How Does Rural Restructuring Impact Rural Development and Construction in Mountainous Areas? A Case Study of Three Typical Villages in Western Sichuan Province, China

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Abstract

Rural restructuring is a dynamic and complicated process of geographical rearrangement, functional coordination, and self-renewal in rural regions that is influenced by a variety of circumstances. This study intends to investigate the features and driving forces of rural restructuring in several types of mountain villages in western Sichuan province, China, an area with unique natural conditions, cultural landscapes, industries, and social structures. Based on field surveys and data analysis, we chose three typical villages as case studies: Tao Yuan, a suburban mountain village with non-agricultural growth; Bai Xiang, an ethnic village with innovative business models; and Jiang Ba, a distant ethnic village with traditional agriculture. We used the landscape index technique to study the geographical features, the entropy TOPSIS approach to assessing the rural quality level, and from 2016 to 2021, the rural restructuring intensity measurement will be used to assess the restructuring intensity of each village. The findings revealed that: (1) Tao Yuan's economic, social, and spatial restructuring was accelerated by urban radiation energy and reached a stable stage of development; (2) Bai Xiang's social restructuring was guided by macro policies, but its economic and spatial restructuring was relatively slow and remained in a developing stage;(3) Jiang Ba's material space restructuring was supported by local government, but its economic and social restructuring was insignificant and remained in a developing stage. The study found that rural restructuring in mountainous areas had specific regional and staged features that were impacted by a variety of elements such as natural environment, cultural landscape, industrial structure, social organization, policy system, and so on. The study also presented some implications and recommendations for rural development and building in hilly locations.

Keywords: Village restructuring, suburban mountain, ethnic village, Western Sichuan

INTRODUCTION

Rapid urbanization, industrialization, and marketization have accelerated the interactions and adjustments of social, economic, and spatial factors in rural areas, as well as the evolution, innovation, and development of land use and spatial structure (Liu, 2021). Consequently, significant changes have occurred in people's relationships with the land, and regional functions in rural areas (Liu, 2020). Rural areas are undergoing varying degrees of restructuring due to the intervention of multiple behavior subjects, such as government organizations, villager

self-organizations, enterprise organizations, religious organizations, and continuous self-reorganization. Rural restructuring is a dynamic process with a cause-and-effect relationship, whose combined function is to integrate the natural, social, and economic elements of rural space while reshaping production, ecological, and living spaces. It is an essential tool for optimizing rural spatial patterns, promoting sustainable rural development, and overall rural revitalization. Rural restructuring emphasizes the impact of spatial differences on rural development (Marsden, 1998). Furthermore, rural restructuring is the process of developing rural socioeconomic structures, institutional frameworks, environmental resources, and residents' joint participation in rural development (Chen, 2019). Therefore, the present study proposes that rural restructuring is a process of spatial reorganization, functional coordination, and self-renewal, with the characteristics of goal, complexity, and stage.

LITERATURE REVIEW AND RESEARCH PROBLEM

Based on a thorough examination of previous research, a number of studies have explored the theory and practice of rural restructuring. For example, Liu et al. (2021) have proposed basic restructuring theories that explore the relationship between humanity and land, and examine the future development of rural areas using historical dialectical materialism. Scholars have also proposed the theory of rural multi-functional development, which reveals the characteristics of rural regional development and shifts from the comprehensive perspective of production, consumption, and protection, based on the theory of productivism and post-productivism (Holmes,2006; Low et al., 2002; Watts et al., 2017).

Other scholars have examined changes in agricultural policies, changing trends in rural functions and values, and the implementation of the rural revitalization strategy in conjunction with the post-productive theory (Yu et al., 2020). Using the rural development index and TOPSIS entropy value, Watts et al. (2017) have compared the different characteristics and dominant trends of initial, developing, stable, and mature stages of various types of rural development, and found that the development and evolution of rural areas are the common results of exogenous factors such as institutions and policies and endogenous factors such as population, land, and capital.

Moreover, some scholars believe that rural restructuring should examine the spatial relationship between rural buildings and settlements in terms of material, social, cultural, economic, and ecological space. Lundgren and Nilsson (2018) have examined rural social structure and development law, and Jones and Heely (2016) as well as Watts et al. (2017) have explored the impact of cultural factors on rural rejuvenation. Woods (2007) and Liu (2021) have examined economic transformation and rural multi-functional development, while Shkaruba et al. (2016), Amit Cohen (2018), and Chunliu Gao and Li Cheng (2020) have revised the formulation of natural resource management and policy systems to summarize the restructuring path between rural spatial elements, units, and systems.

Furthermore, Lu et al. (2020) found that in the process of rural restructuring, rural areas were generally in the evolution stage dominated by economic restructuring and that differences in the degree of influence of endogenous foundation and external power in each region lead to an imbalance in the restructuring process. Yu et al. (2020) concluded that rural restructuring in underdeveloped areas is constrained by location conditions and endogenous foundation, and when the degree of restructuring is weak, rural areas in city suburbs maintain regional advantages. Yu et al. (2020) have investigated the mechanism, mode, and method of rural

restructuring from various angles, and established the external driving index system and rural restructuring calculation method to identify the dominant factors and geographical effects of restructuring. Li et al. (2015) have constructed the measurement index and theoretical framework system of rural spatial restructuring and conducted empirical analyses combined with case studies.

