RESEARCH ARTICLE

The role of ecological environmental protection in promoting rural tourism development in digital rural areas

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This study investigated the role of ecological environmental protection in promoting rural tourism development in the context of digital rural areas. The digital countryside refers to the integration of modern information technology into rural regions to enhance agricultural production, living conditions, and public services. Qiannan Buyi and Miao Autonomous Prefecture in Guizhou Province, China was selected as the study target, which faced challenges such as ecological degradation and inefficient tourism management. The data for this study were retrieved from the Guizhou Statistical Yearbook and databases provided by the local Environmental Protection Bureau and Tourism Bureau from 2014 to 2022. A comprehensive evaluation model, coupling degree model, and coupling coordination degree model were constructed *via* the analytic hierarchy process (AHP) and entropy method and implemented in SPSS and MATLAB software. The comprehensive development index model and the coupling coordination degree model proposed in this study applied the range method for dimensionless processing and the entropy method for weight determination. The results revealed that the degree of coupling coordination between the digital countryside, the tourism economy, and the ecological environment increased from 0.52 in 2014 to 0.75 in 2022, which indicated that digital technology applications had effectively promoted tourism economy growth and ecological improvements. These findings were supported by the continuous growth in development indices, underscoring the positive impact of regional policies and digital infrastructure on sustainable development.

Keywords: digital village; ecological environment; rural tourism economy; coupling and coordinated development.

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Introduction

With the rapid development of digitalization, the construction of the digital countryside has become an important strategy to promote agricultural modernization and the comprehensive revitalization of rural areas. Through the extensive application of information technology, not only do rural production and living conditions greatly improve but also the efficiency of rural governance and service levels. Moreover, ecological environmental protection has received increasing attention worldwide and has become one of the key factors of sustainable development. As a green development model, rural tourism is closely related to ecological protection. In the context of the digital countryside, exploring the interaction between ecological environmental protection and rural tourism development will not only help promote

the diversified development of the regional economy but also effectively realize the goal of constructing an ecological civilization.

The coupling and coordination relationship between ecological environmental protection and rural tourism development in the context of the digital countryside has been widely studied both domestically and internationally. The coupling and coordination between tourism development and the ecological environment system in resource-based cities was investigated and the results found that tourism development could promote ecological environmental protection to a certain extent [1]. Yin *et al*. further emphasized the coupling and coordination relationships among the tourism economy, social welfare, and the ecological environment in empirical analysis of western China and indicated that regional tourism development had an important impact on the ecological environment [2]. Yao *et al*. studied the problems and countermeasures of the rural tourism ecological environment and noted ecological destruction in tourism activities and proposed corresponding environmental protection countermeasures [3]. Wan *et al*. discussed the coupling and coordination between urbanization and the ecological environment in 13 urban agglomerations in China, emphasizing the necessity of maintaining ecological balance in the process of urbanization [4]. In addition, scientists focused on the coordinated development of the economy, tourism, and ecological environment in the Sanjiangyuan region and proposed strategies for comprehensive governance and sustainable tourism development [5]. The coupling development of the regional economy, tourism, and ecology in Henan Province was analyzed and the actual effect of regional development strategies on promoting ecological and environmental protection was demonstrated [6]. In a more extensive study, Ren *et al*. discussed the coupling and coordinated development of the urban tourism-economy-ecological environment against the background of network intelligence, arguing that the integration of information technology provided a new way for the coordinated development of the three fields [7]. Li analyzed the characteristics of tourism eco-efficiency based on carbon emissions and the perspective of regional tourism eco-efficiency, providing a theoretical basis for the development of eco-tourism [8]. Further, Han *et al*. also confirmed that a higher level of coordination among the three fields could be achieved to promote the overall sustainable development of a region by studying three-way sustainable development policies for cities, the economy, and the environment [9]. Lai *et al*. studied the coupling and coordination among the environment, the economy, and tourism within a broader scope of China and revealed the unbalanced development in these aspects among different regions [10]. Zhang *et al*. further confirmed the coupling and coordination among the regional economy, tourism, and the ecological environment through the study of the western region and emphasized that policymakers should pay attention to the balance of this relationship in regional planning [11].

