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RESPONSE OF ECOSYSTEM AND ECO-ECONOMIC SYSTEM TO THE LAND USE STRUCTURE CHANGE IN TOURISM TYPICAL TOWN: A CASE STUDY IN YANYANG TOWN OF GUANGDONG PROVINCE, CHINA

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ABSTRACT

Purpose: The main purpose of this paper is to explore the relationship among rural tourism development, land use structure and ecosystem, and provide decision-making basis for the sustainable development of rural tourism destination.

Theoretical framework: Based on the theory of sustainable development, this paper explores the sustainable development of rural tourism destinations with the framework of the relationship among ecosystem, economy and society.

Design/Methodology/Approach: The research methodology used quantitative analysis. Taking Yanyang Town as the study area, based on the land use interpretation data from satellite remote sensing in 2004, 2014 and 2020, with the help of land use structure change index, ESV evaluation model and EEH index, the change characteristics of land use structure, and the response of ecosystem and eco-economic system in Yanyang Town were analyzed.

Findings: Rural tourism is more conducive to the coordination development of rural ecosystem and economy than traditional agricultural production. However, in the process of tourism development, it is very important to reduce the interference to land use, protect ecological land, maintain the continuity and complexity of land use, enhance the ESV of land use, and pay attention to the excavation of ecosystem value and cultural connotation.

Research, Practical & Social implications: It provides a basis for the optimizing land use structure, improving ecosystem service function, adjusting regional development model and coordinating economic development and ecological protection.

Originality/Value: This research explores the influence mechanism of land structure-ecology-economy system in rural tourism destinations, which enriches the research results of rural sustainable development.

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RESPOSTA DO ECOSSISTEMA URBANO TÍPICO DO TURISMO E DO SISTEMA ECONÔMICO ECOLÓGICO À MUDANÇA NA ESTRUTURA DE USO DA TERRA - TOMANDO YANGYAN, GUANGDONG, COMO EXEMPLO

RESUMO

Objetivo: Explorar a relação entre o desenvolvimento do turismo rural e a estrutura de uso da terra e os ecossistemas, e fornecer uma base para a tomada de decisões sobre o desenvolvimento sustentável dos destinos turísticos rurais.

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Referencial teórico: Com base na teoria do desenvolvimento sustentável, este artigo explora o desenvolvimento sustentável dos destinos turísticos rurais com base nas relações entre ecossistemas, economia e sociedade.
Desenho/metodologia/abordagem: Os métodos de pesquisa utilizam análise quantitativa. Tomando Yangyan como área de pesquisa, com base nos dados de interpretação de uso da terra de detecção remota por satélite de 2004, 2014 e 2020, usando o índice de mudança da estrutura de uso da terra, o modelo de avaliação ESV e o índice EEH, as características de mudança da estrutura de uso da terra na cidade de Yangyan, bem como a resposta do sistema ecológico e econômico.
Resultados: O turismo rural é mais benéfico do que a produção agrícola tradicional para o desenvolvimento harmonioso do ecossistema rural e da economia. No entanto, no processo de desenvolvimento turístico, é muito importante reduzir a interferência no uso da terra, proteger a terra ecológica, manter a continuidade e a complexidade do uso da terra, melhorar o ESV do uso da terra, prestar atenção ao valor do ecossistema e à conotação cultural da mineração.
Pesquisa, implicações práticas e sociais: Fornecer uma base para otimizar a estrutura de uso da terra, melhorar a função dos serviços do ecossistema, ajustar o modelo de desenvolvimento regional e coordenar o desenvolvimento econômico e a proteção ecológica.
Originalidade/valor: Este estudo explora o mecanismo de influência do sistema estrutural-ecológico-econômico da terra para o turismo rural e enriquece os resultados da pesquisa sobre o desenvolvimento rural sustentável.

Palavras-chave: Estrutura de uso da Terra, Valor dos Serviços do Ecossistema (ESV), Harmonia Ecológica e Econômica (EEH),Turismo Rural.

RESPUESTA DE LOS ECOSISTEMAS URBANOS TÍPICOS TURÍSTICOS Y LOS SISTEMAS ECOLÓGICOS Y ECONÓMICOS A LOS CAMBIOS EN LA ESTRUCTURA DE USO DE LA TIERRA: TOMANDO LA CIUDAD DE YANGYAN EN GUANGDONG COMO EJEMPLO

RESUMEN
Propósito: El objetivo principal de este documento es explorar la relación entre el desarrollo del turismo rural, la estructura del uso de la tierra y el ecosistema, y proporcionar una base para la toma de decisiones para el desarrollo sostenible del destino de turismo rural.
Marco teórico: Basado en la teoría del desarrollo sostenible, este artículo explora el desarrollo sostenible de destinos de turismo rural en el marco de la relación entre ecosistema, economía y sociedad.
Diseño/Metodología/Enfoque: La metodología de investigación utilizó análisis cuantitativo. Tomando la ciudad de Yanyang como área de estudio, con base en los datos de interpretación del uso de la tierra provenientes de sensores remotos satelitales en 2004, 2014 y 2020, con la ayuda del índice de cambio de estructura de uso de la tierra, el modelo de evaluación ESV y el índice EEH, las características de cambio de la estructura de uso de la tierra y se analizó la respuesta del ecosistema y el sistema ecoeconómico en la ciudad de Yanyang.
Hallazgos: El turismo rural favorece más el desarrollo coordinado del ecosistema y la economía rurales que la producción agrícola tradicional. Sin embargo, en el proceso de desarrollo turístico, es muy importante reducir la interferencia en el uso de la tierra, proteger la tierra ecológica, mantener la continuidad y complejidad del uso de la tierra, mejorar el ESV del uso de la tierra y prestar atención a la excavación del valor del ecosistema. y connotación cultural.
Implicaciones de investigación, Prácticas y Sociales: proporciona una base para optimizar la estructura del uso de la tierra, mejorar la función de los servicios ecosistémicos, ajustar el modelo de desarrollo regional y coordinar el desarrollo económico y la protección ecológica.
Originalidad/valor: Esta investigación explora el mecanismo de influencia de la estructura del suelo-ecología-sistema económico en destinos de turismo rural, lo que enriquece los resultados de la investigación sobre desarrollo rural sostenible.

Palabras clave: Estructura de uso de la Tierra, Valor de los Servicios del Ecosistema (ESV), Armonía Ecológica y Económica (EEH), Turismo Rural.

INTRODUCTION

Human's different economic activities show different ways of land use and form different land cover (Fu et al.,2022; Li et al.,2020). Therefore, it is an effective way to reveal

the degree of human activities by analyzing the temporal-spatial changes of land use structures (Wu et al., 2014; Ning et al., 2018; Yang et al., 2022). Development of rural tourism is also a process of land use and an important factor driving land use change (Gao & Cheng,2020; Hang et al.,2020; Li et al.,2020). While land is the carrier of ecosystem, and ecosystem is the guarantee of economy developmen. So change of land use structure will inevitably change the ecosystem and economy (Hasan et al.,2020; Schirpke et al.,2020; Ma &Wen, 2021).Correctly handling the relationship among economy development, land use structure change and ecosystem protection is very important for the sustainable development of rural tourism destinations (Liang et al.,2022; Liu et al., 2022; Huang et al.,2023).

