Construction and Empirical Analysis of a Comprehensive Evaluation System for the Human Settlement Environment of Traditional Villages in Sichuan

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Abstract: *With the acceleration of modernization and urbanization, traditional villages in Sichuan face challenges such as population loss, outdated infrastructure, and environmental degradation. This study focuses on traditional villages in Sichuan, exploring the current state and development potential of their human settlements. While existing research on human settlements often focuses on urban areas, traditional villages have received comparatively less attention. Therefore, this study constructs a comprehensive evaluation system to assess the suitability of human settlements in Sichuan's traditional villages, providing a scientific basis for the preservation of traditional culture and rural revitalization. The research methods include field surveys, literature analysis, and the Analytic Hierarchy Process. The evaluation system, consisting of 16 specific indicators across three criteria layers—natural environment, socio-economic conditions, and development potential—was tested on human settlements in the western Sichuan Plateau and northeastern Sichuan hilly regions, demonstrating the feasibility of the comprehensive evaluation system. Additionally, by comparing the differences in human settlements across various regions, targeted improvement measures are proposed.*

Keywords: **Traditional villages, human settlements, evaluation system, Sichuan**

1. INTRODUCTION

Sichuan Province, located in southwestern China, is renowned for its rich natural resources, diverse geographical environment, and deep cultural heritage [1]. As an essential part of the Chinese nation's historical and cultural legacy, Sichuan's traditional villages preserve many unique architectural styles, traditional cultures, and lifestyles [2]. However, with the acceleration of modernization and urbanization, the living environments of these traditional villages are facing a series of challenges, such as population loss, outdated infrastructure, and environmental degradation [3]. Evaluating the suitability of the human settlement environment in these villages is not only conducive to the protection and inheritance of traditional culture but also provides significant references for sustainable development and ecological civilization construction [4].

As the global agenda for sustainable development deepens, the scope of research on human settlement environments has expanded from a focus on physical spaces to a multidimensional synthesis that includes natural environments, social environments, and economic conditions [5]. These research topics encompass the diversity of urban and rural areas, modern and traditional settings, and developed and developing regions, aiming to explore how to optimize the overall human living environment to enhance quality of life and promote sustainable development [6-9]. From a research perspective, studies on human settlement environments cover multiple levels and viewpoints [10]. Traditional research has primarily focused on the physical environment of living spaces, such as air quality, water resources, noise control, and green space areas. With the development of socio-economic conditions, research has gradually extended to social and cultural factors, including community interaction, cultural identity, and accessibility to public services [11-13].

In terms of comprehensive evaluation systems for human settlements, researchers have proposed various evaluation methods and indicator systems. These evaluation systems typically include multiple dimensions, such as natural environment, socio-economic conditions, infrastructure, public services, and cultural heritage [14-16]. The research on human settlement environments is supported by various complex computational models and analytical tools, such as Geographic Information System (GIS) analysis, Analytic Hierarchy Process (AHP), entropy method, and fuzzy comprehensive evaluation method. These models generate environmental quality evaluation results under different scenarios by integrating and analyzing natural environment data, socio-economic data, and residents' perception data [17–19].

Despite significant progress in the study of comprehensive human settlement environments, current research still has some shortcomings. Firstly, the primary focus of current research on human settlements is on urban environments, with relatively little attention given to rural and traditional villages. Even in the few studies focusing on rural areas, many tend to adopt urban environment evaluation standards, which overlook the unique natural and cultural environments of traditional villages [20]. Therefore, this paper selects 396 traditional villages in the Sichuan Tibetan Plateau as research subjects from the "China Traditional Villages List." It constructs a comprehensive evaluation indicator system for the human settlement environment in traditional villages, covering three aspects: natural environment, socio-economic conditions, and development potential. Using the Analytic Hierarchy Process, this study evaluates the overall level of human settlement environments in traditional villages in Sichuan and conducts a differential study on the comprehensive levels of human settlements in these regions. This research will provide scientific references for the comprehensive management of human settlements in Sichuan's traditional villages and the revitalization of rural areas.

