



Ecological Civilization Construction and Tourism Development: A Case Study of the Wuling Mountain Area in Western Hunan, China

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ABSTRACT

Ecological civilization construction is a new urban development concept, while tourism is a resource-saving and environment-friendly industry. The study of the coordinated development between ecological civilization construction and tourism is of great practical significance. Taking the Wuling Mountain area in western Hunan, China, as an example, the entropy weight and TOPSIS methods are used to score the ecological civilization construction system and the tourism industry. A coupling coordination degree model is constructed to analyze the relationship between ecological civilization construction and tourism development. The results show that the Wuling Mountain Region in western Hunan Province showed a lag in tourism development from 2017 to 2019. The coupling coordination degree between ecological civilization construction and the tourism industry is slightly imbalanced. A coordinated pattern of ecological environment construction and tourism development should be accelerated.

Keywords: western Hunan area; index system; entropy weight method; TOPSIS method; coupling coordination degree model

INTRODUCTION

This paper will evaluate the ecological civilization construction system and tourism in the Wuling Mountain area in western Hunan, China, using the entropy weight and TOPSIS methods. And then, a coupling coordination degree model is built to coordinate the relationship between ecological civilization construction and tourism development. In 2015, China formulated the Master Plan to Reform the Ecological Civilization Construction System. The plan aims to establish a complete ecological civilization system and accelerate ecological civilization construction. The principle of ecological civilization system reform is to encourage pilot projects and coordinate and promote the projects. For a long time, the local government

of the Wuling Mountains in western Hunan has regarded the development of tourism as one of the essential pillars of the regional economy, and the development of the tourism industry is inseparably related to ecological civilization construction. Compared with other traditional industries, tourism features a combination of accelerated development and environmental friendliness.

Ecological civilization construction affects the benefits of the tourism industry, and the tourism industry bases itself on ecological civilization construction. However, the coordination between ecological civilization construction and the tourism industry has been a common concern for all stakeholders in recent years. Using the coupling coordination degree model, some scholars analyzed the coupling coordination degree of tourism development and ecological civilization construction in Wuhan, demonstrating that the two have a coupling effect and gradually increase (Xia and Xiao, 2016). Some scholars also analyzed the relationship between ecological civilization construction and tourism development in Yunnan Province and concluded that the coupling coordination degree between ecological civilization construction and tourism development in Yunnan Province is reluctant coordination (Lu et al., 2018). Some foreign scholars believe that the positive and negative effects coexist between ecological civilization construction and tourism development and can both promote and impede ecological civilization construction (Smith, 1992).

Based on the existing studies, this paper thoroughly explored the relationship between ecological civilization construction and tourism economic development in the target region. A relevant model was constructed to guide the local authorities in coordinating the relationship between tourism economic development and ecological civilization construction. After the introduction, this paper first discussed the ecological civilization construction and the construction of the index system to evaluate tourism development. Then, the research methodology of this paper was explained. After that, the relationship between ecological civilization construction and tourism economic development in the target region was empirically analyzed. The weight of ecological civilization construction and tourism development in western Hunan was analyzed and evaluated by the TOPSIS method, and the coupling coordination degree was analyzed. Finally, the study was summarized, and specific operational policy recommendations were made.

Construction of an Evaluation Index System for Ecological Civilization and Tourism Development

The ecological civilization construction and tourism development systems can be divided into subsystems. We use the data of three central cities, Western Hunan Tujia and Miao Autonomous Prefecture, Huaihua City and Zhangjiajie City, for analysis. Our analysis, based on similar research results, combined with the characteristics of the Wuling Mountain Area in Western Hunan and followed the scientific, feasible and systematic principles of establishing evaluation indicators. The evaluation indexes used more frequently in the literature and comprehensively reflect the overall situation of ecological civilization construction and tourism development were selected. Based on this, an evaluation index system of ecological civilization construction and tourism development was constructed (Wu and Li, 2020; Zou et al., 2017; Liu and Guo, 2016; Ma et al., (2017).