Ecosystem service value (ESV) is an index to measure the ecosystem service function to human beings (Costanza et al.,1997,2014; Daily,1997; Pearce,1998; MEA,2005). Evaluating the ESV can quantify the ecological products and functions obtained by human beings from the ecosystem. At present, the commonly used pricing methods of ESV are mainly divided into four categories: actual market method, alternative market method, virtual market method and equivalent factor method. The first three methods involve a large number of parameters, and it is difficult to collect all the data needed, especially in rural areas. Also the thresholds or criteria of each parameter are no unification, so the comparability of calculation results is weak (Liu & Zhang, 2017; Wang et al., 2018). While the equivalent factor method evaluates the ESV based on regional LUCC data, which is easy to obtain and the results are easy to compare. In particular, the availability of high-precision remote sensing data at present improves the accuracy of the calculation results of equivalent factor method, and can dynamically monitor ESV (Xie et al., 2008,2015). Therefore, the equivalent factor method is now widely used in the value evaluation of various regional scales and various ecosystems (Xie et al., 2001,20003; Pan et al.,2021; Han et al., 2021, Liu et al.,2021). Ecosystem and Economy harmony(EEH) is an important indicator to measure the stable development of regional ecosystem and economy (Wu et al.,2007). EEH evaluation based on ESV can quantitatively reflect the coordination degree and the temporal-spatial dynamic changes characteristics of regional ecosystem and economy development.

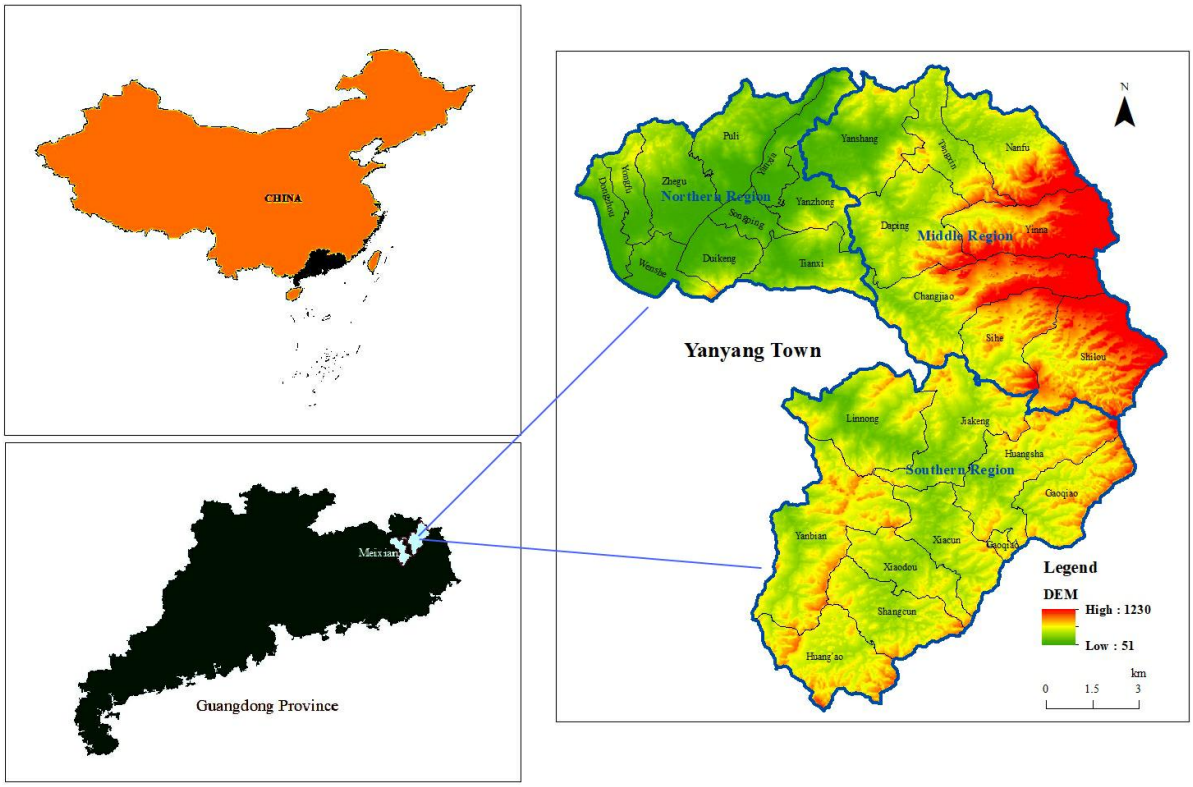
Under the background of global sustainable development, the evaluation of ecosystem and eco-economic system coordination based on the sustainable development theroy,is a hot spot of current academic circles and governments (Yang et al.,2021; Zhang et al.,2021). However, the existing related research mainly focuses on large regions(zhang et al.,2021; Wu et al.,2020; Li et al.,2022) or urban areas(Liu et al.,2021; Li et al.,2023; Yuan et al.,2023), there

is little research on villages, especially on rural tourism destinations.Li and Lei (2023) made an empirical analysis on the sustainability of land, ecosystem and land-eco-economic system in Yanhe village based on GDP, ESV and EEH. The results show that the ecosystem and economy of Yanhe Village changed significantly with the change of rural land use. The benign evolution of rural land use structure and the coordinated development of eco-economic system are the basis for the sustainable development of rural tourism destinations.So the purpose of this research is to explore the coordinated relationship between economy development and ecosystem protection under the development of rural tourism, and provide theoretical basis for optimizing land use structure, improving ecosystem service function, adjusting regional development model and coordinating economy development and ecosystem protection. The specific objectives of this research include:(a) Analyzing the temporal-spatial changes of land use structure in tourism town; (b) Exploring the response of local ecosystems and eco-economic systems to land use structure changes; (c)Forming the countermeasures for the sustainable development of rural tourist destinations.

METHERIAL AND METHODOLOGY

YanYang Town locates in the northeast area of Guangdong Province, China. Its area is 183km2 with 27 administrative villages. As a mountain town, mountains, hills, valleys and basins crisscross the town, and the terrain is high in the east and low in the west. Yinna Mountain Nature Reserve is in the east part of middle region, with Wuzhi Peak as the first peak in the County, and the ecosystem in the reserve is basically undisturbed by human activities, with dense forests. Considering the differences in topography and main economy, Yanyang Town can be divided into three regions. The northern region is the economic and administrative center of Yanyang Town because of its flat terrain and convenient transportation, with the most concentrated industry and population. The middle region, as mountain area with the highest terrain, rural tourism has developed rapidly because of the high-quality ecological environment and profound cultural resources. The southern region is a traditional agricultural production area with mountains and basins alternating(Figure1).

Figure 1: Location and regions of study area

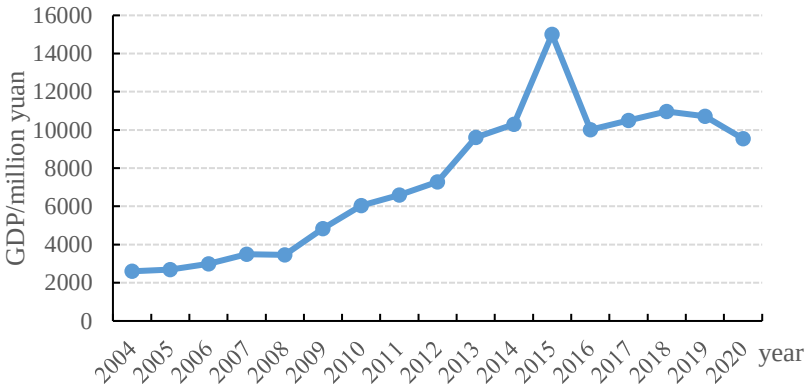


Source: Prepared by the authors (2023).