2. METHODS AND DATA

2.1. Study area

Sichuan is the fifth-largest province in China, covering an area of approximately 486,000 square kilometers. The province is administratively divided into 21 prefecture-level units, including 18 prefecture-level cities and 3 autonomous prefectures for ethnic minorities. Sichuan has a population of about 83 million. In 2023, Sichuan's GDP reached approximately 5.7 trillion yuan, with the Chengdu Plain Economic Zone in central Sichuan being the most economically developed area of the province [21]. In contrast, the northeastern and northwestern regions of Sichuan have relatively slower economic development, primarily relying on agriculture and mineral resources. Sichuan's geographic environment is complex and diverse. The eastern part is the Sichuan Basin, characterized by relatively flat terrain suitable for agricultural development, while the western part lies on the eastern edge of the Qinghai-Tibet Plateau, with rugged terrain and an average altitude exceeding 3,000 meters. These diverse geographical conditions have resulted in abundant natural resources and a unique ecological environment. Sichuan also exhibits a variety of climate types [22]. The eastern region experiences a subtropical monsoon climate, which is warm and humid, making it suitable for agricultural production. In contrast, the western plateau region has a cold and dry climate, with distinct characteristics of a high-altitude climate [23,24].

2.2. Research methods

Traditional villages exhibit characteristics of complexity and diversity, with significant variations in their geographical locations, socio-economic conditions, and the perspectives of villagers and local officials. Consequently, the development status of traditional villages varies widely. This study, based on extensive field research and literature analysis, integrates an understanding of the formation, development, and evolution of traditional villages in Sichuan. By drawing on evaluation frameworks and methodologies established

by scholars in other disciplines, we have developed a comprehensive evaluation system for the human settlements in traditional villages. The construction of the indicator system employs the Analytic Hierarchy Process, and the evaluation results for each indicator are assessed using a five-point scoring method [25].

2.3. Data Sources

Due to the common challenges in collecting data on traditional villages, such as difficulties in statistical measurement, lack of standardized statistical criteria, and the complexity and diversity of indicator types, research on traditional villages often faces obstacles in data collection. To address this, indicators that were difficult to obtain data for were excluded during the screening stage. Geographic environment data were obtained from open data platforms such as the Geographic Spatial Data Cloud and the Resource and Environment Data Cloud of the Chinese Academy of Sciences. Socioeconomic data were acquired from statistical yearbooks and bulletins released by government departments. Additionally, a wide range of sources, including news reports, academic literature, and field surveys, were collected to corroborate the findings. These raw data, having been reviewed by relevant authorities and experts, possess a high degree of credibility.

2.4. Indicator System

The comprehensive human settlement environment of traditional villages is a complex process shaped by multiple factors [26]. To accurately understand this environment, we based our evaluation on the principles of authenticity, operability, and guidance. By referring to various perspectives from recent studies, we categorized the factors influencing the human settlement environment of traditional villages into three dimensions: natural environment, socio-economic conditions, and development potential. This approach led to the construction of a comprehensive evaluation indicator system for assessing the human settlement environment of traditional villages.

The Analytic Hierarchy Process is a mathematical tool for systematic analysis, which allows for the decomposition of complex problems into individual components and the construction of a hierarchical structure based on the relationships of dominance among them [27]. By employing pairwise comparisons, the relative importance of each factor within the decision-making process is determined. Following the modeling steps of the AHP, the hierarchical structure model for the comprehensive evaluation of traditional village human settlement environments is divided into three levels: the goal level, the criterion level, and the indicator level. The goal level specifies the purpose of the evaluation system, which is to analyze the comprehensive human settlement environment of traditional villages, aiming to compare the differences among various traditional villages through quantitative analysis methods. The criterion level includes three major factors: natural environment, socio-economic conditions, and development potential, each of which is further refined into multiple evaluation indicators. The selection of indicators underwent continuous screening and adjustment, ultimately resulting in the identification of 16 evaluation indicators. Each indicator has a clear definition and is assigned specific grading criteria.