Domestic and international scholars have made a series of important achievements in the coupling and coordination of rural tourism development and ecological environmental protection in the context of the digital countryside. However, it is still necessary to further explore and improve relevant theories and practical strategies to achieve the long-term goal of regional sustainable development [12]. This study was to explore the interaction and promotion mechanism between ecological environmental protection and rural tourism development in the context of the digital countryside through constructing a coupling coordination degree model of the tourism economy and the ecological environment to evaluate the interaction effect of the two aspects to clarify the role of rural tourism in promoting ecological environmental protection and then provide a theoretical basis and strategic suggestions for the sustainable development of the digital countryside. This study was highly valuable for understanding and promoting the coordinated development of rural

tourism and ecological environmental protection under the digital rural development strategy and would provide decision support for policymakers, optimize ecological and environmental protection policies and rural tourism development strategies, and promote the green transformation of the local economy. The empirical analysis could provide a model and experience for other regions to learn from and promote the sustainable development of rural tourism and the protection of the entire country's ecological environment.

Materials and methods

Data sources

Qiannan Buyi and Miao Autonomous Prefecture, Guizhou, China was taken as the study target with more than 70% of the areas as rural areas and the penetration rate of digital rural areas accounting for more than 80%. The data for this study was collected from 2014 to 2022 through Guizhou Statistical Yearbook (Statistics Bureau of Qiannan Buyi and Miao Autonomous Prefecture, Guizhou, China) (https://www.qiannan.gov.cn/), Annual Environmental Reports and Data (Qiannan Ecology and Environment Bureau, Guizhou, China) (http://sthjj.qiannan.gov.cn/), and Tourism Statistics and Development Reports (Qiannan Culture and Tourism Bureau, Guizhou, China) (http://whly.qiannan.gov.cn/). These sources provided comprehensive information on the tourism economy, the ecological environment, and digital infrastructure development including the total tourism revenue, tourist arrivals, number of hotels and travel agencies, industrial wastewater discharge, industrial sulfur dioxide discharge, urban sewage treatment rate, forest coverage rate, and other indicators. To analyze the impact of the digital countryside on the rural tourism economy and ecological environmental protection in depth, data related to the level of digitalization such as internet coverage and the popularity of digital services were also collected [13]. A total of 1,587 data records were obtained. Through preliminary data cleaning and screening, incomplete, duplicate, or abnormal records were excluded, and then 1,354 valid data points were ultimately obtained, which covered multiple dimensions including tourism economic benefits, the tourism economic scale, the tourism economic structure, pollutant emissions, pollutant treatment, and ecological conditions, providing a solid data foundation for the empirical analysis of this study.

Principles of construction of the evaluation index system

The evaluation index system was constructed to ensure that the selected index could comprehensively, accurately, and effectively reflect the characteristics and status of the research object. Five principles adopted for the construction of the evaluation index system for the coupling coordination degree of the digital rural tourism economy and ecological environmental protection were scientificity, systemicity, operability, comparability, and dynamics [14]. The evaluation index system selected the key indexes that could fully reflect the degree of coupling coordination between the rural tourism economy and ecological environmental protection. Scientificity ensured that the selected indicators were based on sound theoretical foundations. Systemicity meant that the indicators comprehensively reflected the interaction between different aspects of the studied systems. Operability guaranteed that the indicators were practical and could be easily measured. Comparability allowed the indicators to be used for comparing different regions or time periods. Dynamics ensured that the indicators could reflect changes over time. The indicators selected for this study not only had strong theoretical support but also facilitated data collection and processing and could be effectively used to analyze and compare the coordinated development of different times and regions to provide a scientific basis for policy formulation and practical operation [15].