There are many high-quality tourism resources in Yanyang Town. For example, it is the hometown of Marshal Ye Jianying, the second international slow city in China, one of the old revolutionary areas in Meixian District and the representative area of Hakka culture. Yanyang Town began to develop rural tourism in the mid-1990s, and now it has developed into a tourism typical town with tourism as its pillar industry. Generally speaking, the development of rural tourism in YanYang Town has roughly experienced three stages, namely initial stage (1997-2004), high-speed development stage (2005-2013) and mature stage (2014-present). In the initial stage, the rural tourism form is mainly leisure tourism based on its own advantages in ecosystem with few tourism products, tourism development has minimal intervention on the earth surface. The strongest intervention occurred during the high-speed development stage, because the government has increased the investment in rural tourism, vigorously improved the construction of tourism supporting facilities, and lacked the awareness of ecological protection. However, when entered the mature development stage, Yangyan Town government positioned the development of rural tourism as eco-tourism, and the intervention weakened. There also formed four tourism development modes villages, namely, historical-cultural tourism village (such as Yanshang), eco-tourism village (such as Nanfu), agricultural-element tourism villages (such as Daping and Tangxin) and service-oriented tourism village around key scenic spots

(such as Changjiao and Yinna) (Wang, et al.,2023). Driven by tourism, the overall economy of Yanyang Town developed rapidly with an average annual growth rate of 11.56% from 2004 to 2019. The growth rate of GDP has shown a slowing trend since 2015， but the GDP of Yangyan Town still reach 9.54 billion yuan in 2020 even under the severe epidemic situation(Figure 2).

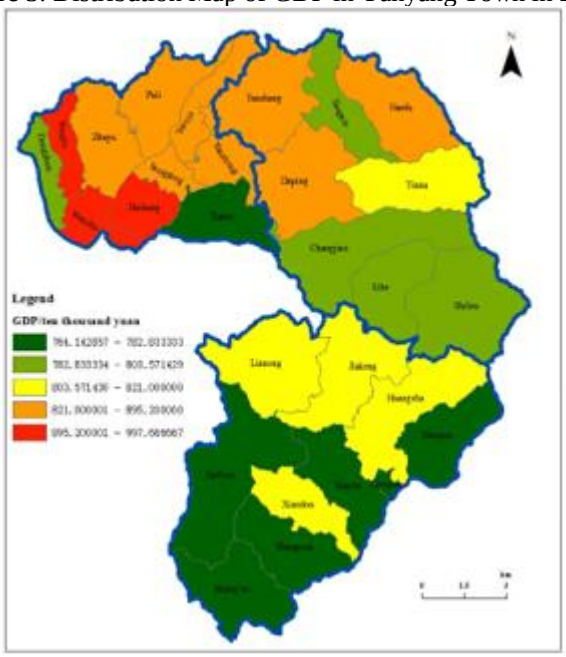
Figure 2: GDP Change Map of Yanyang Town from 2004 to 2020



Source: Prepared by the authors (2023).

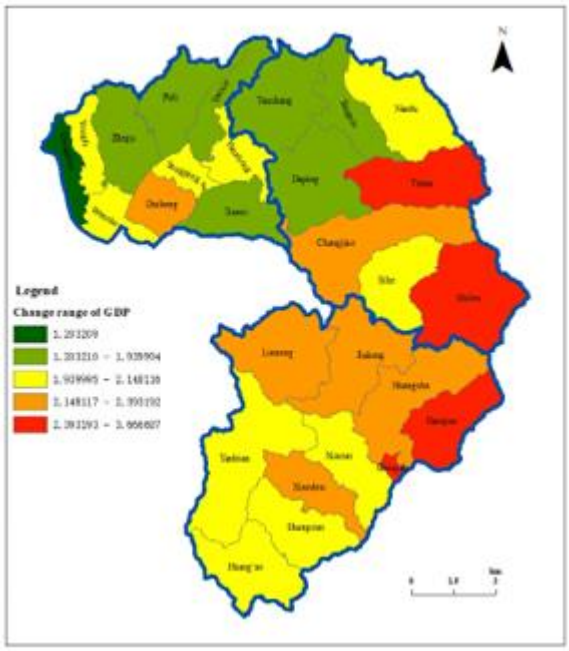
In order to explore the spatial differences of the economic development level in Yanyang Town, based on the GDP values of each village, the distribution map of the GDP (Figure 3) and the GDP change map (Figure 4) are drawn. Figure 3 shows that there are obvious regional differences in the economic development level in 2020. The northern region has the highest economic level. Followed by the middle region, typical tourism area. The southern agricultural area has the lowest economic level. However, Figure 4 shows that the change ranges of GDP in the middle and southern regions are significantly higher than that in the northern region from 2004 to 2020. The main reason is that middle and southern regions have promoted economic development by developing rural tourism and characteristic agriculture under the support of government policies and funds to revitalize the countryside (Agustina et al., 2023; Dewi & Ginting, 2022).

Figure 3: Distribution Map of GDP in Yanyang Town in 2020



Source: Prepared by the authors (2023).

Figure 4: Spatial Distribution Map of GDP change range in Yanyang Town (2004-2020)



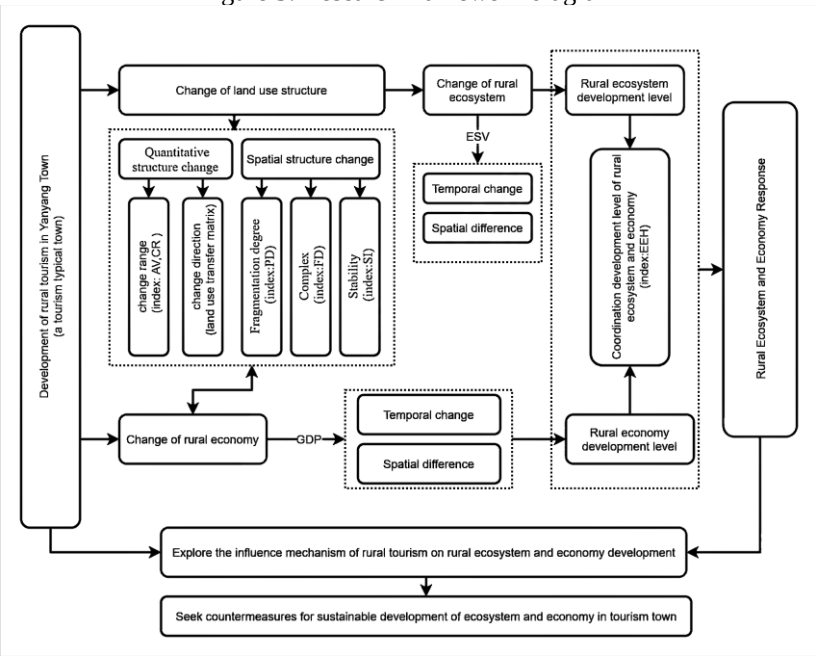
Source: Prepared by the authors (2023).

