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STUDY ON THE TEMPORAL-SPATIAL VARIATION CHARACTERISTICS OF ECOSYSTEM SERVICE VALUE IN TOURISM TYPICAL TOWN AT YANYANG TOWN, GUANGDONG PROVINCE

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Abstract: The dynamic change of ESV can directly reflect the changes of regional ecosystem under the influence of human activities. In order to explore the nature and mechanism of the impact of rural tourism on rural ecosystem, based on the LUCC data and taking ESV as the evaluation index, the temporal-spatial change of the ecosystem in Yanyang Town, a tourism typical town, was evaluated. Conclusions as following: (1) The total ESV decreased by 7.19 million yuan in the past 16 years, but the ESV showed a trend of decreasing first and then increasing corresponding to different development stages of rural tourism. (2) As rural tourism's intervention on land, especially on forestland, is much lower than that of traditional agriculture, the ESV of most rural tourism villages shows an upward trend, which showed that most rural tourism activities have a positive impact on rural ecosystem. But rural tourism under different development modes also has different impacts because of the different dependence on ecosystem. Those conclusions show that rural tourism is an effective way to realize rural revitalization and sustainable development, but the exploitation of rural traditional culture and rural ecosystem value should be emphasized in the process of development.

Key words: Ecosystem Service Value (ESV), rural tourism, tourism typical town, Land Use and Land Cover Change (LUCC), Yanyang Town

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INTRODUCTION AND BACKGROUND OF THE STUDY

Ecosystem Service Value (ESV) is an index to measure the ecosystem service function, which reflects the contribution of ecosystem to human beings and the income of human beings from ecosystem (Costanza et al., 1997). The temporal-spatial change of ESV can directly reflect the specific change of regional ecosystem under the influence of human activities, which is an important basis for formulating regional sustainable economic development strategies (Ouyang et al., 1999a). There are many factors that affect the ESV, such as human awareness of the importance of ecosystem, scarcity of ecosystem services, dependence of economic and social development on ecosystem, climate change and many other factors (Li et al., 2022; Kang et al., 2023), while the Land Use and Land Cover Change (LUCC) play a decisive role in maintaining ecosystem services (Yao et al., 2009; Zhang et al., 2023). Different land use structures have different ecosystem effects, and the reduction of land use types (such as forests and waters) with high ESV Coefficient can lead a significant reduction of the total ESV of regional ecosystem (Wang and Dun, 2015). Tourism development activities will inevitably change the land use type of tourism destinations, which will lead to changes in ecosystem service functions (Li et al., 2020).

Evaluation of ESV is one of the effective methods for studying the impact of land use change. Since the Millennium Ecosystem Services Assessment (2005), there has been a worldwide upsurge in ESV research. However, existing researches are concentrated on large-scale areas, such as global (Daily, 1997; Costanza et al., 1997, 2014), regional (Xie et al., 2001, 2003; Ouyang et al., 1999b; Xu et al.,2023), and watershed scale (Cheng et al., 2017; Han et al., 2021; Zeng et al., 2022), lacking the research on rural scale (Li and Lin, 2023), especially little research on the influence of rural tourism on rural ecosystem (Ding et al., 2016; Xiong et al.,2020; Liu et al.,2021).

Additionally, several studies have discussed the positive significance of rural tourism pertaining to the social culture and ecological environment (Jiang and Chen, 2010; Wu et al., 2012; Chen et al., 2023). However, many research results show that the ecosystem of rural areas suitable for tourism development are well preserved and also fragile, which can

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be easily damaged with the entry of large amount capital investment and person under the tourism development (Chi and Cui, 2006; Deng, 2017; Zhang et al., 2019; Li et al., 2020). Thus it can be see that the impact of rural tourism activities on rural ecosystem is very complicated, and it is scientific value to discuss the nature (positive or negative) and the mechanism of the impact. Tourism typical town refers to a small town with superior tourism resources, providing tourism services and products, and leading by the tourism industry (Chen and Yuan, 2016), which is a typical area for tourism development. Yanyang Town, a tourism typical town, has developed rural tourism since 1990s. Based on the remote sensing satellite image data and LUCC data of Yanyang Town, supported by GIS spatial analysis technology, this study analyzed the temporal-spatial variation characteristics of ESV of Yanyang Town under different development stages and modes, in order to explore the mechanism of rural tourism activities affecting rural ecosystem. This research can not only increase research sample of small-scale ESV research, but also provide a scientific basis for the development of rural tourism and the formulation of land control strategies in tourism destinations.

