain on settlement space. Relevant analysis indicates that as the slope increases, the distribution index of rural settlements shows a significant downward trend. Residents actively avoid areas with steep slopes and concentrate their settlement sites on gentle slopes or terraces to reduce the risks of landslides, mudslides and other disasters as well as engineering investment. The thresholds of slopes such as 15° and 25° have been repeatedly verified in the research on ecological sensitivity and safety patterns, and in this study, they also exhibit the spatial characteristics of "sparse steep slopes and dense gentle slopes" (Yang et al., 2023). The slope orientation is closely related to sunlight and the prevailing wind direction. Traditional settlements often choose sunny and sheltered orientations to obtain passive heating and good ventilation conditions in winter, reduce energy consumption and improve living comfort. This experience of "living in accordance with the trend" reflects the deep coupling of terrain and ecological wisdom.

Hydrological conditions organize the linear and block-like structure of settlements in a complex background. Research indicates that the location selection of villages, population density and community growth are highly correlated with factors such as rivers, lakes and the depth of groundwater burial. A large number of settlements are distributed in a beaded pattern along streams (rivers), forming a banded or clustered pattern to maximize irrigation and drainage efficiency. The traditional wisdom of site selection in the southwestern part of Fujian Province, which is "backed by mountains and facing water", has a concrete manifestation. It will closely rely on water sources. By doing so, it can ensure water supply for production and daily life. Because water is a very crucial resource in people's production and life, only by closely relying on water sources can water supply be guaranteed. In addition, it will rely on raising the foundation site and arranging slope Spaces to reduce the risk of flood erosion and achieve adaptive utilization of the water environment. Raising the foundation site can make buildings and other facilities safer when facing floods, and arranging slope Spaces can also alleviate the impact force of floods to a certain extent. With the abnormal temporal and spatial distribution of precipitation, the problems of extreme rainstorms and low water levels coexisting have become increasingly prominent. The availability of water resources and hydrological security are generally regarded by experts as the key variables determining the layout of settlements and the zoning of land use. Experts have found through research that the availability of water resources affects whether settlements have sufficient water to meet their needs, while hydrological security is related to whether settlements will be threatened by floods and other water disasters. They play a crucial role in the layout of settlements and the zoning of land use. Hydrological resilience is becoming one of the core topics in village spatial planning. Climate and soil conditions add time and process dimensions to the natural environment. Temperature changes, humidity levels and precipitation patterns not only affect crop types and agricultural rhythms, but also influence settlement patterns through architectural forms and spatial arrangements. The high-humidity environment has prompted the village to adopt more breathable and mold-resistant building materials, and to improve drainage and ventilation by means of raising, elevating and increasing the spacing between buildings. The intense monsoon and heavy rain have led the settlement to adopt a layout strategy that combines "leaving blank Spaces - flood discharge - infiltration and storage" in terms of road slopes, courtyard drainage and building foundations. Soil type and texture determine the spatial distribution of cultivated land and the stability of building foundations.

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Transportation

Constrained by the mountainous terrain, the external channels and internal main roads in the southwestern part of Fujian Province mostly follow the development of rivers and branch valleys. The main roads are laid out along the river valleys and the edges of basins, while the secondary roads extend towards the branch gullies and slopes. Overall, a network structure of overlapping beaded and radial patterns is formed. On the one hand, the transportation corridors extend along the low-resistance zones of natural landforms, connecting county towns, market towns and important industrial nodes. On the other hand, they form several highly accessible intersection nodes in local areas, becoming the core fulcrums for rural public services and the flow of elements. Empirical studies in mountainous areas have also shown that road density, road grade and their distance from township centers are important factors driving the agglomeration of settlements along river valleys and roads, and forming a gradient distribution pattern between valleys and slopes. The spatial orientation of roads and rivers significantly strengthens the linear agglomeration characteristics of settlements along corridors (Chen et al., 2022; Wang & He, 2022). Against this backdrop, areas with convenient transportation are more likely to form service centers and industrial nodes shared by multiple villages. In contrast, villages located at higher elevations, with greater slopes, or far from main roads often rely solely on a few rural roads to maintain their connections with the outside world, resulting in significantly lower accessibility, smaller settlement scales, and scattered distribution.