It is worth noting that rural restructuring must be distinguished from rural transformation or change, as the former is a multifaceted socio-economic phenomenon. Rural restructuring is a systematic evolution of rural areas driven by the interaction of three core elements: "people, land, and industry." The present study attempts to simulate rural restructuring within the context of rural revitalization, analyze the complexity of rural functional structure, and assess the sustainability of rural spatial element energy before developing a scientific plan for the rural renewal process.

The research problem addressed in this paper is to understand the process of rural restructuring and its implications for rural revitalization in China. Specifically, the paper seeks to answer the following research questions:

RQ1: How can the spatial features, quality, and restructuring intensity of the sample village be used to assess rural development trends, restructuring stages, and associated characteristics?
RQ2: What are the driving factors for the restructuring of traditional mountain villages?
RQ3: What implications does the restructuring process have for rural development and construction?

RESEARCH AREA, DATA SOURCES, AND ANALYSIS METHODS

This study adopted a case study approach to explore the characteristics and driving factors of rural restructuring in different types of mountain villages in western Sichuan province. We selected three typical villages as case studies based on their geographical location, topographical environment, ethnic composition, industrial structure, and development level. The three villages were: Tao Yuan, a suburban mountain village with non-agricultural development; Bai Xiang, an ethnic village with new business models; and Jiang Ba, a remote ethnic village with traditional agriculture. We collected and analyzed various data sources, such as maps, land use data, socio-economic statistics, and field survey data. We also applied different analysis methods, such as the landscape index method, entropy TOPSIS method, and rural restructuring intensity measurement method, to examine the spatial characteristics, rural quality level, and restructuring intensity of each village from 2016 to 2021. The details of the research area, data sources, and analysis methods are described below.

Overview of the Study Area

Tao Yuan, a suburban mountain village with non-agricultural development

TY village is located in the Long Quan Yi district of Chengdu city (30°55′59″N,104°32′85″E), with an average elevation of 900m. It has a mild climate with an annual sunshine duration of 1206h and an average annual temperature of 15.6-℃ (Liu et al.,2021). The village covers a total area of 6.62km² and has a population of 2761 residents. Tao Yuan village has developed tourism and lodging industries by taking advantage of its rich natural resources, beautiful scenery, and proximity to urban areas. Tourism has become the main source of income for

the village since 2002. By the end of 2021, tourism's output value reached 36.7-million-yuan, accounting for 45.06% of the village's total GDP (Tu et al.,2019). The development of tourism has also led to the optimization and adjustment of rural spatial form, social organization, and economic structure. Tao Yuan village is a representative case of rural restructuring driven by urban radiation energy.

Bai Xiang, an ethnic village with new business models

BX village is situated at the junction of Le Shan City, Yi Bin City, and Liang Shan Yi Autonomous Prefecture (28°84′92″ N,103°58′73″ E), with an altitude range of 800—1300m. It has a subtropical monsoon climate with an annual sunshine duration of 942.3h and an average annual temperature of 16.9-℃. The village is one of the main Yi-inhabited areas in Sichuan province, covering a total area of 18.5Km² and having a population of 2203 people (Zhang,2019). Since 2016, the village has received various support from the local government in terms of infrastructure construction, capital investment, and technical assistance. The village has actively developed ecological plantations, such as tea, citrus, walnut, and pepper, as well as agricultural product processing and tourism industries, forming a multi-industry development pattern. However, the village still faces some challenges, such as population loss, extensive land use, and lagging ethnic education. The endogenous strength of the village is weak, and the rural restructuring is relatively slow. Bai Xiang village is a typical case of rural restructuring guided by macro-policies.

Jiang Ba, a Traditional Agricultural Village in a Remote Ethnic Area

JB village is situated in western Shi Mian County (30°13′22'' N,103°36′07″ E), at an altitude of 1300-2000m. With an average annual temperature of 17-℃ and 1237h of sunshine per year, the village covers a land area of 24Km² and has a population of 777 people. As one of the Er SU Tibetan settlements, JB boasts a well-preserved traditional cultural landscape and was recognized as one of the "first batches of traditional villages in China" in 2012. For the past decade, traditional crops such as corn, potatoes, and radishes, as well as livestock breeding, including pigs and cattle, have dominated the rural economy, supplemented by the production and processing of vegetables and meat products. However, to address population loss and homestead waste, JB village became a member of the first batch of pilot villages for new rural construction in 2015, with support from the provincial government. This led to a significant improvement in the village's living environment. Nevertheless, due to poor location conditions, lagging transportation and information networks, and insufficient industrial development power such as technology, labor, and capital, JB village experiences slow spatial flow, typical of agriculturally dominated ethnic villages in remote mountainous areas.