The data needed in this study mainly includes LUCC data, which is obtained by high-precision interpretation of remote sensing images, and spatial analysis technology of GIS software. In order to monitor the dynamic changes of land use structure in different stages of rural tourism development of Yangyan Town, 2004, 2014 and 2020 were selected as sample years, and the high-precision remote sensing data of these three years were collected. Such as

the World View-II image data of January 30th, 2020 and January 24th, 2014 are selected respectively from the source images of Google Earth, and the spatial resolution is 0.5m. The Landsat 7 ETM image of May 7, 2004 is selected from the Geo-Spatial Data Cloud (http://www.gscloud.cn/), and the spatial resolution is 15m. The above data are all projected by WGS84 coordinate system and UTM, and each image is geometrically corrected precisely to ensure the accurate correspondence of the coordinate positions of the objects with the same name. Remote sensing classification and interpretation is based on the classification of land use types. According to the National Standard for Land Use Classification（GB/T21010-2017）, the land use in YanYang Town was categorized into 7 types, known as the farmland, forestland, grassland, water land, construction land, shrub land and bare land (Wang, et al.,2023). Additionally, this study also involves some economic data, such as the GDP data of towns and villages. The multi-year GDP data of towns comes from Yanyang Town Government Work Report, while the GDP data of villages were obtained from the Resources and Environmental Science Data Center (https:‖www.resdc.cn/) .

This study first discussed the changing characteristics of rural land use structure under the economy development, then analyzes the response of rural ecosystem and eco-economic systems to the change of land use structure based on the combination of various methods. The specific technical route is shown in Figure 5.

Figure 5: Research framework diagram



Source: Prepared by the authors (2023).

Research methods of land use structure change: Land use structure is the proportion of land use types to the total land area of the region and their spatial combination, including land use quantitative structure and land use spatial structure. In this study, three indexes, namely the land use area variation, land use change range and the matrix of land use transfer, are selected to describe the land use quantitative structure change. Specific indicators are described as follows:

Table 1-Table of land use quantitative structure change index

Index	Index Notice	Computing Formula
Land use area variation (AV)	Represent the change value of the area, and the greater the value, the greater the change.	AV=$U_b - U_a$ (Formula 1)
Land use change range (CR)	Indicate the land use change change, the larger the value, the greater the change.(Yao et al., 2021)	$CR = \frac{U_b - U_a}{U_a} \times 100\%$ (Formula 2)
Land use transfer matrix (S_{ij})	Show the area transfer between land use types, which can reflect the transfer direction and mutual transformation process of each land use type. (Yao et al., 2021)	$S_{ij} = \begin{bmatrix} S_{11} & S_{12} & \cdots & S_{1n} \\ S_{21} & S_{22} & \cdots & S_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ S_{n1} & S_{n2} & \cdots & S_{nn} \end{bmatrix}$ (Formula 3)

Note: U_a and U_b indicate the areas at the beginning and the end of the study period respectively; S_{ij} indicate the area of one land type transfer to other land types during the study period; i and j are the land use types before and after the transfer respectively , and n is the number of land use types, in this study, n=7.

Source: Prepared by the authors (2023).

Fractal refers to the geometric form in which its components are similar to the whole in some way, or refers to a phenomenon in which there is no characteristic scale but there is self-similarity and self-affine (Xu, 2002). Fractal Theory was first put forward by Mandelbrot (1989), and it is the frontier and important branch of modern nonlinear science with irregular geometry as the research object. Because the land use system is highly dynamic, complex, relatively unstable and non-isolated (Li et al., 2007), it has a typical fractal structure in space (Li et al..2014). At present, Fractal Theory is widely used to study the spatial structure of land use, and focuses on the changes of land pattern caused by human land use spatial behavior and its explanation (Li et al.,2014; Wu & Liao, 2019; Wang, 2022). Based on Fractal Theory, this study mainly uses patch density, fractal dimension and stability index to study the dynamic change of land use spatial structure. Table 2 is the description and expression of each index.

Table 2-Land use spatial structure change index table

Index	Description	Computing Formula
Patch Density (PD_i)	It indicates the number of patches of a certain type in unit area, and reflects the fragmentation degree of the landscape of this type. The larger the value, the more fragmented it is （Wang, 2022）	$PD_i = \frac{N_i}{A_i}$ (Formula 4)
Fractal Dimension (FD_i)	It indicates the complexity of landscape patch shape. The larger the value, the greater the difference and the more irregular the patch shape, with the range of [1,2]. Generally speaking, when the FD value is 1, it means that its shape is round and its boundary is the most regular. When the FD value is 2, it means that the structure of this kind of patch is extremely complex and the boundary is the most irregular (Wu &Liao, 2019).	$\ln A_i = \frac{2}{FD_i} lnP_i + C$ (Formula 5)
Stability Index (SI_i)	It indicates the degree of stability of land use structure, and the value range is [0,0.5]. The larger the value, the more stable the spatial structure of the land type deviates from Brownian motion (Wu & Liao, 2019).	$SI_i = \lvert 1.5 - FD_i \rvert$ (Formula 6)

Note: PD_i, N_i, A_i, P_i stands for patch density, number, area and perimeter of land type i respectively; FD_i and SI_i stands for fractal dimension and stability index of land type i respectively.

Source: Prepared by the authors (2023).

Estimation mothod of ESV: Because it needs to study the spatial-temporal change characteristics of ESV under land structure changes in Yanyang Town, and the research data is specific to villages, which is difficult to obtain, the equivalent factor method is used to estimate ESV values in this study. The calculation formula (Costanza, 1997) is as follows:

$$\mathrm{ESV} = \sum(A_i \times VC_i) \quad \text{(Formula 7)}$$

Where ESV is the total value of the ecosystem service of the study area (Yuan); VC_i is the ESV of land use type k per unit area (Yuan /hm^2), different land types have different VC_i, the values of land types in Yanyang Twon refer to Wang et al.(2023); A_i is the area of each land use type (hm^2).

Calculation method of EEH: In this study, the eco-economic harmony index (EEH) is introduced to quantitatively evaluate the coordinated development level between ecosystem and economy. The calculation formula is as follows (Wu et al., 2007):

$$\mathrm{EEH} = \frac{(ESV_{r1} - ESV_{r0}) / ESV_{r0}}{(GDP_{r1} - GDP_{r0}) / GDP_{r0}} \quad \text{(Formula 8)}$$

Where EEH is eco-economic harmony index; ESV_{r0} *and* ESV_{r1} are the ESV per unit area at the beginning and end of the study period respectively (yuan /km^2); GDP_{r0} *and* GDP_{r1} are the GDP per unit area at the beginning and end of the study period respectively (yuan /km^2). According to the existing research results (Wu et al., 2007; Zhang et al., 2018; Yang &Wu, 2022; Tang &Yang, 2023), formulated the classification table of coordinated development level (see Table 3).

Table 3-Classification table of coordinated development level

EEH	*Representation* state (harmonious zone)		EEH	Representation state (conflict zone)
(∞～1]	High-level harmonious		(0～-0.5]	High-level conflict
(1～0.5]	Moderate-level harmonious		(-0.5～-1]	Moderate-level conflict
(0.5～0]	Low-level harmonious		(-1～-∞)	Low-level conflict

Source: Prepared by the authors (2023).