In terms of tourism development, three primary indexes were determined: tourism impact, tourism income and tourism resources; six secondary indexes were selected, including the number of Chinese tourists, number of foreign tourists, total revenue of China's domestic tourism, and number of 4A-level and above tourist attractions. For ecological civilization construction, four primary indexes were: economical construction, cultural construction, social construction, and environmental construction. Fifteen secondary indexes were selected, including GDP per capita, residents' Engel coefficient, education expenditure, registered urban unemployment rate, forestry output value, and average concentration of PM2.5. All the indexes are listed in Table 1.

Table 1 Evaluation system of ecological civilization construction and tourism development

Primary index	Secondary index	Unit of secondary index	Attribute
Economic construction of urban ecological civilization (A)	GDP per capita (A1)	Yuan	Positive
	The proportion of secondary industry value-added to GDP (A2)	%	Negative
	The proportion of tertiary industry value-added to GDP (A3)	%	Positive
	Disposable income per capita (A4)	Yuan	Positive
	Residents' Engel coefficient (A5)	%	Negative
The cultural construction of urban ecological civilization (B)	Current students in colleges (B1)	Person	Positive
	Education expenditure (B2)	100,000,000 Yuan	Positive
	Integrated population coverage of radio programs (B3)	%	Positive
The social construction of urban ecological civilization(C)	Registered urban unemployment rate (C1)	%	Negative
	Urbanization level (C2)	%	Positive
Environmental construction of urban ecological civilization (D)	Forest coverage(D1)	%	Positive
	The average concentration of PM2.5 (D2)	µg/m ³	Negative

	Forestry output value (D3)	%	Positive
	Sewage treatment rate (D4)	%	Positive
	Percentage of days with good air quality (D5)	%	Positive
Tourism impact (E)	Number of Chinese tourists (E1)	10,000 persons	Positive
	Number of foreign tourists (E2)	Person	Positive
Tourism income (F)	Total revenue of China's domestic tourism(F1)	100,000,000 Yuan	Positive
	Foreign exchange earnings from the tourism industry (F2)	10,000 Dollars	Positive
Tourism resources (G)	Number of 4A-level and above tourist attractions (G1)		Positive
	Tourist-class scenic spots (G2)		Positive

RESEARCH PROCESS AND METHODOLOGY

The data was standardized based on the above index system built to clarify whether there is any coupling coordination between the ecological civilization construction of the Wuling Mountain Region in western Hunan and the development of the tourism industry. The weights of the indexes were calculated using the entropy weight method. Then the indexes were evaluated employing the TOPSIS method. Finally, the coupling relationship between ecological civilization construction and tourism development was analyzed with the coupling coordination degree model.

Data Selection and Pre-processing

The data we use for conducting analyses are mainly from the Xiangxi Tujia and Miao Autonomous Prefecture's statistical yearbook of Huaihua City, the statistical yearbook of Zhangjiajie City, and the Statistical Bulletins of various cities from 2017 to 2019. In addition, part of the data comes from the information published on the official websites of various government departments. Because of the incomparability of each index with different scales and magnitudes, the data should be preprocessed to make them comparable using the extreme value method. The data were processed in the following ways:

$$X_{ij} = \frac{X_{ij} - m_{ij}}{M_{ij} - m_{ij}} \quad (i = 1, 2, \dots, n; j = 1, 2, \dots, m), \text{ where } X_{ij} \text{ denotes a positive index} \quad (1)$$

$$X_{ij} = \frac{M_j - X_{ij}}{M_j - m_j} \quad (i = 1, 2, \dots, n; j = 1, 2, \dots, m), \text{ where } X_{ij} \text{ denotes a negative index} \quad (2)$$

In Equations (1) and (2) $M_{ij} = \max\{X_{ij}\}$, $m_j = \min\{X_{ij}\}$, X_{ij} denote the standardized data of the index j in the system i .