Construction of the index system and determination of index weights

To comprehensively evaluate the degree of coupling coordination between the tourism economy and ecological environmental protection in the context of the digital countryside, an index system covering the digital countryside, the tourism economy, and the ecological environment was constructed. The weights of the indicators were determined *via* a combination of the analytic hierarchy process (AHP) and the entropy method. The AHP was employed to derive subjective weights based on expert judgment and literature review, ensuring that the relative importance of each indicator reflected expert consensus and theoretical foundations. The entropy method was used to calculate objective weights by measuring the variability of indicators, ensuring the inclusion of data-driven insights. Specifically, the entropy method involved calculating the entropy value for each indicator to quantify the amount of information provided by the indicator followed by determining the redundancy that reflected the effective information of the indicator, and finally calculating the weight of each indicator by combining subjective and objective assessments. This approach ensured a balanced and comprehensive weighting system that accounted for both expert knowledge and empirical data, providing a robust foundation for the evaluation models used in the study. The weights of the indicators assigned to this study were shown in Table 1. When constructing the index system and determining the index weights, a comprehensive empowerment strategy that combined subjective and objective methods was adopted to ensure scientific and objective evaluation, which included dimensionless treatment of indicators (range method) and objective determination of weight (entropy method). The range method was a common data normalization method used to convert data into the [0, 1] interval, eliminating dimensional effects. The positive indicator (the larger, the better) was expressed in equation (1), while the negative indicator (the smaller, the better) was expressed in equation (2).

$$x'_{ij} = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)} \quad (1)$$

$$x'_{ij} = \frac{\max(x_j) - x_{ij}}{\max(x_j) - \min(x_j)} \quad (2)$$

where x_{ij} was the original value of the i evaluation object in the j index. x'_{ij} was the value after nondimensionalization. $\max(x_j)$ and $\min(x_j)$ were the maximum and minimum values of the j index. The entropy method was based on the concept of information entropy to measure the variability of indicators and their contribution to decision-making. The calculations were shown below.

(1) Calculating the entropy of the index.

$$E_j = -k\sum_{i=1}^{n} p_{ij} \ln(p_{ij}) \quad (3)$$

where $p_{ij} = \frac{x'_{ij}}{\sum_{i=1}^{n} x'_{ij}}$. $k = \frac{1}{\ln n}$. n was the sample size.

(2) Calculating the redundancy of the indicators.

$$D_j = 1 - E_j \quad (4)$$

Redundancy (D_j) reflected the effective information of the index.

(3) Calculating the index weights.

$$W_j = \frac{D_j}{\sum_{j=1}^{m} D_j} \quad (5)$$

where m was the total number of indicators. W was the weight of the j indicator.

Table 1. Evaluation index system and weights of digital countryside, tourism economy, and ecological environment.