STUDY AREA AND DATE RESOURCE

1. Study Area Overview

Yanyang Town is located in the northeast mountainous area of Guangdong Province of China. It covers an area of 183 km^2, governs 27 administrative villages, and with a population of 34,183 in 2020. The terrain is high in the east and low in the west (Figure 1). Meijiang River and Shiku River cross its west. it has a subtropical monsoon climate, mild and rainy. The forest coverage rate is as high as 78.1%, and the air quality has reached the national first-class standard all the year. Agriculture focuses on planting Shatian pomelo and tea. Under the background of vigorously developing rural tourism, there are few traditional agricultural villages characterized by single agricultural production, for example, Hang 'ao, Shangcun, Xiaodu and other villages, which are mainly concentrated in the south of the town. There are many high-quality scenic spots gathered in this little area, including one national 5A scenic spot, three national 4A scenic spots and one national 3A scenic spot (Table 1). Yanyang Town is also the core area of Meizhou Hakka Cultural Tourism Area. Expect for the typical Hakka residential buildings, the folk customs, language, diet, drama, spirit, clothing, history and other Hakka cultures in Yanyang Town are very typical.

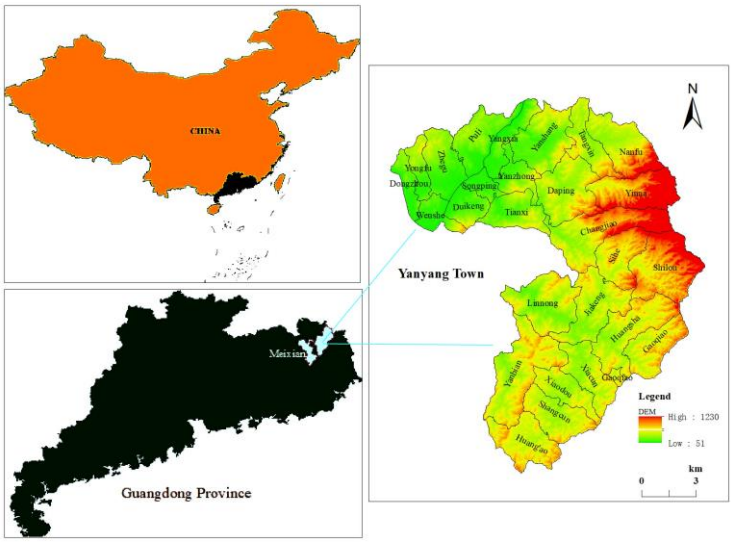

Figure 1. Location and administration map of Yanyang Town, China

Table 1. Advantageous scenic spots in Yanyang Town

Scenic spot grade	Scenic spot name
National 5A scenic spot	Yannanfei Tea Field Scenic Spot
National 4A scenic spot	Ye Jianying Memorial Park Yanming Lake Tourism Resort Lingguang Temple Scenic Spot
National 3A scenic spot	Wuzhifeng Tourism Resort

Based on good resource endowment, Yanyang Town began to develop tourism in the mid-1990s, and formed four tourism development modes as a result of difference in resources, namely, historical-cultural tourism village, eco-tourism village, agricultural - element tourism villagesand service-oriented tourism village around key scenic spots (Gan and Liu, 2017), their corresponding typical villages are shown in Table 2.

Table 2. Types and typical villages of rural tourism villages (Source: Authors)

Villages types	Tourist attraction	Typical villages
Historical-cultural tourism village	Rural cultural heritage with high historical and cultural value	Yanshang
Eco-tourism village	Original rural natural ecological environment	Nanfu
Agricultural-element tourism village	Theme characteristic agriculture	Daping, angxin
Service-oriented tourism villages	Around key scenic spot, special catering, accommodation and shopping	Changjiao, Yinna