Data Sources and Processing

The data sources used in this study include maps and relevant texts, land use data, socio-economic statistics, and field survey data. The maps and relevant texts include a topographic map of Sichuan province (1:240,000), vector village administrative boundary (1:4000), the 2020 China County Statistical Yearbook (township volume), the work report of the county poverty alleviation government, Sichuan province land use data in 2021, and Statistical Yearbooks of Le Shan, Ya' An, and Chengdu from 2016 to 2021. The land use data were obtained from the third National Land Use Survey. The socio-economic statistics were collected from official sources and publications. The field survey data were gathered through participatory rural appraisals (PRAs) conducted in TY, BX, and JB villages. We collected relevant data on the

construction and governance of sample villages through field investigations and interviews with village committee staff and farmers. We also recorded data on buildings, structures, infrastructure, public service facilities, land use types, property rights, family structure, and population flow. We used Arc GIS v.10.8 to process the spatial data, FRAGSTATS v. 4.2 to calculate the landscape index, SPSS v.23 to calculate the entropy weight, and GraphPad Prism v.9.0 to perform the TOPSIS evaluation.

Analysis Methods

The analysis methods used in this study include the landscape index method, entropy TOPSIS method, and rural restructuring intensity measurement method. These methods were applied to examine the spatial characteristics, rural quality level, and restructuring intensity of each village from 2016 to 2021. The details of the analysis methods are described below.

Spatial Features Analysis

We used the landscape index method to analyze the spatial features of each village, such as spatial scale, shape, and distribution. We extracted five important land types from the village landscape: buildings, roads, water areas, cultivated land, and forests. We used Arc GIS v.10.8 to create distribution maps of these land types for each village. We then used FRAGSTATS v. 4.2 to calculate six landscape indices for each land type: Number of Patches (NP), Patch Density (PD), Average Patch area (AREA MN), Largest Patch Index (LPI), Patch Shape Index (SHAPE), and Plaque Fractal Dimension (PAFRAC). These indices reflect the spatial characteristics of each land type in terms of size, shape, and distribution. We compared and analyzed the values of these indices for each village to identify their spatial differences and similarities.

Rural Quality Assessment

The article adopts the concept of urban quality and applies it to the analysis of rural quality, constructing a rural quality evaluation index system and emphasizing the key factors that influence rural development. Water and land resources are fundamental for production, life, and ecological units, and serve as the basis for assessing rural development prospects. The ratios of infrastructure and public service facilities, the distance between working areas and residences, and the nearby employment opportunity rate are the predominant factors limiting rural population and the stock and increment of spatial factors. The human-land system is highly interdependent and symbiotic (Ma et al., 2019).

Firstly, the proportion of the Number j index for the Number i evaluation object were calculated: $y_{ij}=\frac{x_{ij}^{i}}{\sum_{i=1}^{m} x_{ij}^{i}}$, where X_{ij}^{i} represents the j^{th} index of the i^{th} evaluation object, which is the normalized value of x_{ij}. Secondly, the information entropy of the Number j index was derived via: $e_j=-K\sum_{i=1}^{m} yijlnyij$, where K is the constant equal to $\frac{1}{lnm}$。 Thirdly, the weight of the Number j index was obtained using: $w_j=\frac{1-e_j}{\sum_j 1-e_j}$ （Zhang, 2019), while the weighted summation formula was used to calculate the sample score values: $S=\sum_j 100 \times y_{ij} w_j$ (You et al., 2017; Zhang, 2019).

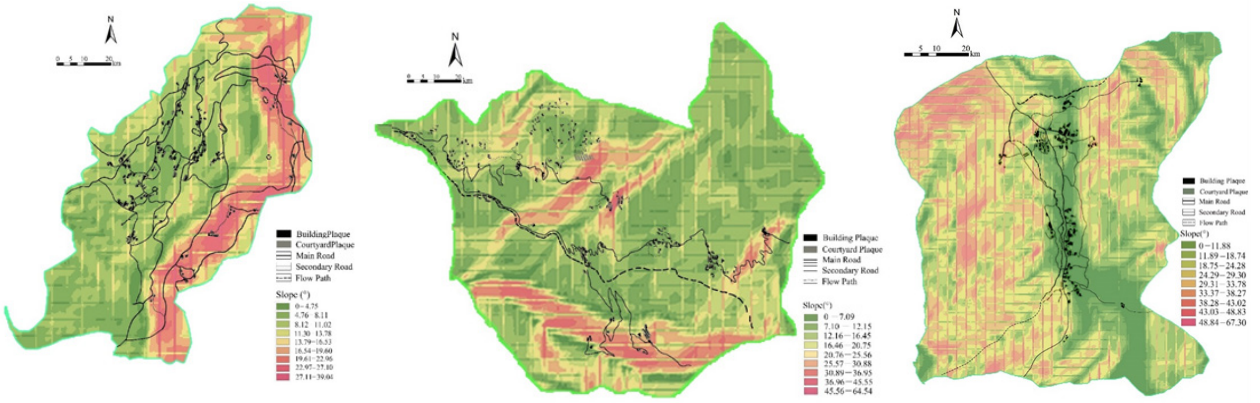
Measurement of Rural Restructuring Intensity

We used the rural restructuring intensity measurement method to measure the changes in rural economic quality, social quality, and spatial quality from 2016 to 2021. Rural restructuring intensity reflects the degree of adjustment and optimization of rural spatial elements, functions, and systems in a given period. We calculated the rural restructuring intensity from three dimensions: economy, society, and space. Economic restructuring intensity (RI_{EC}) was mainly measured by the economic scale, industrial structure, and per capita income level. Social restructuring intensity (RI_{SO}) was mainly measured by population size, infrastructure, and public service facilities. Spatial restructuring intensity (RI_{SP}) was mainly measured by consumption level, internverate, living area, and travel distance. We calculated the values of RI_{EC}, RI_{SO}, RI_{SP} and for each village using the ratio of DQEc, DQSo, and DQSp at the beginning and end of the study period. We also calculated the overall rural restructuring intensity (RRI) for each village using the ratio of RDIC at the beginning and end of the study period. The higher the RRI value, the higher the restructuring intensity. We then analyzed the dominant factors and trends of rural restructuring for each village based on the values of RI_{EC}, RI_{SO}, RI_{SP}, and RRI.