With the advancement of the new round of transportation infrastructure construction, high-grade highways, county and township roads, and tourist channels have been further integrated into the valley system. The spatial pattern of rural settlements in southwestern Fujian is showing a dual effect of being "connected" and "cut off". On the one hand, the improvement of road accessibility has significantly shortened the spatio-temporal distance from villages to county towns and central towns, enhanced the possibility of transporting agricultural products, labor commuting and access to public services, and enabled some traditional peripheral villages to be incorporated into the new development network (Zhang et al., 2024). On the other hand, large-scale roads and Bridges inevitably introduce ecological risks such as landscape fragmentation, habitat fragmentation and hydrological process interference when crossing valleys, wetlands and foothills. During the process of continuous top-down densification of the transportation network, how to reduce the damage caused by roads to the continuity of mountainous areas through means such as road route selection, three-dimensional intersections and ecological corridor restoration has become a key issue that needs to be corrected through ecological wisdom in the transportation dimension.

Social Economy

Villages close to county towns and important transportation nodes, relying on a relatively high level of urbanization, industrial agglomeration and well-developed infrastructure, show a continuous trend of population and function concentration towards axes and nodes, and the settlement forms tend to be compact and multi-functional superimposed. In contrast, mountainous counties and peripheral villages far from the development axis, under the backdrop of long-term population outflow and aging, are confronted with multiple pressures such as shrinking population size, declining space utilization efficiency, and intensifying "hollowing out", thus forming distinct differentiated development paths and phased optimization demands (Li et al., 2021).

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Within the socio-economic dimension, population size and density, population structure, and the spatial distribution of population in the landscape are the primary factors shaping the form of settlements. Existing studies have shown that the population size of rural settlements has a significant impact on spatial organization, while the population structure (age, gender, occupation) further restricts the allocation of resources and the layout of public services. The distribution of population in the landscape is directly related to the spatial connectivity and development gradient between settlements. Population density has a high correlation with the spatial layout of settlements and land use patterns: densely populated areas tend to adopt compact development to improve land use efficiency, while areas with sparse populations and severe aging are more prone to spatial fragmentation and an increase in idle land (Zheng et al., 2022).

At the economic activity level, the overall economic level, per capita income and industrial structure of rural areas have a direct impact on the spatial development and modernization degree of settlements. Research indicates that the economic aggregate level in rural areas will drive the modernization transformation of living and production Spaces, while per capita income affects the spatial distribution pattern of housing and public infrastructure. The differences in industrial structure determine the variations in spatial organization and economic sustainability of settlements: villages mainly based on traditional agriculture tend to present a linear or clustered form dominated by "production space", while those that introduce new business forms such as ecological agriculture, rural tourism, and cultural and creative industries are more likely to form a spatial pattern with superimposed composite functions. Economic activities deeply integrated with ecological practices can help increase income and employment while guiding land use to evolve towards higher landscape connectivity and lower ecological pressure.

The land ownership model and land use structure will rely on relatively deep-level institutional arrangements to intervene in spatial reconstruction. The land ownership model and land use structure play a crucial role in spatial reconstruction. They participate in spatial reconstruction through deeper institutional arrangements. The scale of land ownership will have an impact on the spatial organization of rural settlements. It will also have a certain impact on the land use pattern, because the scale of land ownership varies, and the spatial organization of rural settlements and the land use pattern will also be different. The fragmentation of land will reduce spatial consistency and have a negative impact on the sustainable development of agriculture. This has led to an unreasonable expansion situation of "multi-point dispersion" in the built-up area. Land fragmentation has negative effects. It weakens spatial consistency and affects agricultural sustainability. Eventually, it leads to an unreasonable expansion state of "multi-point dispersion" in the built-up area. In contrast, if the ownership structure is relatively concentrated, it is conducive to forming a more compact and clear settlement pattern. The land ownership system and the way homesteads are used not only relate to the layout of living and cultivated land, but also to the long-term investment of residents and the stability of spatial governance. In recent years, with the advancement of rural revitalization practices, land transfer and integration carried out through mechanisms such as land cooperatives, shareholding cooperation and ecological compensation are reshaping the structure and functional zoning of plots and guiding the internal land use of settlements to transition to a more orderly spatial structure (Zhou et al., 2020).

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Historical Culture

The Tulou architecture and the layout of traditional villages reflect the comprehensive wisdom in security defense, land conservation and public life, and are one of the most representative spatial carriers of historical and cultural factors in southwestern Fujian. The architectural style and settlement form are highly coupled here. The thick rammed earth exterior walls, the inwardly enclosed courtyard Spaces, and the public courtyard at the center of the enclosure not only respond to the defense and climate adaptation needs in mountainous environments but also enhance land use efficiency and energy utilization efficiency through high-density settlement and shared spaces.