Weight Calculation by the Entropy Weight Method

The entropy weight method (Gong and Wang, 2017; Tan, Huang and Gu, 2017) is an objective weighting method. The term "entropy" is derived from thermodynamics, and in information theory, it is a measure of information. The basic principle is that the weight of each index in the evaluation system depends on the difference of X_{ij} . The more significant the difference of X_{ij} , the greater the weight of the index.

(1) Calculate the proportion of the evaluated target i under the index j :

$$P_{ij} = \frac{X_{ij}}{\sum_{i=1}^n X_{ij}} \quad (3)$$

(2) Calculate the entropy value of the index j :

$$e_j = -k \sum_{i=1}^n P_{ij} \ln(P_{ij}) \quad (4)$$

$$k = \frac{1}{\ln n} \text{ (n is the number of evaluated targets)} \quad (5)$$

(3) Calculate the coefficient of variation of the index j :

$$g_j = 1 - e_j \quad (6)$$

(4) Determine the weight:

$$w_j = \frac{g_j}{\sum_{j=1}^m g_j} \quad (7)$$

Comprehensive Evaluation by the TOPSIS Method

The TOPSIS method (Wan, Su and Liu, 2020; Zhou and Wu, 2021) is a method to rank the evaluated targets according to their proximity to the idealized target. TOPSIS method ranks each evaluated target by assuming positive and negative ideal solutions, measuring the distance between each set of data and the positive and negative perfect solutions, and obtaining the proximity to the ideal solution.

(1) Preprocess the data to obtain the matrix Q :

$$Q = (X_{ij})_{mn} \quad (8)$$

(2) Based on the weight w_j obtained by the above entropy weight method, construct the weighted normalized matrix Z :

$$Z = (X_{ij} * w_j) \quad (9)$$

(3) Determine the positive and negative ideal solutions

By letting the value of the attribute j of the positive ideal solution Z^* be x_j^* , and the value of the attribute j of the negative ideal solution Z^0 be x_j^0 , the following can be concluded:

$$\text{Positive ideal solution } Z^* = \begin{cases} \max z_{ij}, j \text{ is a benefit - type attribute} \\ \min z_{ij}, j \text{ is a cost - type attribute} \end{cases} \quad (10)$$

$$\text{Negative ideal solution } Z^0 = \begin{cases} \min z_{ij}, j \text{ is a benefit - type attribute} \\ \max z_{ij}, j \text{ is a cost - type attribute} \end{cases} \quad (11)$$

(1) Calculate the distance of each set of data from the positive and negative ideal solution:

$$s_i^* = \sqrt{\sum_{j=1}^n (z_{ij} - z_j^*)^2} \quad (12)$$

$$s_i^0 = \sqrt{\sum_{j=1}^n (z_{ij} - z_j^0)^2} \quad (13)$$

(2) Calculate the proximity of each evaluated target to the ideal solution, and solve for the composite score:

$$u = \frac{s_i^0}{(s_i^0 + s_i^*)} \quad (14)$$

Construction of the Coupling Coordination Degree Model

"Coupling" originates from physics. Drawing on the capacity coupling concept in physics and applying it to economics, the coupling degree can reflect the dynamic relationship between ecological civilization construction and tourism development. Also, the coupling degree is of great significance in predicting the development of ecological civilization construction and tourism development. Since ecological civilization construction and tourism development are two systems, the coupling degree model of the two systems can be obtained (Wang, 2017).

$$C = \frac{\sqrt{u_1 u_2}}{u_1 + u_2} \quad (15)$$

where, u_1, u_2 , denote the composite scores of ecological civilization construction and tourism development.