ANALYSIS AND RESULTS

Spatial Characteristics and Influencing Factors of Typical Villages

We compared and analyzed the spatial characteristics (**Figure 1**) and influencing factors of TY, BX, and JB villages based on the results of the landscape index method and spatial data analysis **(Table 1)**. We found that the three villages had different spatial features in terms of scale, shape, and distribution of land types (**Figure 2**). We also found that the spatial features were affected by various factors, such as altitude, slope, sunlight, water source, vegetation, cultivated land, traffic, ethnic culture, etc.



(a) Tao Yuan Village Domain *(b) Bai Xiang Village Domain* *(c) Jiang Ba Village Domain*

Figure 1. Spatial characteristics of the three villages

Table 1. The Landscape index analysis of Tao Yuan, Bai Xiang, and Jiang Ba Villages
Note: The five key patch indices of buildings, roads, water systems, plough (cultivated lands), and forested (wood) lands that affect the characteristics of rural spatial patterning were selected as the foci of analysis.

		SCALE			FORM		DISTRIBUTION	
Village name	Land- use Type	NP	AREA_MN	LPI	LSI	PAFRAC	PD	ENN_MN
Tao Yuan	Building	9	0.1913	2.7997	3.6364	0.8372	27.7257	29.9998
	Road	102	0.0239	2.0308	10.875	1.442	314.2252	18.2606
	Water system	0	0	0	0	0	0	0
	Plough	10	2.6381	68.7106	5.1705	1.2876	30.8064	19.4682
	Wood Land	22	0.0329	0.5126	5.0909	1.3429	67.7741	34.6433
Bai Xiang	Building	101	0.2637	0.29	12.3293	1.3255	12.0729	57.4674
	Road	358	0.0407	0.0477	23.8361	1.6736	42.793	31.1939
	Water system	1	0.1596	0.0191	1.0000	N/A	0.1195	N/A
	Plough	66	2.7791	6.0034	15.9116	1.4342	7.8892	50.3088
	Wood Land	17	35.1282	69.7825	10.3592	1.4397	2.0321	50.4336
Jiang Ba	Building	55	0.4254	0.1756	9.8852	1.3734	3.7355	97.3064
	Road	312	0.0481	0.0226	20.3878	1.6787	21.1905	195.5759
	Water system	26	0.4106	0.0209	6.2683	1.3701	1.7659	44.9213
	Plough	35	22.414	0.3321	6.7583	1.3406	2.3771	46.7932
	Wood Land	16	17.6464	13.1481	10.7014	1.3922	1.0867	108.3806