RESULTS AND DISCUSSION

Change characteristics of land use structure: The area of land use types in Yanyang Town in 2004, 2014 and 2020 are obtained by using GIS software, and the area change (AV) and change range (CR) of land use types are calculated according to formulas (1) and (2) (see Table 4). Then, based on the spatial analysis function of GIS and the data perspective function of Excel, the land use transfer matrixes of Yanyang Town from 2004 to 2014 and 2014 to 2020 are obtained (see Table 5 and Table 6).

Table 4-Area and quantitative change of land use types in Yanyang Town

year	Land type	Farmland	Forestland	Water land	Construction land	Shrub land	Grassland	Bare land
2004	Area/km^2	24.32	132.62	4.11	9.19	7.31	3.54	1.73
2014	Area/km^2	28.07	126.20	4.31	8.80	8.94	4.48	2.02
2020	Area/km^2	27.34	133.98	4.16	9.18	4.30	2.56	1.33
	Proportion/%	14.95	73.27	2.28	5.02	2.35	1.40	0.73
2004-2014	AV/ km^2	3.75	-6.42	0.20	-0.39	1.63	0.94	0.29
	CR/%	15.42	-4.84	4.87	-4.24	22.30	26.55	16.76
2014-2020	AV/ km^2	-0.73	7.78	-0.15	0.38	-4.64	-1.92	-0.69
	CR/%	-2.60	6.16	-3.48	4.32	-51.90	-42.86	-34.16
2004-2020	AV/ km^2	3.02	1.36	0.05	-0.01	-3.01	-0.98	-0.4
	CR/%	12.42	1.03	1.22	-0.11	-41.18	-27.68	-23.12

Source: Prepared by the authors (2023).

As can be seen from Table 4, as a mountainous town, forestland is the most important land type in Yanyang Town, accounting for 73.27% of the total area in 2020, and it is the base of Yanyang Town's ecosystem. The second land type is farmland, but it only accounts for 14.95% of the total area. The area of other land types is very small. As a tourism typical town,

economy development has constantly changed the land use structure. Table 4 shows that, except for the increase in farmland, forestland, and water land, all other land types decreased from 2004 to 2020. The area of forestland and farmland increased by 1.03% and 12.42% respectively. However, corresponding to the different stages of rural tourism development, the change of forestland and farmland area shows obvious stages, and the change trend is just the opposite. Specifically, during the rapid development stage of rural tourism, the forestland area decreased by 6.42km^2. It can be seen from Table 5 that, during this period, the main transfer direction of forestland was farmland (3.80%), followed by degradation into shrubs (1.39%) or occupation by construction land (1.03%). However, the forestland area increased by 7.78 km^2 in the mature development stage. Table 6 shows that 51.53% of shrub land and 11.85% of farmland area were converted into forestland. After area conversion, it is concluded that the transferred areas of them account for 43.83% and 28.29% of the total area of transferred forest land in 2020 respectively, so shrub land and farmland are the main sources of forestland area growth. The reason for the expansion of forestland area in the later period is that government and people of Yanyang Town realize that forest and superior ecosystem are the superior resources and core competitiveness of tourism development. Therefore, for the sustainable development of tourism, Yanyang Town government has adopted a series of policies to protect forestland, such as returning farmland to forests and closing hillsides to facilitate afforestation. The implementation of these policies has transformed a large number of shrubs and sloping farmland into forest land.

Table 5-Land use transfer matrix from 2004 to 2014 (%)

Land type in 2014	Land type in 2004						
	Farmland	Forestland	Water land	Construction land	Shrub land	Grassland	Bare land
Farmland	88.98	3.80	2.10	10.75	2.08	3.20	2.81
Forestland	4.92	92.59	3.29	12.36	6.76	5.87	12.91
Water land	0.65	0.19	90.29	1.07	0.33	1.34	1.09
Construction land	3.32	1.03	1.45	68.46	1.86	2.14	3.35
Shrub land	1.22	1.39	0.47	3.03	87.06	2.05	4.57
Grassland	0.49	0.64	0.86	2.01	1.03	84.69	12.93
Bare land	0.42	0.36	1.53	2.31	0.87	0.71	62.34

Source: Prepared by the authors (2023).

Table 6-Land use transfer matrix from 2014 to 2020 (%)

Land type in 2020	Land type in 2014						
	Farmland	Forestland	Water land	Construction land	Shrub land	Grassland	Bare land
Farmland	82.47	1.87	1.36	4.50	7.29	11.93	9.85
Forestland	11.85	96.81	3.03	8.47	57.64	41.81	26.24
Water land	0.24	0.04	90.75	0.37	0.12	0.91	2.47
Construction land	2.66	0.46	0.59	82.61	2.54	1.49	13.21
Shrub land	1.28	0.45	0.29	1.18	28.94	11.17	8.17
Grassland	1.00	0.23	2.40	1.58	2.26	31.54	7.13
Bare land	0.50	0.14	1.58	1.29	1.22	1.15	32.93

Source: Prepared by the authors (2023).

At present, the area of water and grassland with the high ecosystem value has shown a downward trend, while the construction land with low ecosystem value has shown an increasing trend. From 2014 to 2020, the water land decreased by 3.48%, the grassland area reached -42.86%, while the construction land increased by 4.38%. Based on the area conversion in Table 7, it is concluded that farmland and forestland are the main sources of new construction land, accounting for 39.03% and 30.34% respectively. while the transferred area from bare land and shrub land only accounts for 13.95% and 11.87%. It can be seen that the occupation of farmland and forestland by construction land in Yanyang Town is more prominent.

Based on the Fractal Theory, using the land use data and ArcGIS10.6 software, the parameters such as area, perimeter and patch number of each land use type in Yanyang Town were accurately obtained, and the patch density of each land type was obtained by using formula (4) (Table 7). Then the area-perimeter scatter plot was made, and the linear regression model was established for the scatter data, thus the relation between area and perimeter, and R^2 test value were fitted by using Excel software, with the natural logarithm of area as the y axis and the natural logarithm of perimeter as the x axis. The results are shown in Figure 6. Finally, the slope of this area-perimeter relation was equal to 2/FD, and the value of fractal dimension was obtained by formula (5), and the stability index was obtained by formula (6) (Table 7). Figure 6 shows that the fitting effect of regression fitting equations of all land use types in Yanyang Town was very good, and the R^2 were all above 0.92, which indicate that there is a significant linear correlation between the area and perimeter, and the fractal dimension is valuable.