The coupling degree model can hardly reflect the overall level and coordination effect of ecological civilization construction and tourism development under the transformation of multiple regions. Based on the coupling degree model, the coupling coordination degree model was applied to reflect the coordination status between the two systems more accurately.

$$D = \sqrt{C \times T} \quad (16)$$

$$T = au_1 + bu_2 \quad (17)$$

In Equations (16) and (17), C denotes the coupling degree. The higher the coupling degree is, the stronger the interaction between ecological civilization construction and tourism development. D denotes the coupling coordination degree of ecological civilization construction and tourism development. The higher coupling coordination degree indicates that ecological civilization construction and tourism development are at a high level of mutual promotion. T denotes the coordination index of the two systems, and a, b denotes the coefficients to be determined. Based on the actual situation of the Wuling Mountain Region in western Hunan, it is considered that ecological civilization construction is as important as tourism development. Therefore, a was assigned to 0.5, b was assigned to 0.5, and a plus b was equal to 1. In case of $u_1 > u_2$, tourism was evaluated as lagging behind ecological civilization; if not, ecological civilization was evaluated as lagging behind tourism in the case of $u_1 < u_2$. On the contrary, in the case of $u_1 = u_2$, ecological civilization construction was synchronized with tourism development. The criteria for classifying the coupling coordination degree drawing on the existing research results were determined as shown in Table 2 (Zhou, 2019):

Table 1 Criteria for classifying the coupling coordination degree between ecological civilization construction and tourism development

Value range of the coupling coordination degree	Level of the coupling coordination degree
0.00~0.20	Severe imbalance
0.20~0.40	Slight imbalance
0.40~0.60	Reluctant coordination
0.60~0.80	Good coordination
0.80~1.00	High coordination

Empirical Analysis

Based on the research mentioned above, this paper will conduct a quantitative empirical analysis of the weights calculated by the entropy weight method, the comprehensive evaluation results by the TOPSIS method, and the coordination degree derived from the coupling coordination degree model. In this way, it facilitates exploring the multiple relationships between the ecological civilization construction and tourism development in the Wuling Mountain Region of western Hunan.

Weighting Analysis of Ecological Civilization and Tourism Development in Western Hunan, China

Based on the data of Xiangxi Prefecture, Huaihua City and Zhangjiajie City from 2017 to 2019, the entropy weight method was used to calculate the weights of the indexes (specific weights are shown in Table 3) and analyze their weights. Environmental construction of ecological civilization (0.379) had the most weight in the primary indexes for the ecological civilization construction system, indicating that environmental construction plays a significant role in construction. Among the secondary indexes of environmental construction, the forestry output value (0.1518) had the largest share in the overall ecological civilization construction, reflecting that forestry development is an important factor affecting ecological civilization construction. For the tourism development system, the weight of tourism resources (0.514) accounted for more than half of the weight of the primary indexes, which indicates that the development of tourism resources is a crucial way to promote the development of the tourism industry.

Table 3 Index weights derived by the entropy weight method

System-level	Primary index	Secondary index	Weight
The ecological civilization construction system	Economic construction of urban ecological civilization(A) (0.302)	GDP per capita (A1)	0.0628
		The proportion of secondary industry value-added to GDP (A2)	0.0580
		The proportion of tertiary industry value-added to GDP (A3)	0.0618
		Disposable income per capita (A4)	0.0529
		Residents' Engel coefficient (A5)	0.0665
	The cultural construction of urban ecological civilization(B) (0.178)	Current students in colleges(B1)	0.0702
		Education expenditure (B2)	0.0780
		Integrated population coverage of radio programs (B3)	0.0300
	The social construction of urban ecological civilization(C) (0.140)	Registered urban unemployment rate (C1)	0.0915
		Urbanization level(C2)	0.0487
	Environmental construction of urban ecological civilization(D) (0.379)	Forest coverage (D1)	0.0949
		Average concentration of PM2.5 (D2)	0.0567
		Forestry output value (D3)	0.1518
		Sewage treatment rate (D4)	0.0331
		Percentage of days with good air quality (D5)	0.0431
Tourism development system	Tourism impact(E) (0.035)	Number of Chinese tourists (E1)	0.0894
		Number of foreign tourists (E2)	0.2609
	Tourist income (F)	Total revenue of China's domestic	0.1210

		tourism(F1)	
(0.461)		Foreign exchange earnings from the tourism industry (F2)	0.3405
	Tourism resources (G)	Number of 4A-level and above tourist attractions(G1)	0.0625
(0.188)		Tourist-class scenic spots(G2)	0.1257

Comprehensive Evaluation of Ecological Civilization Construction and Tourism Development in Western Hunan by the TOPSIS Method.