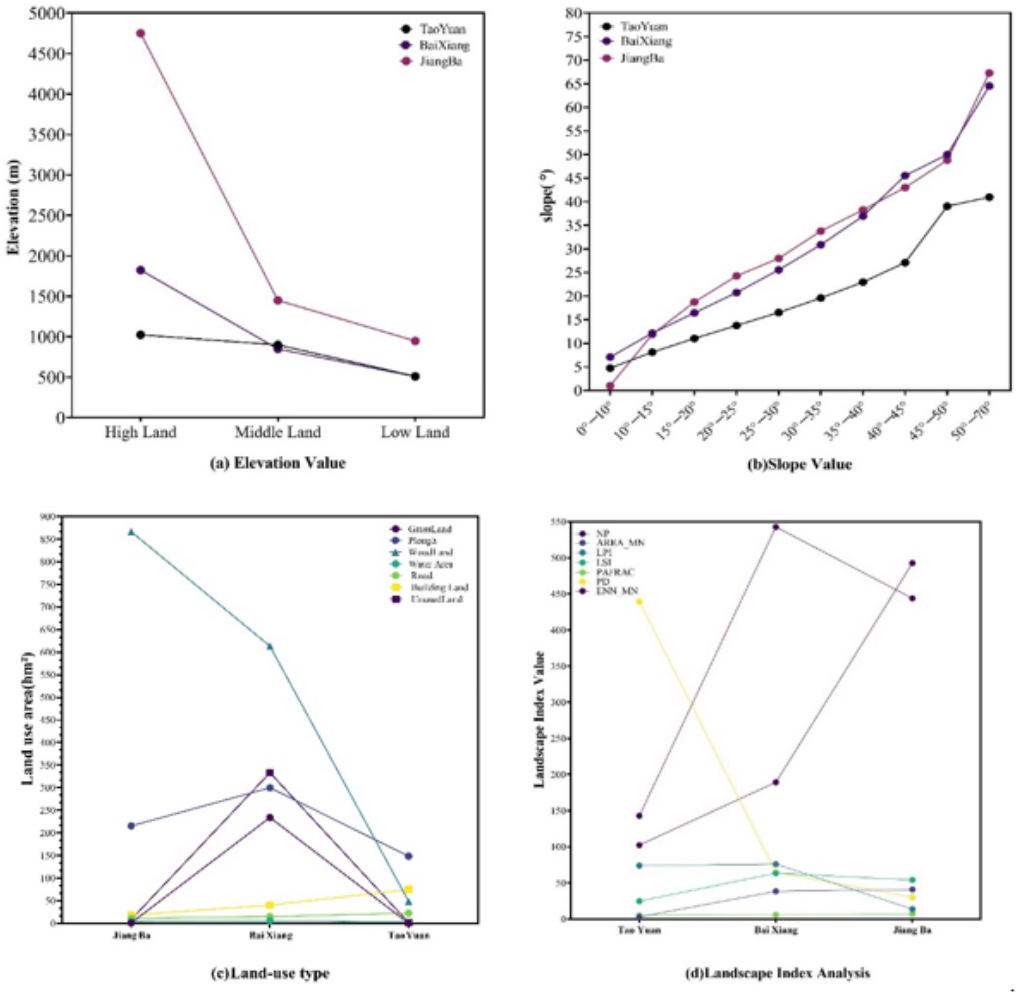


Figure 2. Topography, landscape index, and land use of Tao Yuan, Bai Xiang, and Jiang Ba villages

We summarized the main findings as follows:

- TY village had the smallest spatial scale, the most regular shape, and the highest distribution density of land types. It also had the lowest slope value and the highest road density among the three villages. These features indicated that TY village had a gentle topographic relief and a well-developed infrastructure. TY village was located in a suburban area with rich natural resources and tourism advantages. It also had a strong economic foundation and a diversified industrial structure. These factors contributed to the optimization and adjustment of rural spatial form, social organization, and economic structure. TY village was a model of the non-agricultural montane village in the urban outskirts.

- BX village had the largest spatial scale, the most irregular shape, and the medium distribution density of land types. It also had a medium slope value and a medium road density among the three villages. These features indicated that BX village had a complex topographic relief and a moderate infrastructure. BX village was located in an ethnic area with a distinct cultural landscape and ecological plantation. It also had a weak endogenous foundation and slow economic development. These factors limited the social restructuring and industrial innovation of rural areas. BX village was an example of an ethnic Montane village with new business development.

- JB village had a medium spatial scale, an irregular shape, and the lowest distribution density of land types. It also had the highest slope value and the lowest road density among the three villages. These features indicated that JB village had a steep topographic relief and a poor infrastructure. JB village was located in a remote area with a well-preserved traditional culture and landscape. It also had a low economic scale and a singular industrial structure. These factors constrained the population flow and information exchange of rural areas. JB village was a case of a traditional agricultural montane village in remote areas.

It concluded that the spatial characteristics and influencing factors of typical villages in western Sichuan's mountainous areas were diverse and complex. They reflected the interactions and adjustments of the natural environment, spatial location, ethnic culture, economic development, etc. They also influenced the rural development trends, quality grades, and restructuring stages of different villages.

Rural Quality Assessment Based on Spatial Characteristics

We assessed the rural quality level of TY, BX, and JB villages based on the results of the entropy TOPSIS method and rural quality evaluation index system (Table 2). Next, calculated the rural quality (RQ) and the rural development comprehensive index (RDIC) for each village in 2016 and 2021. We also calculated the economic development quality (DQ_{EC}), social development quality (DQ_{SO}), and spatial development quality (DQ_{SP}) for each village in 2016 and 2021 (Table3). Then, compared and analyzed the changes and differences of these indicators among the three villages, and identified the key factors affecting the rural quality level of each village based on the entropy weight analysis (Table 4).

Table 2. Construction of quality evaluation indices for typical villages in mountainous areas

Standard Layer	Criteria Layer	Indicator Layer	Method of Calculation	Property
DQ_{Ec}	Economic Base	1. Economics of Scale	1. Gross Village Product/Growth Ratio in Recent Years	+
	Development	2. Income Level	2. Total Population/ Per Capita Income Ratio	+
	Prospect	3. Industrial Structure	3. Industry Proportion and Leading Industry	+
DQ_{So}	Administrative Level	1. Administrative Village/ Central Village/ Natural Village	1. Social Influence and Development Status	+
	Social Structure	2. Population Size and Family Structure	2. Local Yearbooks and Statistical Data	+
	Infrastructure	3. Road Network Density	3. The ratio of Road Length to Area	+
		4. Medical Health Level	4. The ratio of Total Medical Facilities to Population	+
		5. Hydroelectricity Facility Level	5. The ratio of Total Hydropower Use to the Population	+
		6. Communication Facility Level	6. The ratio of the Total Number of Communication Devices to the Population	+
DQ_{So}	Production Space	1. Production Function	1. Agricultural Product Types	+
		2. Consumption Level	2. Consumption Expenditure	+
		3. Land Use Rate	3. The proportion of Cultivated Land and Output	+
		4. Land Transfer Rate	4. Land Use Right Transferred to Total Land Area Ratio	+
	Ecological Space	5. Elevation	5. Measurement by Mapping and GIS	-
		6. Slope	6. Measurement by Mapping and GIS	-
		7. Forest Coverage Rate	7. The ratio of Woodland to Village Area	+
	Living Space	8. Per Capita Housing Area	8. The ratio of Total Residential Area to Population	+
		9. Vacancy Rate of Rural Houses	9. The ratio of Vacant Housing Area to Total Housing Area	-
		10. Travel Distance	10. Distance from Central Towns and Cities	-