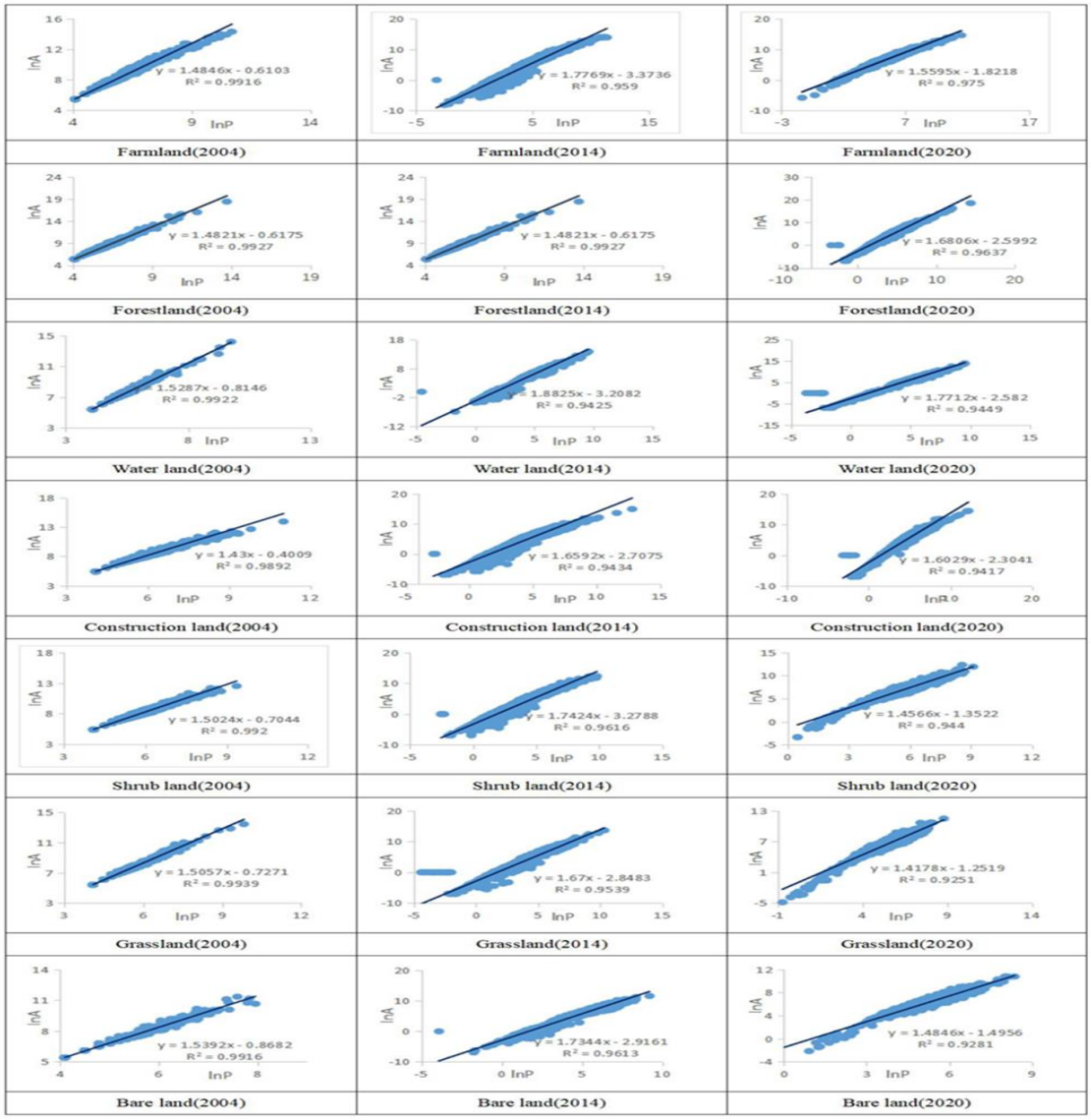
Table 7-Land use spatial structure index table of Yanyang Town in different years

Land type	Year	Number (N)	Perimeter/km (P)	Area/km^2 (A)	Patch density (PD)	Fractal dimension (FD)	Stability index (SI)
Farmland	2004	2169	1074.990	24.321	89.1822	1.3472	0.1528
	2014	3176	2071.456	28.066	113.1618	1.1256	0.3744
	2020	1700	1908.963	27.336	62.1891	1.2825	0.2175
Forestland	2004	2331	1693.620	132.716	17.5638	1.3494	0.1506
	2014	4948	3356.930	126.204	39.2064	1.1606	0.3394
	2020	2657	3134.981	133.984	19.8307	1.1901	0.3099
Water land	2004	836	178.920	4.157	201.1066	1.3083	0.1917
	2014	1181	268.044	4.314	273.7599	1.0624	0.4376
	2020	1367	250.370	4.164	328.2901	1.1292	0.3708
Constructi	2004	4319	824.850	9.192	469.8651	1.3986	0.1014
on land	2014	5272	1685.650	8.796	599.3633	1.2054	0.2946
	2020	4428	1555.983	9.180	482.3529	1.2477	0.2523
Shrub land	2004	2605	565.830	7.310	356.3611	1.3312	0.1688
	2014	3096	1224.420	8.936	346.4637	1.1478	0.3522
	2020	1288	642.680	4.300	299.5349	1.3731	0.1269
Grassland	2004	1570	255.180	3.537	443.8790	1.3283	0.1717
	2014	3384	627.528	4.476	756.0322	1.1976	0.3024
	2020	1911	586.316	2.564	745.3198	1.4106	0.0894
Bare land	2004	1205	170.280	1.728	697.3380	1.2994	0.2006
	2014	1881	396.772	2.021	930.7274	1.1531	0.3469
	2020	1221	288.402	1.331	917.3554	1.3472	0.1528
Total	2004	15035	4763.670	182.962	82.1755	1.3478	0.1522
	2020	14626	8367.694	182.859	79.9851	1.2346	0.2654

Source: Prepared by the authors (2023).

The patch density (PD) reflects the fragmentation degree of the landscape, the larger the value, the more fragmented it is. Table 7 shows that the PD of forestland was the smallest, followed by farmland, which indicate that forestland and farmland were distributed continuously in a large area. However, bare land, grassland and construction land have higher PD, showing that these land types were very fragmented in spatial distribution. As far as the change of PD was concerned, except for the PD of the water land gradually increasing and the shrub land gradually decreasing, all other land types increased first and then decreased, and the value in 2014 was the largest, reflecting that these land types had the largest fragmentation in 2014 and the strongest human impact. As far as the fractal dimension (FD) of each land type was concerned, the FD of land spatial structure in Yangyan Town is small, lower than 1.5, which indicates that the boundary shape of land patches is regular and the complexity is low. It could be seen that the land use types in Yanyang Town were greatly influenced by human factors, which were basically land use types with human participation. The stability index (SI) of each land type shows a trend of increasing first and then decreasing. The SI is the highest in 2014, all above 0.3.

Figure 6: Scatter diagrams of the area and perimeter of land types after taking logarithm in Yanyang Town in 2004 and 2020



Source: Prepared by the authors (2023).

These conclusions showed that, in the high-speed development stage of rural tourism, the massive investment of capital and human resources led to the strongest intervention of human activities on land. Specifically, the degree of land fragmentation increased, accompanied by smaller fractal dimension, more regular patch shape and more stable spatial structure. These will lead to the decrease of species diversity and ecosystem service function of ecosystem, and cause the degradation of rural ecosystem. However, entered a mature development stage, because of the emphasis on the connotative development of economy and the protection of ecosystem, the intervention of human activities on regional land was obviously weakened. It showed that the number of patches is reduced, the continuity of landscape is enhanced, with the increase of fractal dimension, the shape of patches becomes complex and the stability of spatial

structure is weakened. Which shows the enhancement of natural evolution characteristics of landscape and the benign development of ecosystem.