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 of Yanyang Town was mainly agricultural-element tourism based on its own advantages in agricultural resources, with fewer tourism products. While at the beginning of 2005, Yanyang Town made the planning of Yanyang International Tourism Typical Town. The government increased the investment in rural tourism, and vigorously improved the construction of tourism supporting facilities. The number of tourists reached 3.37 million, and the total tourism revenue was 2.79 billion Yuan, accounting for 38% of the town's GDP in 2012. In this stage, the tourism was in a high-speed development, which caused certain pressure on the ecological environment. Then Yanyang government focused on building Yanyang Eco-Tourism Park, emphasizing the connotative development of rural tourism and the protection of rural ecosystem from 2013, the development of rural tourism entered the mature stage. Yanyang Town has becomed a tourism typical town and a tourism hotspot town in eastern Guangdong. The lower threshold of tourism significantly provides opportunities for employment and entrepreneurship. There were 2,576 people (about 18% of the

total employment) employed in tourism in Yanyang Town in 2020, which not only increased their economic income, but also enhanced their sense of identity in developing tourism and raised their awareness of ecosystem protection.

2. Date Sources and Data Pre-processing

The main data used in this study is the LUCC data. This study selected 2004, 2014 and 2020 as sample years according to the three development stages of tourism in Yanyang Town, and collects the remote sensing data of these three years. Because the study area is small, in order to ensure the accurate identification of ground objects and the monitoring of LUCC changes, the WorldView-II image data of January 30th, 2020 and January 24th, 2014 with better cloud cover (the data comes from the source images of Google Earth, including quickbird of Digital Globe Company) are selected respectively, and the spatial resolution after the fusion of multispectral and panchromatic bands is 0.5m.

In addition, the Landsat 7 ETM image of May 7, 2004 (the data comes from the http://www.gscloud.cn/ of the geo-spatial data cloud) is selected, and the spatial resolution after the fusion of multispectral and panchromatic bands 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. According to National Standard for Classification of Land Use Status (GB/T21010-2017) and considering the actual situation of land use in Yanyang Town, the land use can be categorized into seven types, known as the farmland, forestland, water land, construction land, shrub land, grassland, and bare land, then the land use classification system of Yanyang Town is established (Table 3). Based on multi-source remote sensing data and basic geospatial data, land use change monitoring in Yangyan Town was completed under the support of high-precision remote sensing image interpretation, GIS spatial analysis and spatial statistics technology.

STUDY METHOD

This study adopts a variety of technical methods and means, and the specific technical route is shown in Figure 2.

1. Analysis method of Land use dynamic change

The land use change was measured by the land use dynamic index, which refers to the quantitative change of land use types in a certain period of time in a research area (Gao et al., 2013). In this study, single land use dynamic index and comprehensive land use dynamic index were introduced. The meaning of each index and the specific calculation formula were as follows.

(1) Single land use dynamic index

$$K = \frac{(U_b - U_a)}{U_a} \times \frac{1}{T} \times 100\% \quad (1)$$

where K is the dynamic index of a certain land use type in the study period; U_a、U_b are respectively the number of a certain land use type at the beginning and end of the study; T is the research period, in this study, it is set as year (Bai, 2019).

(2) Comprehensive land use dynamic index

$$L_c = \left(\sum_{i=1}^{n} \Delta Lu_{i-j} / 2\sum_{i=1}^{n} Lu_i\right) \times \frac{1}{T} \times 100\% \quad (2)$$

where Lu_i is the area of the land use type i at the beginning; ΔLu_{i-j} is the absolute value of the area of land use type i transformed into other type during the study period; T is the time span of the study (year)； L_c is the comprehensive change rate of land use in the whole study area(Bai, 2019).

Table 3. Classification and definitions of land use types in Yanyang Town (Source: Based on the standard and actual situation, it be made by the author)

Land Use Type	Definition
Farmland	Paddy field, glebe field, and other agriculture lands
Forestland	Broad-leaved forest, and mixed forest
Water land	River, lakes, and pools
Construction land	Lands used for residential, industrial, commercial, and transportation
Shrub land	Fruit garden and tea garden
Grassland	Grass and meadows
Bare land	Bare rocks, riparian zones, and unused land