Table 1. Comprehensive Evaluation System for the Human Settlements Environment of Traditional Villages

Target Layer	Criterion Layer	No.	Indicator Layer	Weight
Comprehensive Evaluation of Traditional Village Human Settlements Environment (S)	Natural Environment (N)	X1	Elevation	0.129
		X2	Slope	0.086
		X3	Aspect	0.082
		X4	Distance to Water	0.072
		X5	Distance to Road	0.062
		X6	Distance to County	0.072

		X7	Temperature	0.058
		X8	Precipitation	0.049
		X9	Green Coverage Rate	0.049
	Economic and Social (E)	X10	Population Density	0.089
		X11	Per Capita Income	0.028
		X12	Population Growth Rate	0.056
		X13	Per Capita Income Growth Rate	0.049
	Development Potential (P)	X14	Spatial Kernel Density	0.028
		X15	Distance to Scenic Spot	0.013
		X16	Honorary Titles	0.078

The "Five-Level Scoring Method" is used to grade each indicator. This method involves evaluating the subject by assigning scores across five levels. It is straightforward and clear, reflecting the inherent characteristics of the subject while facilitating comparisons between different objects. According to this method, the scoring criteria for each indicator are categorized into five levels: Excellent, Good, Fair, Poor, and Very Poor, with corresponding scores of 5, 4, 3, 2, and 1, respectively. For data indicators that cannot be directly quantified, a simplified three-level scoring system is used, with levels of Excellent, Fair, and Poor, and corresponding scores of 5, 3, and 1 [28]. For indicators such as distance to scenic spot, a reverse scoring approach is applied, meaning that the greater the distance, the lower the score. After detailed recording and standardization of data for each traditional village, the project team members assign appropriate scores to each village's evaluation indicators through collective discussion based on the scoring method and grading standards.

2.5. Evaluation Standard

2.5.1 Natural Environment

The natural environment not only affects the comfort and safety of living in traditional villages but also relates to the village's sustainable development [29]. The following nine indicators—elevation, slope, aspect, distance to water systems, distance to roads, distance to towns, temperature, precipitation, and green coverage rate—are selected to represent the natural environment of traditional villages.

Firstly, elevation, slope, and aspect are key factors influencing village construction and agricultural production [30]. Elevation, or the altitude of the land, directly impacts temperature and climatic conditions. Generally, higher altitudes result in lower temperatures and shorter growing seasons, which can be particularly detrimental to crops that require a warm climate. Slope directly affects land use. Flat or gently sloping land is more suitable for agricultural machinery and infrastructure development, whereas steep slopes may lead to soil erosion and drainage difficulties, increasing construction costs and environmental risks. Additionally, aspect, which refers to the orientation of the land relative to the sun, influences solar radiation and microclimatic conditions. South-facing slopes typically receive more sunlight and have higher temperatures, benefiting crop growth and residential lighting, whereas north-facing slopes may be colder and more humid, posing challenges for agriculture and habitation [31].

Secondly, distance to water systems, distance to roads, and distance to towns are core indicators for assessing the accessibility of transportation and water resources in a village [32]. The proximity to water systems is crucial for agricultural irrigation, drinking water supply, and the sustainable use of water resources. In arid regions, villages closer to water

sources can better secure agricultural production and meet residents' water needs [33]. The distance to roads affects the transportation convenience and connectivity of the village. Villages near major transportation routes are typically more accessible for transporting agricultural products, obtaining external information and resources, which is essential for the sustainable economic development of the village. Moreover, distance to towns reflects the proximity of the village to markets and service facilities. A closer distance provides villagers with more convenient access to medical, educational, and commercial services, enhancing quality of life and attractiveness [34].

Temperature, precipitation, and green coverage rate are important indicators for evaluating the natural environment and livability of traditional villages. Suitable temperatures promote crop growth and ensure residents' health and comfort [35]. Precipitation directly impacts water resource availability and agricultural production. Adequate rainfall ensures sufficient water sources for irrigation and enhances agricultural productivity. Reasonable precipitation also helps maintain ecological balance and reduce natural disasters. Green coverage rate reflects the ecological quality of the village. A high green coverage rate not only enhances the aesthetic value of the village but also regulates climate, purifies air, and conserves soil and water. The ecological benefits brought by greenery are crucial for the sustainable development of the village.

2.5.2 Economic and Social

Based on the indicators of population density, per capita income, population growth rate, and per capita income growth rate, a comprehensive assessment of the socio-economic development status of traditional villages can be conducted. Population density reflects the scale and concentration of the village population. High population density may indicate a higher level of social vitality and labor resources in the village but may also lead to resource competition and environmental pressure. Conversely, low population density might suggest that the village's development is lagging and lacks attractiveness [36].