Based on the weights calculated using the entropy weight method, the TOPSIS method comprehensively evaluated ecological civilization construction and tourism development in the Wuling Mountain Region in western Hunan. The results are shown in Table 4.

Table 4 Comprehensive evaluation results using the TOPSIS method

Region and year	The total score of ecological civilization construction	Ranking	The total score of tourism development	Ranking
Xiangxi Prefecture, 2019	0.3123	7	0.0893	6
Xiangxi Prefecture, 2018	0.1995	8	0.0460	8
Xiangxi Prefecture, 2017	0.0794	9	0.0139	9
Huaihua City, 2019	0.8965	1	0.1211	3
Huaihua City, 2018	0.7279	2	0.1016	5
Huaihua City, 2017	0.5263	5	0.0688	7
Zhangjiajie City, 2019	0.5776	3	0.9465	1
Zhangjiajie City, 2018	0.5745	4	0.1538	2
Zhangjiajie City, 2017	0.3294	6	0.1090	4

According to the analysis results using the TOPSIS method, Huaihua City had the highest total score for ecological civilization construction in 2019 (0.8965), and Zhangjiajie City had the highest total score for tourism development in 2019 (0.9465). At the same time, the ecological civilization construction of Huaihua City and Xiangxi Prefecture showed an overall upward trend. It is mainly reflected in the rise of forestry output value, the decreased registered urban unemployment rate and residents' Engel coefficient from 2017 to 2019. The ecological civilization construction of Zhangjiajie City tended to rise and then stabilize overall. The rise

between 2017 and 2018 is mainly reflected in the increase in forestry output value and education expenditure and the decrease in the unemployment rate. The slight increase between 2018 and 2019 is primarily reflected in the decline in GDP per capita, the reduced integrated population coverage of radio programs, and the increased registered urban unemployment rate in 2018 and 2019 (Figure 1).

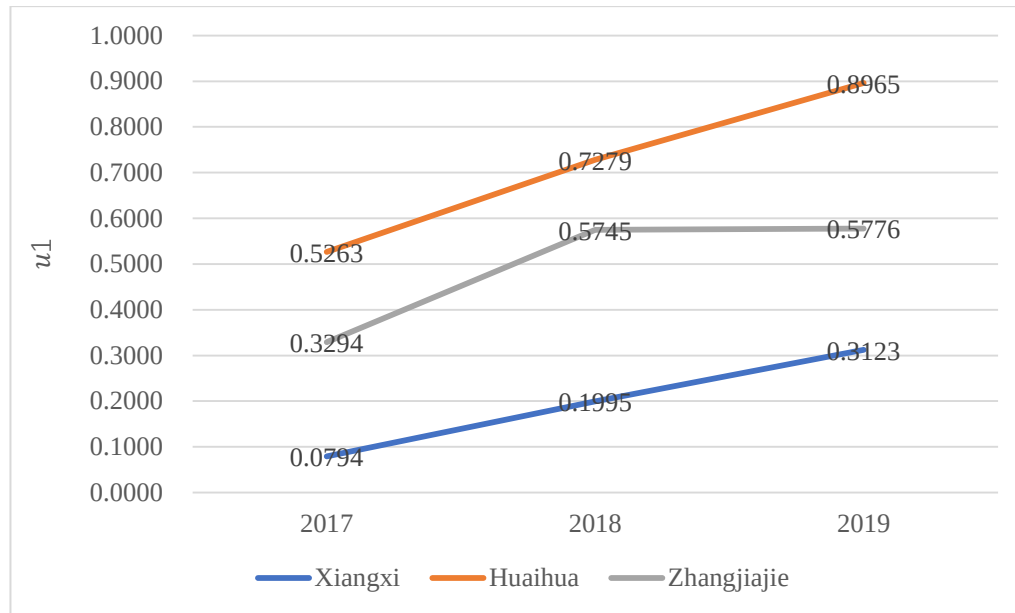


Figure 1 Comprehensive evaluation of overall ecological civilization construction