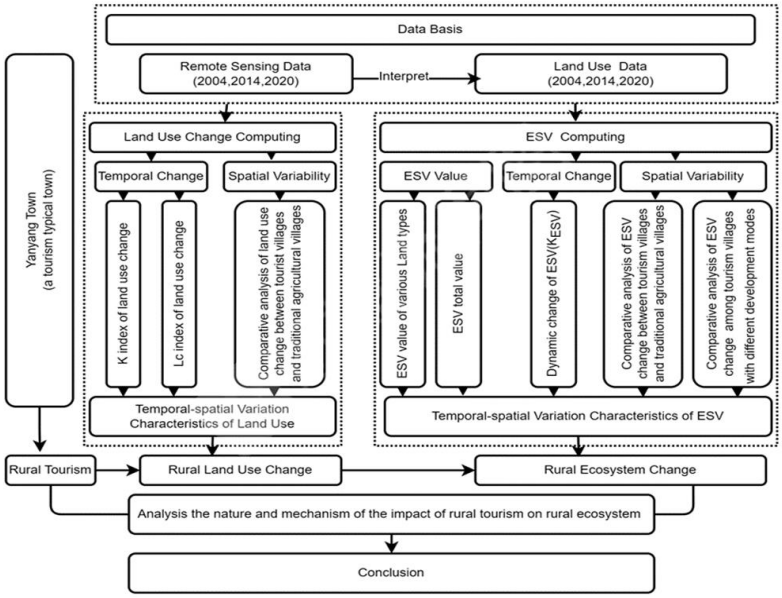

Figure 2. Technical Route of the Study (Source: author)

2 Evaluation Method of ESV

2.1. Evaluation Model

Because the research area of this study was small, the regional physical and geographical characteristics were relatively consistent, and the ecosystem attributes were basically consistent, so the equivalent valuation method could be used to calculate the regional ESV. According to the following formula (Costanaza, 1997), the ESV of main land use types could be calculated:

$$ESV = \sum(A_k \times VC_k) \quad (3)$$

where ESV is the total value of the ecosystem service of the study area (Yuan); VC_k is the ESV of land use type k per unit area (Yuan /hm^2); A_k is the area of each land use type (hm^2).

In order to study the variation differences and trends of regional ESV, this paper introduced the dynamic change of ESV(K_{ESV}) (Zhao et al., 2004), and the calculation formula was as follows:

$$K_{ESV} = \frac{ESV_b - ESV_a}{ESV_a} \times \frac{1}{T} \times 100\% \quad (4)$$

where ESV_a and ESV_b are ESV of a certain land type at the beginning and the end of the research respectively. T is the research period. If $K_{ESV} > 0$, the ESV showed an increasing trend; $K_{ESV} < 0$, the ESV showed a decreasing trend; K = 0, the ESV remained unchanged (Yan et al., 2014).

2.2. Adjustment of the value coefficient

To determinate the value coefficient (VC_k), this study adopted the value equivalent conversion method which was proposed by Xie Gaodi (2008) for China's terrestrial ecosystem. This method proposed that the value provided by the ecosystem was 1/7 of the value of natural grain production per unit area in the region, and the correction coefficient of Guangdong Province was 1.40. According to the statistical yearbook data of the prefecture-level cities where the study area was located, the annual average grain yield in Yanyang Town from 2004 to 2020 was 5753.989kg/hm^2, which was about 1.07 times that of Guangdong Province in the same period. Therefore, this study further revised the service value coefficient of farmland ecosystem in Yanyang Town to 2.07 times of the national level. At the same time, the average grain price in China from 2004 to 2020 was calculated at 2.03 yuan /kg, and the economic value of natural grain yield in Yanyang Town was 1,669.276 yuan/hm^2. Finally, according to the correction coefficient of Yanyan Town, and based on the ESV equivalent per unit area proposed by Xie Gaodi (2015), the VC_k of each land use type in Yanyan Town was calculated (table 4). According to Table 4, the ESV of construction land was not considered in this study, and its value was set to zero. Among the other six land use types, the forestland has the highest VC_k, followed by water land, grassland and shrub land. However, the VC_k value of farmland is small. It is precisely because of the different VC_k of different land types that the change of land types will inevitably lead to the change of regional ESV values.