Per capita income is a key indicator of the village's economic level [37]. Higher per capita income signifies good economic development and a higher standard of living for residents, better meeting their daily life and consumption needs. On the other hand, low per capita income may indicate poverty and restrict further development of the village.

Population growth rate shows the dynamic changes in the village population. Growth typically suggests that the village is attractive in economic and social terms, capable of attracting new residents or retaining local ones. Negative growth may indicate issues such as population loss and aging.

Per capita income growth rate reflects the speed and quality of economic development in the village. A stable and continuous growth rate indicates strong economic growth potential and an improving standard of living for residents. Stagnant or declining income growth may signal economic challenges for the village [38].

2.5.3 Development Potential

Kernel density values reflect the spatial concentration and aggregation characteristics of the village [39]. Higher kernel density values generally indicate that the village is more likely to develop in a concentrated manner with surrounding areas, exhibiting active socio-economic activities and significant development potential. Lower kernel density values might suggest that the village is more dispersed with limited development potential, but it could also imply substantial opportunities for development and resource integration.

Distance to scenic spot directly impacts the village's tourism development potential [40]. Villages located close to famous attractions are more likely to attract tourist traffic, boosting local economic development, especially in regions rich in tourism resources where proximity can be a significant driver of development. Villages farther from scenic spots

may need to rely on other unique resources or innovative tourism development methods to enhance their attractiveness [41].

Achieving national-level honorary titles such as “National Historical and Cultural Village” or “National Rural Tourism Village” represents recognition of the village's value in cultural, ecological, and historical aspects. Such honors not only enhance the village's visibility and attractiveness but may also bring policy support and financial investment, thereby providing strong support for the village's development [42].

Table 2. Evaluation Standard for the Human Settlements Environment of Traditional Villages

No.	Indicator Layer	Evaluation Standard	Score	No.	Indicator Layer	Evaluation Standard	Score
X1	Elevation (meters)	＜800	5	X9	Green Coverage Rate	≥0.77	5
		800 - 1600	4			0.65-0.77	4
		1600 -2400	3			0.53-0.65	3
		2400 - 3200	2			0.41-0.53	2
		≥3200	1			＜0.41	1
X2	Slope (degrees)	＜5	5	X10	Population Density (people/square km)	＜1000	5
		5-15	4			1000-3000	4
		15-25	3			3000-7000	3
		25-35	2			7000-12000	2
		≥35	1			≥12000	1
X3	Aspect (degrees)	150-210	5	X11	Per Capita Income (10,000 yuan/square km)	≥10000	5
		60-120	4			5000-10000	4
		240-300	3			2000-5000	3
		0-30 and 330-360	2			500-2000	2
		Others	1			＜500	1
X4	Distance from Water (km)	＜1	5	X12	Population Growth Rate（%）	1-2	5
		1-5	4			0-1	4
		5-10	3			2-5	3
		10-15	2			＜0	2
		≥15	1			≥5	1
X5	Distance from road (km)）	＜5	5	X13	Per Capita Income Growth Rate（%）	≥3	5
		5-15	4			2-3	4
		15-30	3			1-2	3
		30-50	2			0-1	2
		≥50	1			＜0	1
X6	Distance from County (km)	＜10	5	X14	Kernel Density	≥20	5
		10-30	4			15-20	4
		30-50	3			10-15	3
		50-70	2			5-10	2
		≥70	1			＜5	1
X7	Temperature (Celsius)	≥10	5	X15	Distance from Scenic Spot (km)	＜5	5
		8-10	4			5-15	4
		5-8	3			15-30	3

		2-5	2			30-45	2
		＜2	1			≥45	1
X8	Precipitation (mm)	≥1200	5	X16	Honorary Titles	Received Two or More National Honorary Titles	5
		900-1200	4				
		700-900	3			Received One National Honorary Title	3
		500-700	2				
		＜500	1			Others	1

2.6. Calculation Formula

Under the Analytic Hierarchy Process method, the weights of each indicator are determined, and the comprehensive evaluation score of the human settlements in traditional villages is calculated. First, the evaluation score of each element in the criterion layer is obtained. The calculation formula is as follows:

$$N = \sum_{j=1}^{m} \omega X_j \quad (1)$$

$$E = \sum_{j=1}^{m} \omega X_j \quad (2)$$

$$P = \sum_{j=1}^{m} \omega X_j \quad (3)$$

In the formula: N represents the score for the natural environment; E represents the score for the economic and social environment; P represents the score for development potential; Xj represents the score for indicator j; ω represents the weight value.