The analysis results also indicated that the overall ecological civilization construction in Huaihua was better than that in Zhangjiajie and Xiangxi, as the education expenditure and forestry output value in Huaihua were much higher than those in Zhangjiajie and Xiangxi. Meanwhile, tourism development in the western Hunan area showed an upward trend (Figure 2). Zhangjiajie saw a significant increase from 0.1538 in 2018 to 0.9465 in 2019, as reflected in the number of foreign tourists, China's domestic tourism revenue, and foreign exchange earnings in domestic tourism in Zhangjiajie City from 2018 to 2019. Tourism in Huaihua also rose, but not significantly, mainly represented by the increase in China's domestic tourists and tourist attractions, the decrease in foreign exchange earnings from the tourism industry, and the number of foreign tourists. Xiangxi increased to some extent, mainly manifested by the number of 4A tourist attractions, foreign exchange earnings from the tourism industry, and China's domestic tourism revenue.

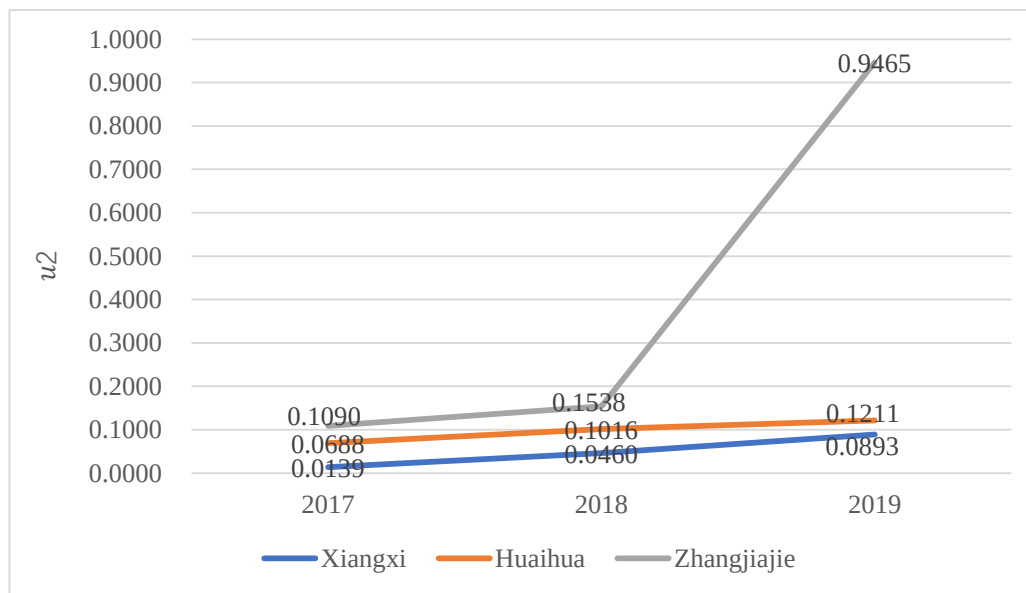


Figure 2 Comprehensive evaluation of tourism development

The western Hunan area is generally lagging in tourism from 2017 to 2019. Zhangjiajie tended to be fading in the ecological civilization. During this period, the number of Chinese and foreign tourists received in Zhangjiajie, the total revenue of China's domestic tourism, and the foreign exchange earnings increased significantly. As a result, the overall rating of ecological civilization construction in Zhangjiajie has grown much more minor than tourism development. Therefore, it tended to develop toward lagging ecological civilization (Table 5).