System Layer	Element Layer	Indicator Layer	Unit	Indicator Nature	Weight
Tourism Economy	A1 Tourism Economic Benefits	B1 Total Tourism Revenue	¥100 million	Positive	0.0978774
		B2 Tourism Foreign Exchange Income	$10,000	Positive	0.0719204
		B3 Domestic Tourism Income	¥100 million	Positive	0.1007842
	A2 Tourism Economic Scale	B4 Total Tourist Arrivals (persons)	100,000	Positive	0.0430364
		B5 Domestic Tourist Arrivals (persons)	100,000	Positive	0.0647633
		B6 International Tourist Arrivals (persons)	Million	Positive	0.0811082
		B7 Foreign Tourist Arrivals (persons)	Million	Positive	0.0907434
		B8 Inbound Tourist Arrivals (persons)	100,000	Positive	0.0963883
		B9 Number of Star-rated Hotels	Units	Positive	0.0504315
		B10 Number of Travel Agencies	Units	Positive	0.0541545
	A3 Tourism Economic Structure	B11 Added Value of Tertiary Industry	¥100 million	Positive	0.0617174
		B12 Regional Gross Domestic Product	¥100 million	Positive	0.0578607
		B13 Proportion of value added of tertiary industry	%	Positive	0.0240851
		B14 Ratio of Total Tourism Revenue to GDP	%	Positive	0.1051503
Ecological Environment	A4 Pollutant Emissions	B15 Industrial Wastewater Discharge (tons)	100 million	Negative	0.0377594
		B16 Industrial Sulfur Dioxide Emissions	10,000	Negative	0.0828019
		B17 Industrial Solid Waste Generation	10,000	Negative	0.0930171
		B18 Energy Consumption per Unit of GDP	tons/¥10,000	Negative	0.0364823
		B19 Fertilizer amount of cultivated land	tons/hectare	Negative	0.1489276
	A5 Pollution Control	B20 Urban Wastewater Treatment Rate	%	Positive	0.0301852
		B21 Comprehensive utilization rate of industrial waste	%	Positive	0.1636365
		B22 Harmless Treatment Rate of Domestic Waste	%	Positive	0.0248727
		B23 Environmental Pollution Control Investment/GDP	%	Positive	0.1076492
	A6 Ecological Conditions	B24 Forest Coverage Rate	%	Positive	0.1622041
		B25 Urban Greening Coverage Rate	%	Positive	0.0306975
		B26 Per Capita Park Green Space Area	m^2	Positive	0.0817663
Digital Rural	A7 Information Infrastructure	B27 Internet Access Rate	%	Positive	0.125
		B28 Mobile Network Coverage Rate	%	Positive	0.075
		B29 Number of Public WiFi Coverage Points	Units	Positive	0.050
	A8 Digital Services	B30 E-commerce Transaction Volume	¥100 million	Positive	0.100
		B31 Smart Tourism Platform Services	Items	Positive	0.080
		B32 Penetration Rate of Digital Financial Services	%	Positive	0.070

Notes: ¥: Chinese yuan (RMB). $: US dollar (USD).

Comprehensive evaluation model

To comprehensively evaluate the coordinated development level of the digital countryside, the tourism economy, and the ecological environment, the weighted sum method was adopted as the comprehensive evaluation model that could summarize the scores of each index and form a comprehensive score to reflect the overall development state and was shown below.

$$S = \sum_{j=1}^{m} W_j \times x'_j \quad (6)$$

where S was the comprehensive evaluation score. W_j was the weight of the j indicator. x'_j was the value of the j indicator after dimensionless processing. m was the total number of indicators. The model converted the weighted average of each index weight into a single comprehensive score.

Coupling degree model of the digital countryside, the tourism economy, and the ecological environment

To measure the degree of coupling among the digital countryside, the tourism economy, and the ecological environment, a coupling degree model was adopted, which could reflect the

degree of interaction among the three factors and was shown equation (7).

$$C = \frac{\sqrt[3]{U \times V \times W}}{\frac{U+V+W}{3}} \quad (7)$$

where U, V, and W were the comprehensive evaluation scores of the digital countryside, tourism economy, and ecological environment, respectively. The calculation method was the same as that of the comprehensive evaluation model. C was the coupling degree and its value ranged between 0 and 1, while the closer the value was to 1, the higher the degree of coupling between the three factors was, and the closer the interaction was. The model could quantitatively describe the synergistic relationships among digital rural development, tourism economic growth, and ecological environmental protection and provide a scientific basis for further analysis of the mutual influence and balance among the three factors. This analysis was highly important for formulating relevant policies, optimizing resource allocation, and promoting regional sustainable development.

Coupling coordination degree model of the digital countryside, the tourism economy, and the ecological environment

To further explore the coupling coordination relationships among the digital countryside, the tourism economy, and the ecological environment, a coupling coordination degree model was developed to evaluate the coordination of the development of the three factors to more fully understand the degree of harmony of their interaction. The coupling coordination degree model was shown in equation (8).

$$T = C \times D \times 100 \quad (8)$$

where T was the coupling coordination degree and its value was multiplied by 100 into a percentage form for easy understanding and analysis. The higher the value was, the better the degree of coordination among the three factors was, and the stronger their ability to support and promote each other, reflecting the comprehensive sustainable development level of these three factors in the region. C was the coupling degree calculated *via* the coupling degree model mentioned above. D was the development degree index calculated *via* equation (9) below.