Next, the human settlements score is calculated. The calculation formula is as follows:

$$S = N + E + P \quad (4)$$

In the formula: S represents the human settlements score; ω represents the weight value.

3. RESULTS AND DISCUSSION

3.1. Empirical Subject

The study selected 237 traditional villages in the western and northeastern regions of Sichuan Province as empirical research subjects to validate the effectiveness of the evaluation system. The selection principle was balance, including traditional villages in mountainous and hilly areas as well as plateau regions, villages with both good and poor protection and development conditions, and both large and small-scale villages.

The northeastern and western regions of Sichuan Province exhibit distinct geographic and economic characteristics, reflecting the rich geographic diversity within the province. The northeastern region of Sichuan, which includes Guangyuan City, Nanchong City, Dazhou City, Guang'an City, and Bazhong City, covers an area of approximately 92,400 square kilometers. This region is characterized mainly by hilly and low mountainous terrain with relatively gentle topography, situated on the periphery of the Sichuan Basin. The climate is warm and humid, belonging to the subtropical monsoon climate zone, with distinct seasons, abundant rainfall, and fertile soil, making it suitable for the growth of various crops. This area is an important grain production base in Sichuan Province.

In contrast, the western region of Sichuan, which includes the Aba Tibetan and Qiang Autonomous Prefecture and the Garze Tibetan Autonomous Prefecture, covers an area of

approximately 237,000 square kilometers. This region is characterized by rugged terrain with numerous mountain ranges and an average elevation of over 3,000 meters. The area is predominantly mountainous and plateau, with a cold and dry climate, less precipitation, and significant temperature variation, exhibiting clear alpine climate features. Due to harsh natural conditions, the ecological environment in the western region is relatively fragile, but it is rich in natural resources, including salt, lithium, and copper. The economic development in the western region is relatively lagging, mainly relying on barley cultivation and animal husbandry. While tourism has brought new economic opportunities, the overall economic level remains relatively low.

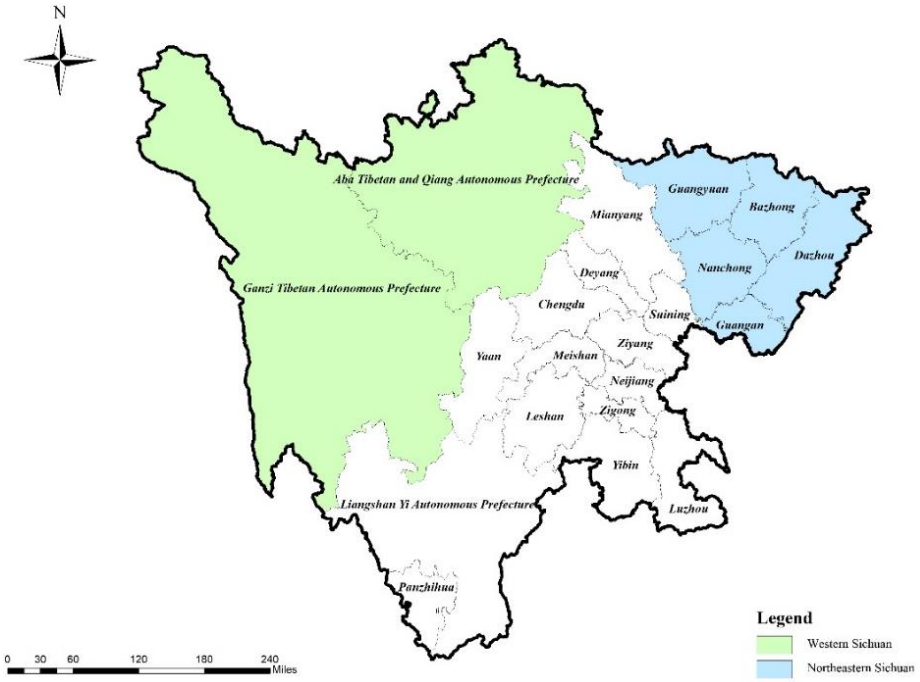

Figure 1. Location Map of Northeastern and Western Sichuan Regions

3.2. Comprehensive Evaluation Analysis

The comprehensive score of the human settlement's environment is derived from the integration of natural environment, economic and social aspects, and development potential. The score ranges from 2.259 to 4.133, indicating significant variations in the overall development levels among different villages. Villages with high scores, approaching or exceeding 4.0, include twelve villages such as Shisun Village and Niutou Village. These villages exhibit strong overall performance, suggesting favorable conditions in natural environment, economic and social aspects, and development potential. Conversely, villages with lower scores, such as Bangbang Village and Bianba Village, have scores below 3.0, reflecting deficiencies in multiple areas and potentially facing substantial development challenges.