At the community structure level, clan networks and blood ties have long dominated the spatial organization of rural settlements in southwestern Fujian. The combination of ancestral halls, ancestral hall squares and main streets and alleys form the "skeleton" of the village space. Through the superimposition of ritual system Spaces, sacrificial Spaces and daily interaction Spaces, it maintains the identity recognition among villagers and social order. Existing studies have pointed out that the layout of traditional villages and the structure of communities have a significant impact on the spatial form and cultural identity of settlements. The continuation of the traditional village pattern can enhance the spatial consistency and social structure of rural communities, and to a certain extent, maintain ecological balance and spatial stability (Hu & Yang, 2023).

Folk culture has also been deeply involved in the shaping of settlement Spaces. Ancestral worship, festival ceremonies, clan gatherings and other activities, with ancestral halls, stages, squares and corridors as the main venues, continuously enhance the functions and usage frequency of public Spaces in the village. From the perspective of cultural heritage and cultural landscapes, the ancient buildings, historical sites and cultural landscapes in the rural settlements of southwestern Fujian are not only the material carriers of historical memory, but also provide stability and resilience for the settlement form on a time scale (Ma et al., 2023).

Overall, the Tulou settlements and clan networks in the southwestern part of Fujian Province have not only shaped unique architectural styles and settlement textures, but also, through community structures, folk practices and cultural landscapes, have long provided an endogenous stability mechanism for the spatial form of rural settlements (Wang et al., 2024). Not only maintaining order and identity in the social dimension, but also enhancing the environmental adaptability and resilience of settlements through spatial wisdom such as feng shui forests, courtyard layout, orientation and scale in the ecological dimension. The characteristics of this historical and cultural factor make it both an object that needs to be protected and an important resource that can be activated in the optimization of rural space.

Policy

Systems such as the national spatial planning, the "Three control lines", and the rural revitalization strategy have set ecological bottom lines and construction boundaries for the spatial development of rural settlements in southwestern Fujian. The land use planning and project approval mechanism directly affect the expansion of construction land and the adjustment of land use structure. The governance capacity and the degree of public participation are related to whether the planning can be truly implemented and whether local ecological wisdom can be institutionalized and absorbed (Zhang, Man, & Zhang, 2023).

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From the perspective of land policy and development planning, the overall land use planning, the management of construction land indicators, and the reform of the homestead system, etc., constitute the "hard constraints" on the boundaries and internal structure adjustment of village construction. Research shows that land use planning and land use right allocation policies not only affect the spatial distribution and expansion direction of rural construction land, but also profoundly influence the spatial organization and fair pattern within villages. The traditional land management approach that has been continued under policy support has, to a certain extent, maintained the ecological balance and spatial order among "cultivated land - forest land - water bodies - settlements". Development policies such as rural reform, agriculture and infrastructure, through industrial structure adjustment, public service and infrastructure network construction, promote the transformation of settlements from production-dominated Spaces to "production-living-ecology" composite Spaces.

At the national level, the policy system centered on ecological civilization construction has embedded the principle of ecological priority into the territorial spatial governance system. Through tools such as ecological protection red lines, "dual evaluation", and "three zones and three lines", ecological thresholds are transformed into rigid spatial control. And it is transmitted layer by layer to provincial, municipal, county and village planning practices (Zhou, Li, & Xu, 2020). For the southwestern part of Fujian Province, this system has unified the protection boundaries of various ecological Spaces such as mountainous, river valley and coastal areas, providing a system handle for controlling excessive mountain development, river valley hardening and wetland reclamation. However, there are still problems of insufficient scale transmission and rule refinement in terms of how to refine operational indicators such as slope classification, buffer zone width and compact threshold at the county and township scales. This also explains that in some villages, the spatial anomaly phenomenon of "being able to be built but scattered at multiple points" still occurs (Sun, Ge, Yuan, & Lu, 2024).

Overall, the policy and governance factors in southwestern Fujian, on the one hand, shape the "institutional field" of rural settlement evolution through the territorial space planning system and land and development policies, strengthening the ecological bottom line and spatial boundaries; On the other hand, it is determined through governance quality, local institutional innovation and multi-subject co-governance whether these systems can form synergy with the natural pattern, social economy and cultural customs.

Discussion

The Significance of the Influencing Factors of Ecological Wisdom Reconstruction

The analysis of the influencing factors of introducing ecological wisdom into the spatial optimization of rural settlements has at least three aspects of significance. Firstly, at the value level, it offers a perspective to re-examine "importance". Taking achieving a high-quality life within the ecological boundary as the fundamental goal means that the significance of different factors is not only a matter of technical weighting, but also a matter of value ranking and development orientation. The reason why natural environmental factors become the "base plate" and why historical culture is worth protecting and embedding is not only because they are statistically significant, but also because they have irreplaceable significance in ecological security, intergenerational equity and identity recognition.