Response of the ecosystem in Yanyang Town: The change of ecosystem is mainly explained based on the ESV in this study. When the ESV increases, it means that the ecosystem is getting better, on the contrary, it is deteriorating. The change of land use structure will directly lead to the change of ESV because each land type has different VC_i. Based on the land use data, the ESV and its change range of those three years were obtained by using formula (7) (Table 8). Then the spatial distribution map of ESV and its change rang were drawn (Figure 7 and Figure 8)

Table 8 shows that the total ESV in Yanyang Town is 1327.96 and 1320.77 million yuan in 2004 and 2020 respectively, with a decrease of 0.54%. However, it shows a trend of decreasing first and then increasing, and the current ESV is in a growing trend. Among the 11 service functions of Yanyang Town's ecosystem during the 16 years from 2004 to 2020, only two functions, such as food production and nutrient cycling, had been enhanced, with an increase of 3.93% and 0.54% respectively, while other nine were all reduced, with the water supply decreasing mostly (-8.71%). The main reason was that the farmland area in Yanyang Town had increased mostly in the past 16 years, reaching 12.42%. Farmland ecosystem had the highest food supply function, second only to the nutrient circulation function of forestland and grassland, and the lowest water supply function.

Table 8-ESV Change in Yanyang Town (Million yuan) (2004-2020)

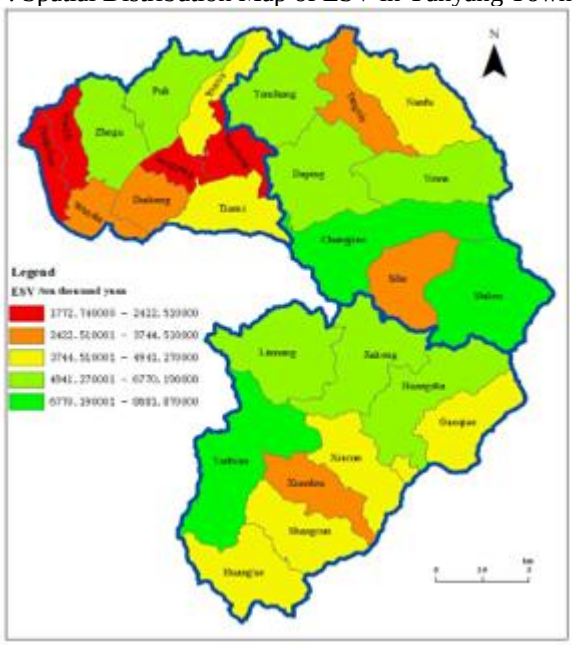
Service Functions	2004	2014	2020	Change range/% (2004-2020)
Food production	24.71	25.78	25.68	3.93
Raw material production	34.4	33.69	34.34	-0.17
Water supply	17.46	15.69	15.94	-8.71
Gas regulation	114.01	111.82	113.83	-0.16
Climate regulation	322.11	312.50	319.52	-0.80
Purify environment	102.94	100.43	102.09	-0.83
Hydrological regulation	389.77	389.87	389.06	-0.18
Soil retention	134.43	131.03	133.63	-0.60
Nutrient cycling	11.12	11.01	11.18	0.54
Biodiversity	122.17	118.78	121.12	-0.86
Aesthetic landscape	54.84	53.39	54.38	-0.84
TOTAL	***1327.96***	***1303.98***	***1320.77***	***-0.54***

Source: Prepared by the authors (2023).

Figure 7 showed that the spatial differences of ESV in Yanyang Town are obvious due to the terrain and land use structure differences. Such as, the proportion of green marked

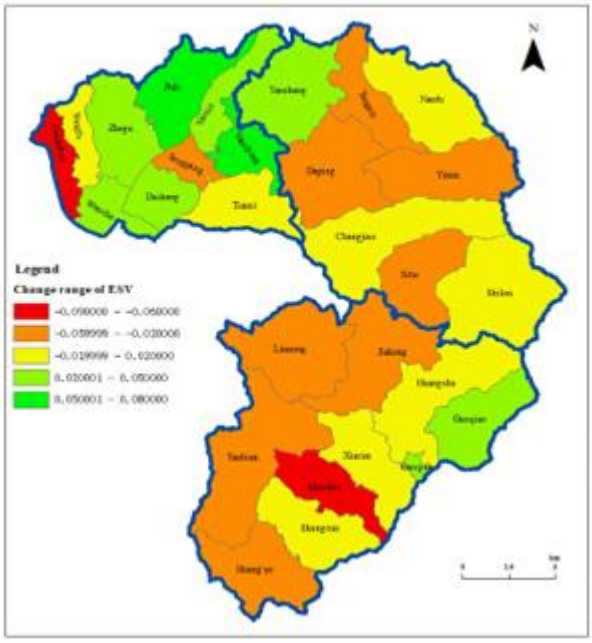
villages with ESV greater than 4,941.27001ten thousand yuan is 20%, 62.5% and 44.44% respectively in northern, middle and southern regions. Which indicates that the ecosystem quality in middle and southern mountainous regions is better than that in northern regions. As far as the change of ESV is concerned, Figure 8 shows that most villages in the middle and southern regions belong to the ESV decline area, while most villages in the northern region belong to the ESV growth area. The main reason was that the economic development in the middle and southern regions is faster than that in the northern region, and human intervention in land is relatively stronger, resulting in the degradation of ecosystem.

Figure 7: Spatial Distribution Map of ESV in Yanyang Town (2020)



Source: Prepared by the authors (2023).

Figure 8: Spatial Distribution Map of ESV Change Range in Yanyang Town (2004-2020)



Source: Prepared by the authors (2023).

Response of eco-economic system in Yanyang Town: Relying on the data of GDP, ESV and total land area of Yanyang Town in 2004, 2014 and 2020, the EEH in different stages of tourism development was calculated by using the formula (8), and the calculation results were shown in Table 9. And the EEH of 27 villages in Yanyang Town were obtained, then the distribution map of coordinated level in the study area was drawn based on the table 4, result showed in Figure 9.

Temporal variation characteristics of EEH: It could be seen from Table 9that the value of EEH in Yanyang Town has a trend of improvement, the coordinated state has upgrade from low-level conflict to low-level harmonious. It showed that the rapid economic development was accompanied by the degradation of ecosystem in the high-speed development stage of rural tourism. In the long run, it would inevitably hinder the sustainable development of the region. At present mature development stage, the EEH value raised to 0.318132, closing to 0, which showed that its eco-economic system was on the verge of low-level harmonious, the ecological risk is still sever.

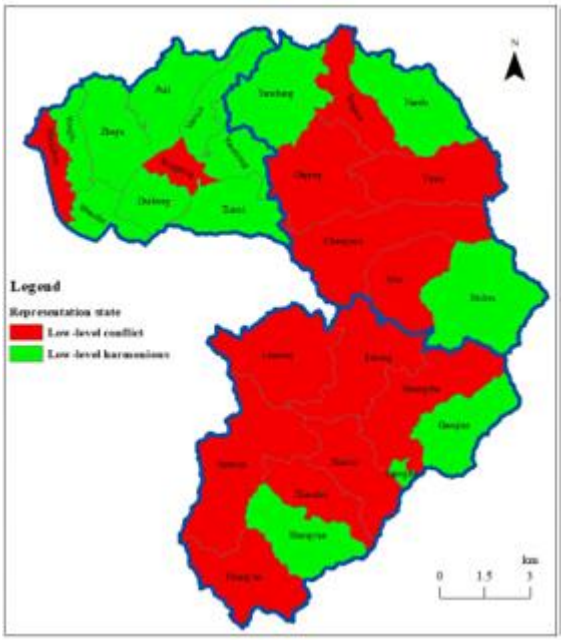
Table 9-EEH of Yanyang Town in different time periods

Year	EEH	Representation state
2004-2014	-0.0061	Low-level conflict
2014-2020	0.318132	Low-level harmonious

Source: Prepared by the authors (2023).