The natural environment scores range from 1.067 to 2.857. High-scoring villages, such as Shisun Village and Baihu Village, have scores exceeding the average of 2.250, indicating favorable natural environment conditions, which may include advantageous geographical locations, abundant natural resources, and good ecological environments. In contrast, villages with lower natural environment scores, such as Bangbang Village and Dingge Village, reflect relatively poor environmental quality, possibly facing issues like environmental degradation, scarcity of natural resources, or pollution. Effective environmental protection and restoration measures are needed.

The economic and social indicators reflect the socio-economic development status of the villages, with scores ranging from 0.486 to 0.998. High-scoring villages, such as Huanshan

Village and Tanhe Village, suggest a relatively strong economic base, stable social development, and higher living standards. Conversely, lower-scoring villages, such as Jinhong Village and Lujiaping Village, exhibit lower levels of economic and social development, potentially facing issues like economic backwardness, inadequate infrastructure, and lack of employment opportunities. Further analysis is needed to understand the causes of such socio-economic imbalances and to overcome development limitations.

The development potential scores range from 0.132 to 0.569, serving as an important indicator of future development prospects. Villages with high scores, such as Yueba Village and Yangrong Village, indicate a strong foundation and potential for future development, including high resource development potential, favorable policy support, or innovation capabilities. Conversely, villages with lower scores, such as Ritou Village and Bianba Village, show limited future development prospects, facing issues such as resource scarcity, insufficient policy support, or weak innovation capabilities. Targeted policy support and development strategies are needed for these villages.

Through the comprehensive analysis of the above four aspects, it is evident that the villages exhibit varying levels of development in each area. Villages with high comprehensive scores typically perform well across natural environment, economic and social aspects, and development potential, indicating overall balanced development with good natural resources, stable socio-economic structures, and strong development potential. Low-scoring villages often show significant deficiencies in one or more aspects, such as poor natural environment, lagging economic and social development, or insufficient development potential.

The natural environment has a significant impact on the comprehensive human settlements environment. Villages with high natural environment scores often provide a solid foundation for economic and social development, thereby enhancing development potential. Economic and social development directly affects residents' quality of life and social stability, reflecting both the current development status and the basis for future sustainable development. Development potential is a crucial indicator for assessing future growth; high potential scores indicate considerable future development opportunities.

Analysis shows that the comprehensive development level of villages is closely related to each indicator. Villages with high comprehensive scores typically excel in natural environment, economic and social aspects, and development potential, reflecting their strong overall development capabilities. In contrast, villages with low comprehensive scores need to enhance efforts in environmental protection, economic development, and potential exploration to improve overall development and achieve sustainable development. Future policymaking should focus on supporting villages with low comprehensive scores, particularly targeting their weaknesses, such as improving environmental quality, promoting economic development, and exploring development potential. Meanwhile, high-scoring villages should continue to leverage their advantages for higher quality development, leading other villages to progress as well. Through differentiated development strategies, the development gap among villages can be gradually narrowed, achieving balanced development and mutual progress within the region.

3.3. Regional Comparative Analysis

The western and northeastern regions of Sichuan exhibit significant differences across multiple dimensions, including natural environment, economic and social development, and development potential. A detailed analysis of the scores provides a clearer understanding of the current conditions and future development prospects of these two regions.

In terms of comprehensive human settlements scores, the northeastern region of Sichuan performs better overall than the western region. The average score for the northeastern region is higher than that of the western region, indicating a relative advantage in

comprehensive performance. Moreover, the highest total score in the northeastern region reaches 4.133, while the highest score in the western region is 3.89, which is noticeably lower. This difference reflects the comprehensive advantages of the northeastern region in terms of natural environment, economic and social aspects, and development potential.