Table 2 Comprehensive evaluation of ecological civilization construction and tourism development

Region and year	u_1	u_2	Relationship between u_1 and u_2	Type of comprehensive evaluation
Xiangxi Prefecture, 2019	0.3123	0.0893	$u_1 > u_2$	Lagging tourism
Xiangxi Prefecture, 2018	0.1995	0.0460	$u_1 > u_2$	Lagging tourism
Xiangxi Prefecture, 2017	0.0794	0.0139	$u_1 > u_2$	Lagging tourism
Huaihua City, 2019	0.8965	0.1211	$u_1 > u_2$	Lagging tourism
Huaihua City, 2018	0.7279	0.1016	$u_1 > u_2$	Lagging tourism
Huaihua City, 2017	0.5263	0.0688	$u_1 > u_2$	Lagging tourism
Zhangjiajie City, 2019	0.4462	0.9465	$u_2 > u_1$	Lagging ecological civilization
Zhangjiajie City, 2018	0.3867	0.1538	$u_1 > u_2$	Lagging tourism
Zhangjiajie City, 2017	0.3951	0.1090	$u_1 > u_2$	Lagging tourism

Analysis of Coupling Coordination Degree between Ecological Civilization Construction and Tourism Development in Western Hunan

The interaction and mutual constraint between ecological civilization construction and tourism development are called the coupling relationship by economists. The coupling coordination degree of Xiangxi, Huaihua, and Zhangjiajie from 2017 to 2019 was measured based on the entropy weight method and the coupling coordination degree model. The radar chart was applied to visualize the coupling coordination degree stage to reflect the relationship between ecological civilization construction and tourism development (Figure 3).

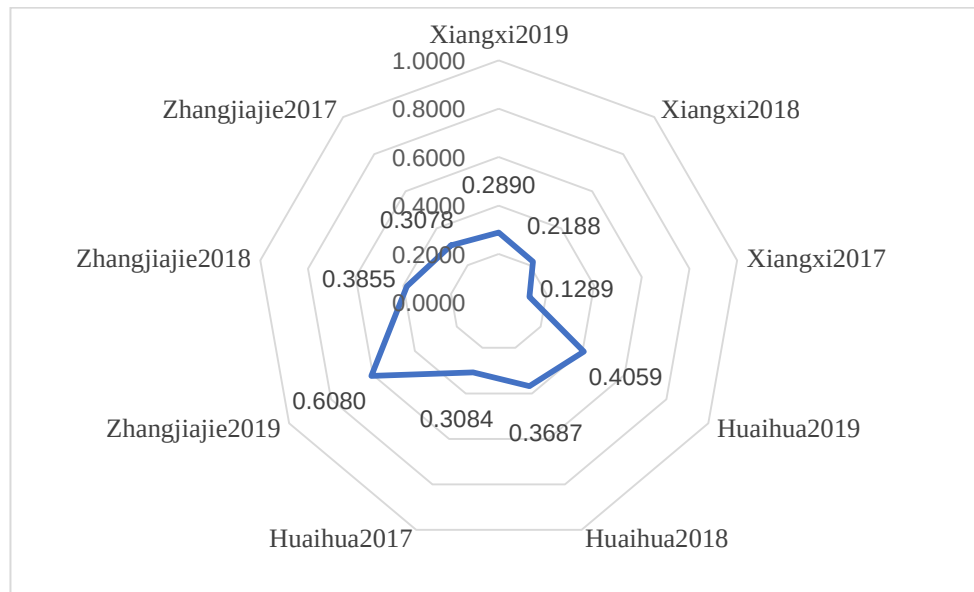


Figure 3 Coupling coordination degree between ecological civilization construction and tourism development

From 2017 to 2018, ecological civilization construction gradually rose, and tourism development had an upward trend. However, ecological civilization construction did not play a significant role in promoting tourism development. Due to the low level of ecological civilization construction and insufficient support for tourism development from ecological civilization infrastructure construction, tourism development suffered from a lack of momentum. Therefore, the coupling coordination degree between ecological civilization construction and tourism development in the western Hunan area increased. In the Wuling Mountain Region of western Hunan, the coupling coordination degree between ecological civilization construction and tourism development was slightly imbalanced from 2017 to 2019. The coupling coordination degree presented a rising trend.