Table 3. Rural quality analysis of Tao Yuan, Bai Xiang, and Jiang Ba villages in 2016 and 2021

Village name	Tao Yuan Village				Bai Xiang Village				Jiang Ba Village			
Dimension	DQ_{Ec}	DQ_{So}	DQ_{Sp}	RQ	DQ_{Ec}	DQ_{So}	DQ_{Sp}	RQ	DQ_{Ec}	DQ_{So}	DQ_{Sp}	RQ
2016	0.999	1.000	0.989	2.988	0.015	0.658	0.008	0.681	0.511	0.000	0.012	0.063
2021	1.000	0.902	1.000	2.902	0.090	0.105	0.697	0.892	0.000	0.024	0.013	0.038

Table 4. TOPSIS Evaluation of Tao Yuan, Bai Xiang, and Jiang Ba villages in 2016 and 2021

			Tao Yuan	Bai Xiang	Jiang Ba
2016	DQ_{Ec}	PISD (D+)	0.111	218.873	107.137
		NISD (D-)	-218.968	-3.271	-3.271
		RP (C)	0.999	0.015	0.511
	DQ_{So}	PISD (D+)	0.308	425.247	1243.966
		NISD (D-)	-1243.966	-818.719	-0.308
		RP (C)	1.000	0.658	0.000
	DQ_{Sp}	PISD (D+)	23.281	2077.444	2068.118
		NISD (D-)	-2077.437	-17.607	-25.076
		RP (C)	0.989	0.008	0.012
2021	DQ_{Ec}	.....	0.022	6818.209	7495.591
		.....	1.000	0.090	0.000
		.....	0.282	232.249	679.394
	DQ_{So}	.....	-679.394	-447.144	-0.282
		.....	1.000	0.658	0.000
		.....	0.282	232.249	679.394
	DQ_{Sp}	.....	22.248	1840.507	1832.222
		.....	-1840.477	-15.608	-24.07
		.....	0.988	0.008	0.013

We summarized the main findings as follows:

- TY village had the highest RQ and RDIC values among the three villages in both 2016 and 2021. It also had high values of DQ_{EC}, DQ_{SO}, and DQ_{SP} in both years. These results indicated that TY village had a high-quality rural development in terms of economy, society, and space. The key factors affecting its rural quality level were industrial structure, per capita income, infrastructure, public service facilities, consumption level, land turnover rate, etc. These factors reflected its strong economic foundation, diversified industrial structure, well-developed infrastructure and public service facilities, high consumption level, active land circulation, etc. These factors also contributed to its optimization and adjustment of rural spatial form, social organization, and economic structure.

- BX village had the lowest RQ and RDIC values among the three villages in both 2016 and 2021. It also had low values of in both years. These results indicated that BX village had a low-quality rural development in terms of economy, society, and space. The key factors affecting its rural quality level were water area, cultivated land DQ_{EC} , DQ_{SO}, and DQ_{SP}area, vegetation coverage, population size, industrial structure, per capita income, etc. These factors reflected its weak endogenous foundation, slow economic development, low population size, unreasonable industrial structure, low-income level, etc. These factors limited its social restructuring and industrial innovation of rural areas.

- JB village had medium RQ and RDIC values among the three villages in both 2016 and 2021. It also had medium values of DQ_{EC}, DQ_{SO}, and DQ_{SP} in both years. These results indicated that JB village had a medium-quality rural development in terms of economy, society, and space. The key factors affecting its rural quality level were water area, cultivated land area, vegetation coverage, infrastructure, public service facilities, consumption level, living area, etc. These factors reflected its abundant natural resources, improved living environment, poor infrastructure and public service facilities, low consumption level, small living area, etc. These factors constrained its population flow and information exchange of rural areas.

Based on the analysis, it is evident that the rural quality levels of typical villages in the mountainous areas of western Sichuan exhibit significant variation concerning their spatial characteristics, influencing factors, and structural adjustment stages. TY villages demonstrated a high level of rural development quality with a stable stage of structural adjustment. In contrast, BX villages exhibited a low level of rural development quality and were in the stage of developmental adjustment. JB villages displayed moderate rural development quality and were in the primary stage of structural adjustment. These findings highlight the importance of considering multiple factors and stages in assessing rural development quality and provide valuable insights for policymakers and stakeholders in enhancing rural development in mountainous regions.

Rural Restructuring Intensity Analysis

We analyzed the rural restructuring intensity of TY, BX, and JB villages based on the changes in RQ and RDIC from 2016 to 2021, and analyzed the changes in RI_{Ec}, RI_{So}, and RI_{Sp} for each village from 2016 to 2021. We compared and analyzed the differences and trends of these indicators among the three villages, and identified the dominant factors and trends of rural restructuring for each village based on the values of RI_{Ec}, RI_{So}, RI_{Sp} and RRI.