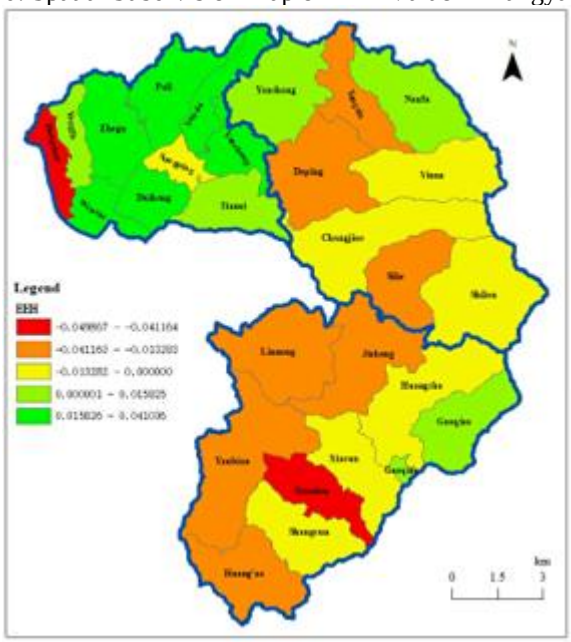
Figure 9 shows that the low-level conflict villages and low-level harmonious villages coexist at present in Yanyang Town. There were 14 villages in the low-level conflict zone, accounting for 51.85%, mainly distributed in the middle and south of the town, and most of them were are with rapid development of tourism or agriculture. And the northern region and a few villages in the southeast were low-level harmonious zone. In order to facilitate further horizontal comparison, this study classifies EEH values into five categories based on the natural discontinuity classification method of GIS, and the results are shown in figure10. Figure 10 shows that, in terms of the comparison of EEH values, the ecological risk in southern region is relatively higher than middle region. Then, specifically for tourism villages with different development models in the middle region, there are also significant differences in ecological risks due to the varying degrees of intervention on land use caused by tourism development activities. For example, both Yanshang Village, as a historical-cultural rural tourism destination, and Nanfu Village, as an eco-tourism destination, had the smallest ecological risk, Daping Village and Tangxin Village, both as agricultural-element rural tourism destinations, had the greatest ecological risk, while Changjiao Village and Yinna Village, as service-orient rural tourism destinations, the risk live in the middle. These conclusions showed that rural tourism development is more conducive to the harmonious development of regional ecosystem and economy compared to traditional agricultural production. In addition, as far as the development mode of rural tourism was concerned, the tourism development activities that focus on the connotative excavation of rural culture and ecosystem resources were more conducive to the sustainable development of rural areas.

Figure 9: Map of Coordinated Development Level of eco-economic system in Yanyang Town.



Source: Prepared by the authors (2023).

Figure 10: Spatial Subdivision Map of EEH Value in Yangyan Town.



Source: Prepared by the authors (2023).

CONCLUSION

This study analyzed the change characteristics of land use structure in Yanyang town, a tourism typical town, based on LUCC data. Then taking ESV and EEH as indicators, the response of ecosystem and eco-economic system were researched, aiming at exploring the relationship among economy, land use structure and ecosystem, so as to provide

countermeasures for the sustainable development of rural tourism destinations. The specific conclusions are as follows:

Firstly, research shows that the economic growth rate of the middle and southern regions in Yanyang Town exceeds that of the northern region due to the development of rural tourism. Which indicates that rural tourism can enrich the rural industrial structure, promote the development of characteristic agriculture and accelerate the development of rural economy. Rural tourism is an effective way to revitalize the countryside.

Secondly, corresponding to the high-speed development stage of rural tourism to the mature development stage, the change of forestland area shows a trend of first decreasing and then increasing, and the main transfer direction of forest land is always farmland. However, at the present stage, the areas of water land and grassland with higher ESV are on the decline, the construction land with the lowest ESV is on the rise, and the phenomenon that construction land occupies farmland and forestland is obvious. The spatial structure change of land use also shows obvious stages. In the high-speed development stage of rural tourism, because of strong human intervention, the fragmentation of land increases, the complexity decreases and the stability increases, which leads to the decrease of ecosystem diversity and the weakening of ecosystem service function. However, when rural tourism enters the mature development stage, the related index of land use spatial structure presents a completely opposite trend to the previous stage, and the ecosystem is continuously optimized, because the awareness of ecosystem protection is improved and the ecosystem protection countermeasures are implemented. This also proves the effectiveness of Fractal Theory in the analysis of land landscape pattern.

Thirdly, as a mountain town, forestland is the base of local ecosystem in Yanyang Town. The ecosystem quality in the middle and southern mountainous regions is higher than that in the northern region because of the wider forest area. However, as far as the changes of ESV are concerned, ESV of most villages in the middle and south regions is decreasing, while that of most villages in the northern region is increasing. The main reason is that the economic growth rate in the middle and southern regions is higher than that in the northern, and the intervention in the land structure is stronger. This indicate that the size of ESV depends on the land use structure, and the economic development controls the direction and speed of ESV change because of its influence on the land use structure.

Lastly, rural eco-economic system in Yanyang Town also showed different response characteristics in the level of coordinated development. The coordination level has changed

from low-level conflict to low-level harmonious, but the ecological risk was still severe. At present, as far as the spatial distribution of EEH is concerned, low-level conflict villages and low-level harmonious villages coexist, and low-level conflict villages are mainly distributed in the middle and southern regions, which shows that the rapid economic growth in the middle and southern regions is accompanied by the degradation of the ecosystem. The EEH of tourism villages is generally higher than that of agricultural villages. And the EEH is also different among tourism villages with different development modes. Such as the EEH value of historical-cultural rural tourism destination and eco-tourism destination is the largest, the agricultural-element rural tourism destination is the smallest, and the service-orient rural tourism destination is in the middle.

Above conclusions show that rural tourism can promote rural economy, and more conducive to the rural ecosystem than traditional agricultural production. However, as an economic activity, rural tourism also has an impact on the regional land use structure and ecosystem. So following points should be paid attention to in the process of tourism development. First of all, adhere to ecosystem priority, protect ecological land such as forestland, water, grassland and farmland, reduce human intervention in land, maintain the continuity and complexity of landscape, and make the ecosystem evolve benign. Strictly control the occupation of forestland and farmland by construction land, and meet the demand of construction land by developing bare land and shrubs. Secondly, returning to nature is the main driving force for the development of rural tourism. Excellent ecosystem and unique culture are two famous brands of Yanyang Town. It is very important to excavate rural culture, present rural ecosystem value, and shape tourism products with spiritual connotation. This not only can enhance the competitiveness, but also reduce the intervention in land, and facilitate the coordinated development of ecosystem and economy. Lastly, pay attention to the evaluation of the ESV and EEH degree of rural tourism destinations, which can play an ecological risk warning role and enhance the public's awareness of ecosystem value.

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