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Secondly, at the knowledge level, ecological wisdom emphasizes the diversity of knowledge, advocating that in addition to scientific data, local knowledge, traditional experience and community perception should be given equal attention. Compared with making judgments solely based on external indicator systems, regarding long-term accumulated agricultural experience, site selection wisdom, feng shui practices and village regulations and conventions as important sources of knowledge for understanding the spatial logic of settlements helps to make the analysis of influencing factors closer to the actual situation and historical continuity of the village.

Secondly, at the practical level, by identifying key elements in specific regional contexts and extracting spatial guidelines and governance suggestions with normative significance on this basis, the traditional "explanatory" analysis of influencing factors can be connected with the planning guidelines, design strategies and governance tools of "what should be done". This will enhance the usability and operability of research results in rural planning and policy-making.

Implications for Rural Spatial Planning and Rural Revitalization

Rural planning should take the natural environment as the bottom line, incorporate factors such as slope, hydrology and ecological sensitivity as rigid constraints into the decision-making of village space, and avoid exceeding the ecological carrying capacity or increasing disaster risks during the process of form adjustment and land use expansion. In terms of spatial connection and infrastructure layout, the optimization of transportation and accessibility should adhere to the principles of green connectivity and priority for slow traffic. Both the road and greenway systems should be regarded as dual corridors for ecology and society, avoiding the situation where a single vehicle road, while facilitating transportation, exacerbates ecological fragmentation and landscape fragmentation. Social and economic development should not be simply equated with the expansion of construction land, but should promote the spatial reconstruction of "compact and livable" through industrial transformation and functional integration. Taking advantage of opportunities such as characteristic agriculture, eco-tourism and rural industries, guide the organic integration of production, living and ecological Spaces, and improve the efficiency of space utilization and environmental quality under limited land use conditions.

At the same time, in the field of ecological education, community building, and spatial governance, we should carry out "utilization" operations on historical and cultural resources and "activate" them. Traditional settlement patterns, tulou architecture, feng shui forests, water inns and related folk practices can serve as important venues for ecological awareness cultivation, community participation and spatial governance experiments. Through moderate renewal and functional reconstruction, they can be transformed into endogenous vitality sources that support the sustainable development of rural areas. Institutional design and governance practices need to reserve space for the integration of ecological wisdom. Whether it is the compilation of territorial space planning or the implementation of village planning and project approval, mechanisms and conditions should be created for the expression of local knowledge, public participation and multi-party consultation in terms of systems. Through participation mechanisms, technical standards and supervision and evaluation systems, the translation and implementation from concepts to rules and from rules to daily practices should be truly achieved.

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Conclusions and Prospects

Main Conclusions

This paper constructs a five-dimensional influencing factor system for the spatial optimization of rural settlements oriented towards ecological wisdom, regarding the natural environment, transportation and accessibility, social economy, historical culture, and policies and governance as the key dimensions that jointly constitute the core dynamic field of rural spatial optimization. Among them, the natural environment provides the ecological foundation and boundary constraints, while the social economy and transportation shape the driving force and corridor structure for spatial reconstruction. Historical culture and governance factors respectively offer support for the continuity of settlement forms and the implementation of systems.

The research further revealed the specific functional characteristics of the five major factors. The regional topography and hydrological conditions have determined the settlement pattern of "choosing gentle slopes and avoiding steep ones, being close to water but not getting trapped in it". Industrial transformation and infrastructure construction have promoted the agglomeration development along river valleys and transportation corridors. The Tulou culture and clan networks have maintained the historical continuity of settlement forms and community structures, while the ecological civilization system and territorial space planning have reshaped the logic of spatial control. They jointly shaped the beaded pattern of "mountain - valley - road - village" and its evolutionary process of coexistence of agglomeration and contraction, reflecting the spatial logic of seeking a balance between ecological constraints and development opportunities.

Outlook

Future research can further test and expand the five-dimensional factor system proposed in this paper on a broader regional scale, apply it to different types of mountainous areas, wetlands and complex ecologically sensitive regions, and compare the differences in the importance and action paths of influencing factors in different situations. Supported by complete data, methods such as multi-scale spatial statistics and structural equations are introduced to quantitatively model the relationships among the five major factors, provide stronger support for ecological intelligence-oriented planning and interpretation. At the same time, ecological wisdom should be combined with new technologies such as digital twins and spatial big data to explore the path of "digital and intelligent" governance and dynamic optimization of rural Spaces. Moreover, through methods such as villagers' participation, public perception surveys, and scenario simulations, the manifestations and operational paths of ecological wisdom in specific rural practices should be further enriched.

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