The RRIs of the three villages were then calculated using the ratio of RDI_{Ci}, to RDI_{Cf} as follows: TY, BX, and JB have RI_{Ec}, RI_{So}, and RI_{Sp} value of 1.00, 1.11, 0.98; 0.17, 6.27, 0.62; and 0.00, 0.00, 0.92, respectively; whereas RRI_{TY}, RRI_{BX}, and RRI_{JB} were: 1.03, 0.76, and 13.50, respectively, as Figure 3:

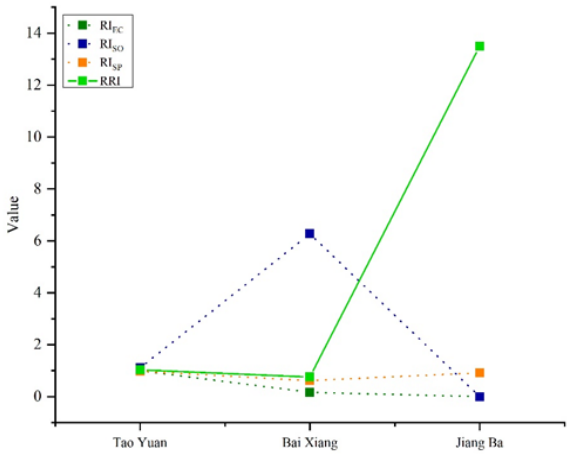


Figure 3. Comparison of the reconstruction intensity of three villages

We summarized the main findings as follows:

- TY village had a low RRI value among the three villages. It also had low values of RI_{Ec}, RI_{So}, and RI_{Sp}. These results indicated that TY village had a low intensity of rural restructuring in terms of economy, society, and space. The dominant factor of its rural restructuring was economic restructuring. TY village adjusted and optimized its industrial structure by integrating the planting industry with the processing and service industries. It also promoted the linkage between functions and elements of rural space. It also boosted the symbiosis and integration of life, ecology, and production space. The prosperity of industry also encouraged the improvement of rural infrastructure and public service facilities, as well as the construction of new communities. The rural restructuring of TY village was relatively stable and balanced, and it entered a stable stage of complementary benefits.

- BX village had a medium RRI value among the three villages. It also had medium values of RI_{Ec}, RI_{So}, and RI_{Sp}. These results indicated that BX village had a medium intensity of rural restructuring in terms of economy, society, and space. The dominant factor of its rural restructuring was social restructuring. BX village improved its infrastructure and public service facilities with the support of national policies and government investment. It also developed ecological plantations and tourism industries based on its natural resources and cultural landscape. However, it lacked endogenous foundation and external power for economic development. It also had a low population size and an unreasonable industrial structure. The rural restructuring of BX village was unbalanced and unstable, and it remained in a developing stage.

JB village had a high RRI value among the three villages. It also had high values of RI_{Ec}, RI_{So}, and RI_{Sp}. These results indicated that JB village had a high intensity of rural restructuring in terms of economy, society, and space. The dominant factor of its rural restructuring was spatial restructuring. JB village renovated its houses, roads, and other facilities with the special funding from the government as a national-level traditional village. It also introduced

enterprises to contract plantations and breeding plants to develop agricultural production functions. However, it had a low economic scale and a singular industrial structure. It also had a large population flow and a poor information network. The rural restructuring of JB village was rapid but unstable, and it stayed in an initial stage

Characteristic Analyses of Rural Restructuring in Typical Montane Areas

Based on the analysis of spatial features, rural quality, and restructuring intensity of three sample villages in western Sichuan's mountainous areas, this study summarizes the characteristics of rural restructuring as follows:

(1) Compound: Rural restructuring is a process of spatial reorganization, functional coordination, and self-renewal that involves multiple dimensions, such as economy, society, and space. The interaction and adjustment of these dimensions affect the development trend, quality grade, and restructuring stage of rural areas.

(2) Goal-oriented: Rural restructuring is driven by the goal of optimizing rural spatial patterns, promoting sustainable rural development, and achieving rural revitalization. It requires the examination and improvement of the efficiency, resilience, and value of rural space and land use (Liu et al., 2020), as well as the balance and harmony of human-nature relations in social production activities.

(3) Regional: Rural restructuring is influenced by regional factors, such as geographic environment, spatial pattern, location conditions, ethnic culture, etc. These factors determine the developmental potential, resource endowment, and restructuring mode of rural areas. Different types of mountainous villages have different spatial characteristics, development quality, and restructuring intensity.

(4) Complex: Rural restructuring is a dynamic process that involves various actors, such as government organizations, villager self-organizations, enterprise organizations, religious organizations, etc. These actors intervene in rural areas with different interests, motivations, and behaviors, resulting in complex changes in rural socio-economic structures, institutional frameworks, environmental resources, and residents' participation (Yu et al., 2020).

(5) Phased: Rural restructuring progresses from quantitative to qualitative changes in different stages. The stages can be identified by the quality of rural development and the intensity of restructuring (Watts et al., 2017). According to this study, the three sample villages are in different stages: Tao Yuan village is in a stable stage with balanced and complementary restructuring; Bai Xiang village is in a developing stage with dominant social restructuring; Jiang Ba village is in an initial stage with prioritized spatial restructuring.