$$D = \frac{U+V+W}{3} \quad (9)$$

where *U*, *V*, and *W* were the comprehensive evaluation scores of the digital countryside, the tourism economy, and the ecological environment, respectively. The calculation of the degree of coupling coordination could clarify the aspects that needed to be considered and improved in the regional development strategy to provide a scientific basis for decision-making and help promote the harmonious development of the regional economy and environment. To comprehensively analyze the degrees of development between the digital countryside and the tourism economy, the digital countryside and the ecological environment, and the tourism economy and the ecological environment, the relative development degree model was proposed to assess their relative progress and development coordination by comparing the differences in levels of development across different fields and was calculated using equation (10) as follows.

$$R_{ij} = \frac{X_i}{X_j} \times 100 \quad (10)$$

where X_i and X_j were the comprehensive evaluation scores of the two comparison fields.

Results and discussion

The development indices of the digital countryside, the tourism economy, and the ecological environment

Table 2. Development index of digital countryside, tourism economy, and ecological environment.

Year	Index		
	Digital rural development	Tourism economy development	Ecological environment development
2014	45.67	65.32	55.21
2015	47.55	66.78	56.85
2016	49.34	68.92	57.99
2017	51.21	70.45	59.34
2018	53.87	72.13	60.78
2019	55.44	74.55	62.89
2020	57.98	76.33	64.22
2021	59.66	77.85	65.44
2022	61.34	79.27	67.21

From 2014 to 2022, the development indices of the digital countryside, tourism economy and ecological environment in Qiannan Buyi and Miao Autonomous Prefecture, Guizhou, China all showed a trend toward continuous growth. Among them, the digital rural development index increased from 45.67 to 61.34, reflecting improvements in information infrastructure and an increase in digital services annually. The improvement in the tourism economic development index increased from 65.32 to 79.27, reflecting the continued prosperity of the tourism industry and the improvement in management efficiency. The growth of the ecological environment development index also showed the gradual strengthening of environmental protection measures and the effectiveness of ecological restoration (Table 2).

The degree of coupling coordination among the digital countryside, the tourism economy, and the ecological environment

The coupling coordination degree model was applied to analyze the degrees of coupling coordination between the digital countryside and the tourism economy, the digital countryside and the ecological environment, and the tourism economy and the ecological environment. By combining the coupling degree and development degree of each field, the model calculated the coordination degree index. These indicators reflected the degree of coordination and mutual support for development in different areas and were essential for assessing the harmonization of development within a region. The three groups of coupling coordination degree indices all demonstrated increasing trends annually from 2014 to 2022 (Figure 1). The results showed that, over the time, the development of these three areas had become more coordinated, and the interaction and supporting effects had increased. The degree of coupling coordination between the digital countryside and the tourism economy increased from 52.34 in 2014 to 66.45 in 2022, reflecting the positive role of information construction in promoting the development of tourism. Although the degree of coordination between the digital countryside and the ecological environment showed only slightly increased, it also suggested the potential of information technology in promoting the protection of the ecological environment. The steady improvement in the degree of coupling coordination between the tourism economy and the ecological environment reflected the improvement in the balanced development between tourism growth and environmental protection [16].