Regarding the natural environment, the northeastern region generally scores higher than the western region. Natural environment scores reflect factors such as climate, location, and topography. The northeastern region's natural environment score reaches up to 2.857, with most areas scoring above 2.4. In contrast, the western region's natural environment scores are relatively lower, with most areas scoring around 2.0, and the highest score being only 2.665. Villages in the western plateau region are often located at high altitudes with colder climates and limited agricultural production conditions, leading to significant economic development challenges. Additionally, villages with steeper slopes face soil erosion and infrastructure construction difficulties, negatively impacting residents' living comfort and production activities. In contrast, villages in the northeastern hilly region are generally at lower altitudes with milder climates and better agricultural conditions. Villages near major transportation routes benefit from accessibility and resource acquisition advantages. The higher scores suggest that the northeastern region may offer better living comfort and production safety. A favorable natural environment not only improves residents' quality of life but also attracts more investment and talent, driving regional economic development.

In terms of economic and social dimensions, the northeastern region's economic and social scores typically range from 0.9 to 1.0, reflecting a relatively balanced and robust economic and social development level. In contrast, the western region's economic and social scores are generally lower, mostly below 0.8, with only a few areas exceeding this level. Economic and social scores usually reflect the degree of economic development and residents' living standards. Villages in the northeastern region, due to better natural conditions, experience faster social and economic development, higher population density, and improved per capita income levels. These villages show greater vitality in the socio-economic dimension. The higher scores indicate a more developed economic structure, higher resident income levels, and more complete public services and infrastructure.

Regarding development potential, the northeastern region scores higher than the western region. Many areas in the northeastern region have development potential scores close to or exceeding 0.25, with a maximum of 0.439, indicating substantial future development space and potential. In contrast, the western region's scores are lower, with many areas scoring less than 0.2 and a maximum of only 0.498. Development potential is influenced by multiple factors, including proximity to tourist attractions, which offers good tourism development potential, and proximity to other traditional villages, which is beneficial for concentrated development. Villages that have received national honorary titles often attract more policy support and resource allocation due to their unique cultural and historical value, highlighting advantages in policy support, investment opportunities, and innovation capabilities. Villages in the northeastern region exhibit strong development potential due to their advantageous geographical location and abundant tourism resources, while some villages in the western region face development limitations due to natural conditions. Higher development potential scores in the northeastern region result from stronger policy support, more investment opportunities, and higher innovation capabilities and technological reserves, contributing to robust economic growth.

Although the western region scores lower in all dimensions compared to the northeastern region, it does not mean the western region lacks advantages. In fact, some areas in the western region show relatively high scores in specific natural environment and development potential aspects. For example, some areas in the western region have natural environment scores close to 2.5, approaching the average level of the northeastern region. This suggests that the western region may have unique natural resources or environmental advantages in certain areas. Additionally, the western region exhibits some highlights in development potential, with villages like Yangrong Village and Zhongcha Village having

potential scores close to 0.5, indicating considerable development space under appropriate policy guidance and investment support.

Overall, the northeastern region demonstrates stronger advantages in natural environment, economic and social aspects, and development potential, with high overall scores reflecting excellent performance across multiple dimensions. Although the western region's overall scores are lower, it still possesses certain competitive advantages and development potential in specific aspects. In the future, the western region could further unlock its development potential through enhanced policy support, increased infrastructure investment, and improved ecological protection efforts.

4. Conclusion

This study established a comprehensive evaluation system for the human settlements environment in traditional villages of Sichuan Province. The evaluation system includes three main criteria: natural environment, socio-economic conditions, and development potential, comprising 16 specific indicators. This framework provides a systematic and scientific approach for evaluating the human settlements environment in traditional villages.

Empirical research was conducted using 237 traditional villages from the northeastern and western regions of Sichuan to validate the feasibility of the evaluation system. Through comparative analysis of villages in these two regions, the study revealed significant differences in the human settlements' environment across different geographic areas. These differences are evident not only in terms of natural environment and socio-economic conditions but also in the development potential of the villages.

The protection and development of traditional villages require a comprehensive consideration of various factors and should not rely solely on individual indicators. When formulating policies for village protection and development, it is essential to consider the specific circumstances of each village and develop location-specific strategies.

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