From 2018 to 2019, ecological civilization construction and tourism development showed an upward trend. Therefore, the coupling coordination degree of the two systems rose, and the two systems became mutually reinforcing. When ecological civilization reaches a certain level, it accelerates tourism development. From 2017 to 2018, the composite score for ecological civilization construction of Zhangjiajie City increased to 0.5745, and the composite score for tourism development increased from 0.1090 to 0.1538 (up to 0.0442). From 2018 to 2019, the composite score of ecological civilization construction in Zhangjiajie only increased slightly, but the composite score of tourism development rose from 0.1538 to 0.9465 (up 0.7927). Secondly, the ecological civilization construction of Xiangxi and Huaihua cities also contributed to tourism development. Therefore, the coupling coordination degree between

the two further intensified. Thus, it can be seen that the ecological civilization construction and tourism development in the Wuling Mountain Region of western Hunan tended to be mutually reinforcing.

CONCLUSIONS AND RECOMMENDATIONS

The progress of ecological civilization has contributed to tourism development to a certain extent. In this study, the coupling coordination degree model combined with the TOPSIS method was applied to evaluate and analyze the ecological civilization construction and tourism development of the Wuling Mountain area in western Hunan, China. Also, the relationship between the two was investigated. The results showed that the ecological civilization construction in the western Hunan area was on the rise, while tourism development was also on the rise, and some differences existed among regions. However, the western Hunan area was lagging in tourism, while Zhangjiajie shifted to fading ecological civilization. At the same time, the ecological civilization construction and tourism development in the western Hunan area were in a state of slight imbalance. Based on the findings and problems of the study, the following recommendations are proposed for the development of the western Hunan area:

1. More efforts should be made to increase the total investment and propaganda of ecological civilization construction and tourism development. For areas where tourism development is lagging, funds for the tourism industry should be raised to improve tourism facilities and solidify the foundation of tourism development. In addition, we should actively propagate tourist attractions and utilize new media and other devices to enhance the popularity of the attractions and attract Chinese and foreign tourists. At the same time, we should also use the abundant natural and human tourism resources in western Hunan and build high-quality tourist attractions to create a tourist circle in western Hunan.
2. We should further refine and quantify the indexes of larger weights in the ecological civilization construction system. It is an essential component of the modernization of the governance system and the capability to advance ecological civilization construction and implement relevant governance concepts actively. The Wuling Mountain Region in western Hunan should increase the output value of forestry, increase forest coverage, reduce urban unemployment, increase investment and expenditure on education, and improve air quality following the master plan for reforming the ecological civilization construction system.
3. We should actively promote the coordinated development of ecological civilization construction and tourism industry and strive to build a coordinated pattern of ecological environment construction and tourism development. As ecological civilization construction and tourism development are complementary, tourism development is essential for ecological civilization construction. Ecological civilization construction is the core path of sustainable tourism development. Therefore, we should firmly establish that natural resources such as water and mountains are invaluable assets for China. Also, we should never accelerate the development of some aspects at the expense of others but take ecological civilization construction as the core and actively develop green and sustainable tourism.

Although the mechanism of the coupling coordination between the two systems in the Wuling Mountain Region of western Hunan has been studied in-depth, there are still some

deficiencies in this study, mainly in two aspects. Firstly, a small number of composite indices fail to be introduced into the index system due to the lack of index data. In addition, there are few research results on the Wuling Mountain area in western Hunan, China, so the index system is constructed without a standard index system as a basis. Secondly, this paper mainly uses existing data to study the relationship between ecological civilization construction and tourism development in the Wuling Mountain Region in western Hunan from 2017 to 2019. It is only confined to the study of the past and present but does not apply an appropriate approach to predict future relationship development. Further investigation is needed in this regard in future studies.

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