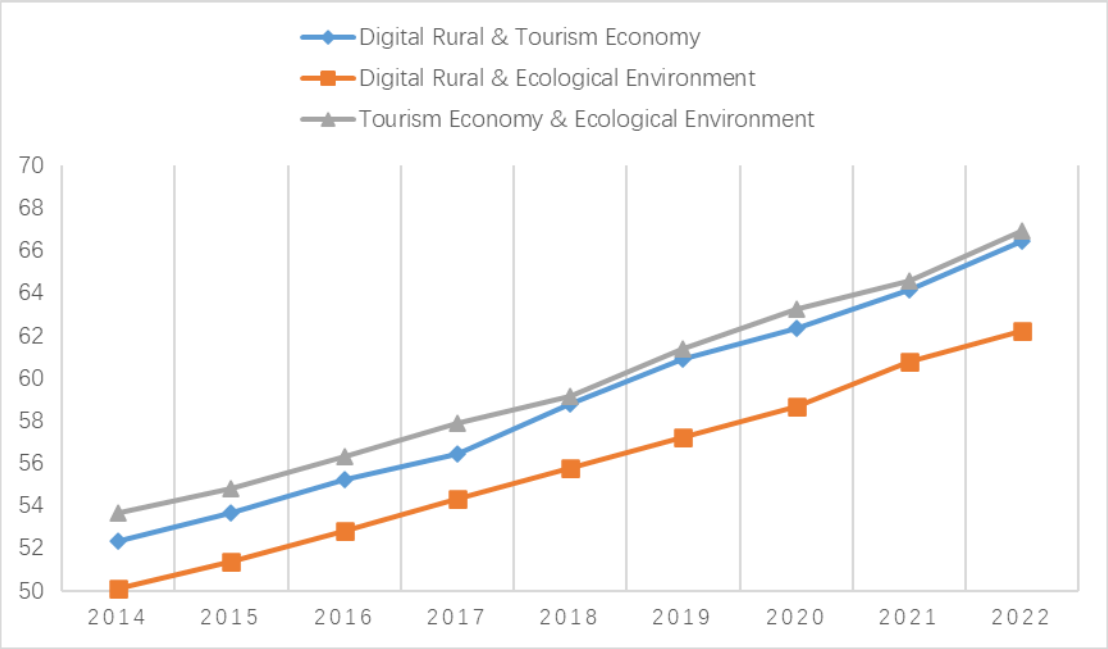

Figure 1. Coupling coordination degree of digital countryside, tourism economy, and ecological environment.

Development of the digital countryside, the tourism economy and the ecological environment

From 2014 to 2022, the degree of development of the digital countryside and the tourism economy, the digital countryside and the ecological environment increased annually (Figure 2), which indicated that the development of the digital countryside was gradually narrowing the development gap between the tourism economy and the ecological environment. In particular, the degree of development of the digital countryside and the ecological environment increased from 82.89 to 91.89, reflecting the increasing effectiveness of digital technology in promoting ecological environmental protection annually. The degree of relative development of the tourism economy and the ecological environment also continued to increase, indicating that the balance between tourism economic growth and environmental protection measures was gradually being optimized [17].

Suggestions from the results of this study

(1) Strengthening the construction of digital rural infrastructure.

Considering that the development of digital countryside showed a significant impact on promoting tourism economic growth and ecological environment protection, it is suggested to increase investment in information infrastructure in rural areas, which included improving Internet access speeds, expanding broadband and mobile network coverage, and adding public Wi-Fi access points. The promotion of smart farming technologies such as precision farming systems and remote monitoring systems can not only improve agricultural production efficiency, but also help achieve sustainable use of resources and environmental protection. Through these measures, the digital skills and quality of life of rural residents can be upgraded, while promoting regional economic development and environmental protection.

(2) Promoting the development of the tourism economy in a green and sustainable direction.

As an important engine for promoting local economic development, the sustainability of tourism has received increasing attention. More