Examining Driving Factors of Montane Rural Restructuring

Based on the characteristic analyses of rural restructuring in typical montane areas, this study examines the driving factors of rural restructuring from four aspects: natural environment, cultural landscape, industrial structure, and social organization. We use the case studies of TY, BX, and JB villages to illustrate how these factors influence the rural restructuring process and outcome. The main findings are as follows:

On the one hand, natural environment: The natural environment is the basic condition and resource for rural development and restructuring. It includes factors such as altitude, slope, sunlight, water source, vegetation, cultivated land, etc. These factors affect the spatial scale, shape, and distribution of rural land types, as well as the production function, ecological function, and living function of rural space. For example, TY village has a gentle topographic relief and rich natural resources, which provide favorable conditions for tourism development and spatial optimization. BX village has a complex topographic relief and diverse ecological plantations, which create opportunities for new business models and industrial innovation. JB village has a steep topographic relief and a well-preserved traditional landscape, which pose challenges for infrastructure construction and information exchange (Liu et al., 2020).

On the other hand, Cultural landscape: The cultural landscape is the historical heritage and ethnic custom of rural areas. It includes factors such as architectural style, religious belief, folk art, festival celebration, etc. These factors affect the spatial form, social structure, and economic value of rural areas. For example, TY village has a modern architectural style and a diversified social structure, which reflect its urban radiation energy and non-agricultural development. BX village has a distinct ethnic culture and a unique folk art, which enhance its cultural identity and tourism attraction. JB village has a traditional architectural style and a strong religious belief, which preserve its cultural diversity and historical continuity (Amit Cohen, 2018).

In addition, industrial structure: The industrial structure is the economic foundation and driving force for rural development and restructuring. It includes factors such as economic scale, industrial type, income level, consumption level, etc. These factors affect the economic quality, social quality, and spatial quality of rural areas. For example, TY village has a large economic scale and a diversified industrial structure, which improve its income level and consumption level. BX village has a small economic scale and an unreasonable industrial structure, which limit its income level and consumption level. JB village has a low economic scale and a singular industrial structure, which reduce its income level and consumption level (Woods,2007). Moreover, social organization: The social organization is the institutional framework and behavioral subject for rural development and restructuring. It includes factors such as government organizations, villager self-organizations, enterprise organizations, religious organizations, etc. These factors affect the policy system, resource allocation, and participation mechanism of rural areas. For example, TY village has a strong government organization and enterprise organization, which provide support and guidance for its tourism development and spatial optimization. BX village has a weak villager self-organization and enterprise organization, which hinder its ecological plantation and industrial innovation. JB village has a strong religious organization and villager self-organization, which maintain its traditional culture and landscape (Shkaruba et al., 2016).

DISCUSSION AND CONCLUSION

This study explored the characteristics and driving factors of rural restructuring in different types of mountain villages in western Sichuan province, China. Based on field surveys and data analysis, we selected three typical villages as case studies: TY, a suburban mountain village with non-agricultural development; BX, an ethnic village with new business models; and JB, a remote ethnic village with traditional agriculture. We applied the landscape index method (Shkaruba et al., 2016), entropy TOPSIS method (Watts et al., 2017), and rural restructuring intensity measurement method (Yu et al., 2020) to analyze the spatial characteristics, rural quality level, and restructuring intensity of each village from 2016 to 2021. The main findings

and contributions of this study are as follows:

Firstly, this study revealed that the rural restructuring in mountainous areas had distinct regional and staged characteristics and was influenced by multiple factors such as natural environment, cultural landscape, industrial structure, social organization, policy system, etc. The study also provided some implications and recommendations for rural development and construction in mountainous areas.

Secondly, this study proposed a comprehensive and systematic framework for analyzing rural restructuring in mountainous areas. The framework integrated spatial features analysis, rural quality assessment, and rural restructuring intensity measurement. The framework also used various data sources and analysis methods to examine the rural restructuring process and outcome from multiple dimensions and perspectives.

Thirdly, this study applied the concept of urban quality to the analysis of rural quality and constructed a rural quality evaluation index system that emphasized the key factors that influence rural development. The system included indicators such as water area, cultivated land area, vegetation coverage, infrastructure, public service facilities, consumption level, land turnover rate, living area, etc. (Amit Cohen, 2018). The system also used the entropy weight method and the TOPSIS model method to calculate the rural quality level of each village.

Fourthly, this study developed a rural restructuring intensity measurement method that measured the changes in rural economic quality, social quality, and spatial quality from 2016 to 2021. The method also identified the dominant factors and trends of rural restructuring for each village based on the values of $RIEc$, $RISo$, $RISp$, and RRI. The method helped to understand the degree of adjustment and optimization of rural spatial elements, functions, and systems in a given period. The limitations and directions for future research are as follows:

(1) The article only selected three villages as case studies, which may not fully represent the diversity and complexity of rural restructuring in mountainous areas. Future research could expand the sample size and scope to include more types and regions of mountain villages.

(2) It only focused on the spatial characteristics, rural quality level, and restructuring intensity of each village. Future research could also explore the impacts and effects of rural restructuring on rural residents' livelihoods, well-being, and satisfaction.

(3) We only analyzed the rural restructuring process and outcome from 2016 to 2021. Future research could extend the time span and examine the long-term changes and trends of rural restructuring in mountainous areas.

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