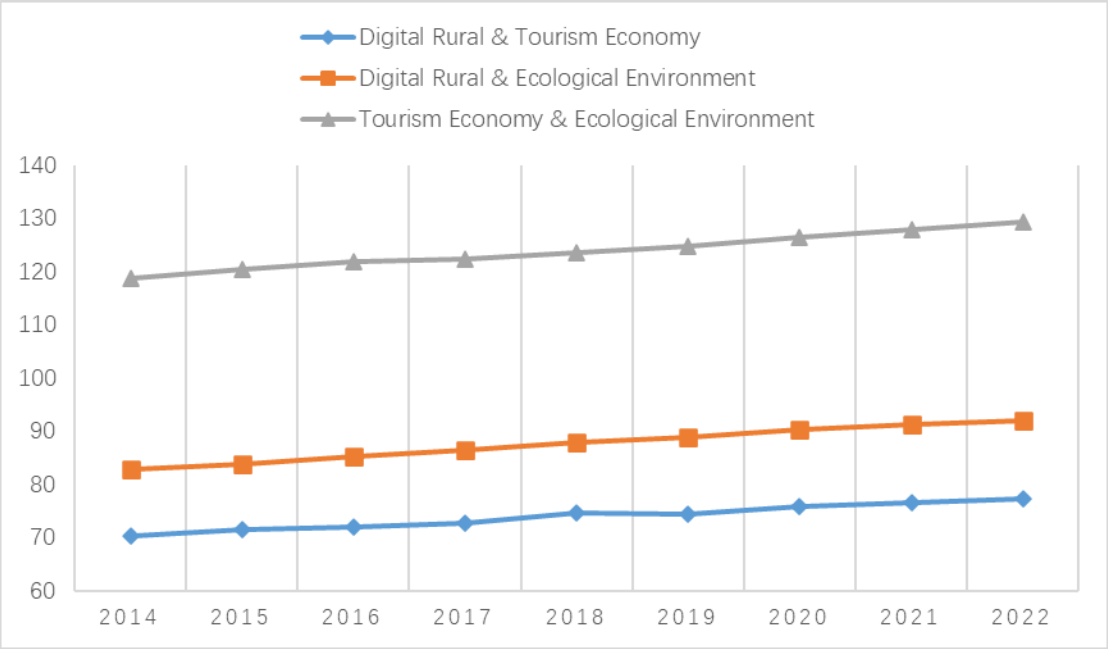

Figure 2. Relative development degree of digital countryside, tourism economy, and ecological environment.

stringent environmental protection measures such as limiting the number of tourists to reduce pressure on the ecological environment, implementing environmentally friendly tourism activities such as ecotourism and agritourism, and developing environmental education programs to increase the awareness of environmental protection among tourists are suggested. Moreover, tourism enterprises are encouraged to adopt green technologies and practices such as using renewable energy, reducing waste generation, and improving resource efficiency. Through these measures, tourism can not only contribute to the local economy but also protect and enhance the ecological environment.

(3) Promoting the comprehensive and coordinated development of the digital countryside, tourism economy, and ecological environment

The results of this study suggested the importance of the establishment of a cross-departmental coordination mechanism to ensure policy integration and consistency in implementation. This mechanism should involve multiple departments of local government including agriculture, tourism, environmental protection, and information technology to jointly formulate and implement policies. It is recommended to use big data and artificial intelligence technology to monitor and analyze regional economic activities and environmental changes in real time to timely adjust policies and measures to achieve the best balance between economic development and environmental protection. Through these integrated efforts, the overall competitiveness of the region and the quality of residents' life can be improved, while protecting and restoring the ecological environment.

Conclusion

This research conducted an empirical study on the digital countryside, tourism economy, and ecological environment system and constructed an evaluation index system. The results showed that construction of the digital countryside had significantly promoted the development of the rural tourism economy and ecological

environmental protection. The rapid development of the tourism economy significantly contributed to the economic growth of the studied area and had positively impacted the ecological environment. Through the implementation of green and sustainable tourism strategies, the coupling and coordination degree between the tourism economy and ecological environment had increased annually, which demonstrated that tourism development and environmental protection could coexist and achieve win-win results. The income generated by the growth of the tourism economy was effectively used for environmental protection and ecological restoration, providing a new path for regional sustainable development. The improvement in the coupling coordination degree between the digital countryside and ecological environment highlighted the crucial role of information technology in environmental management and protection. Digital technologies such as GIS, big data, and cloud computing have played a key role in monitoring environmental changes, assessing ecological impacts, and implementing precise governance, which have greatly improved the efficiency and effectiveness of ecological and environmental management. The promotion of digital villages accelerated this process, strengthening ecological protection and restoration through technological means. The analysis results of the relative development degrees of the digital countryside, tourism economy, and ecological environment showed that the development balance among these three aspects was improving annually, which reflected the effectiveness of regional development strategies that successfully balanced economic growth and environmental protection. This balanced development provided data support and a decision-making basis for regional long-term planning and policy formulation, helping to create more scientific and reasonable development strategies. This research confirmed the potential and effectiveness of digitalization and tourism economic development in promoting ecological and environmental protection, providing experience and strategies for similar regions to learn from and a valuable reference for future policy formulation and practical operation. The results not only enriched the theoretical framework of digital rural research and sustainable tourism development but also had important guiding significance for practical operation and policy implementation.

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References

1. Du LQ. 2021. Coupling coordination between tourism development and eco-environment system in resource-based cities. J Environ Prot Ecol. 22(6):2524-2534.
2. Yin ZX, Tang YL, Liu HN, Dai LY. 2023. Coupling coordination relationship between tourism economy-social welfare-ecological environment: Empirical analysis of Western Area, China. Ecol Indic. 155:110938.
3. Yao HQ, Liu B. 2020. Study on the problems of rural tourism eco-environment and its countermeasures. Fresen Environ Bull. 29(3):1489-1492.
4. Wan J, Zhang LW, Yan JP, Wang XM, Wang T. 2020. Spatial-temporal characteristics and influencing factors of coupled coordination between urbanization and eco-environment: A case study of 13 urban agglomerations in China. Sustainability. 12(21):8821.
5. Wang XH, Zhang XN. 2022. Study on the coordinated development of economy, tourism, and eco-environment in Sanjiangyuan. Math Probl Eng. 2022:9463166.
6. Yang X. 2021. Study on the coordinated development of regional economic, tourism and ecology coupling: Taking Henan Province as an example. Fresen Environ Bull. 30(1):210-215.
7. Ren XL, Zhao JJ, Qiang Y, Li YY. 2020. Research on coupling and coordinated development of urban tourism-economy-ecological environment based on network intelligence background. Fresen Environ Bull. 29(12A):11434-11440.
8. Li X. 2022. Feature analysis of the eco-efficiency of regional tourism industry based on carbon emissions measurement. J Environ Prot Ecol. 23(4):1524-1535.
9. Han ZW, Jiao S, Zhang X, Xie F, Ran J, Jin R, *et al*. 2021. Seeking sustainable development policies at the municipal level based on the triad of city, economy and environment: evidence from Hunan province, China. J Environ Manage. 290:112554.

10. Lai ZZ, Ge DM, Xia HB, Yue YL, Wang Z. 2020. Coupling coordination between environment, economy and tourism: A case study of China. PLOS ONE. 15(2):0228426.
11. Zhang FT, Sarker MNI, Lv Y. 2022. Coupling coordination of the regional economy, tourism industry, and the ecological environment: Evidence from Western China. Sustainability. 14(3):1654.
12. Zhang SY. 2022. The importance of applicability principle in plant combination is discussed - the effect of native plants with obvious applicability characteristics on environmental landscape. J CleanWAS. 6(2):51-53.
13. Zhang T, Li L. 2021. Research on temporal and spatial variations in the degree of coupling coordination of tourism-urbanization-ecological environment: a case study of Heilongjiang, China. Environ Dev Sustain. 23(6):8474-8491.
14. Liu HS, Fu S. 2022. Research on the coordinated development of ecotourism and economy: based on the ecological perspective. Fresen Environ Bull. 31(1):172-178.
15. Li LX, Yang Q, Sun CC, Xie XL, Zhang FT. 2021. Coupling coordinated evolution and forecast of tourism-urbanization-ecological environment: The case study of Chongqing, China. Math Probl Eng. 2021:7271637.
16. Yang YJ, Wu YX. 2021. Modeling and empirical analysis of regional tourism competitiveness based on niche theory. Discrete Dyn Nat Soc. 2021:8384964.
17. Niu Y, Zhou B. 2022. Research on the innovation of the integrated development model of rural revitalisation and ecotourism. J Environ Prot Ecol. 23(2):685-693.