Table 4. Table of ESV coefficient corresponding to each land type of Yanyang Town (yuan /hm^2) (Source: Authors)

First-class type	Second-class type	Farmland	Forestland	Shrub land	Class land	Water land	Bare land	Construction land
supply services	Food production	3835.50	1002.07	656.53	1313.05	2764.32	0	0
	Raw material production	846.57	2280.56	1485.82	1935.02	794.74	0	0
	Water supply	-4509.30	1174.84	760.19	1071.17	28645.27	0	0
Regulation services	Gas regulation	3075.31	7498.22	4872.12	6807.14	2660.66	69.11	0
	Climate regulation	1606.76	22460.11	14616.35	18002.64	7912.87	0	0
	Purify environment	466.48	6668.92	4422.91	5943.29	19177.48	345.54	0
	Hydrological regulation	5165.82	16378.60	11575.59	13199.63	353280.20	103.66	0
Support services	Soil retention	1796.81	9156.81	5943.29	8292.96	3213.52	69.11	0
	Nutrient cycling	535.59	691.08	449.20	621.97	241.88	0	0
	Biodiversity conservation	587.42	8327.52	5424.98	7532.77	8811.27	69.11	0
Culture services	Aesthetic landscape	259.16	3662.73	2384.23	3317.18	6530.71	34.55	0
Total		13666.11	79301.45	52591.20	68036.85	434032.92	691.08	0

RESULT ANALYSIS

1. Spatial Distribution Characteristics of Land Use Types

Under the technical support of RS and GIS, the land use status data of Yanyang Town in 2004, 2014 and 2020 were classified and counted, then the area and proportion of various land use types in each year were obtained (Table 5). By using the mapping function of ArcGIS10.6 software, the spatial distribution maps of land use types in Yanyang Town in 2004, 2014 and 2020 were obtained (Figure 3). Table 5 and figure 3 showed that: As a small mountain town, forestland always is the most important land use type, accounting for 72.52%, 69.04% and 73.27% of the total area in the three years respectively. Which is the foundation of the ecosystem in Yanyang Town, and it also is the main provider of the ESV in Yanyang Town. The second area is farmland, which distributed linearly in valleys. Other land use types are small and scattered.

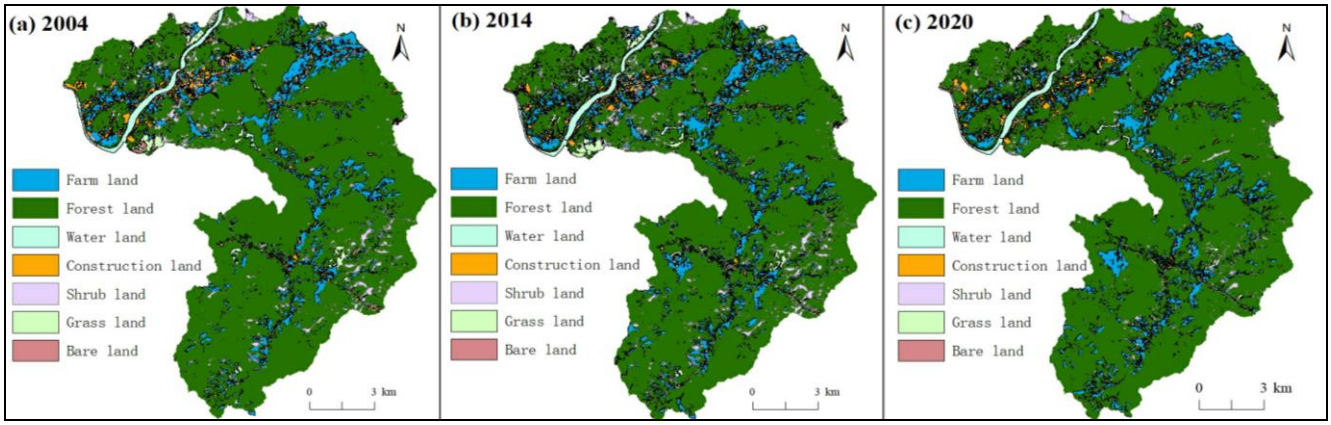

Figure 3. Spatial Distribution Map of Land Use Types in Yanyang Town from 2004 to 2020

2. Analysis of Land Use Change

2.1. Temporal variation characteristics of land use types

Based on the area data of land use types in the three years and related formulas (1) and (2), the area variation, single dynamic index (K) and comprehensive dynamic index (Lc) of land types in different periods were obtained, as shown in Table 6.

Table 5. Area and Proportion of Land Use Types in Yanyang Town in Different Periods (Source: Authors)

year	Land type	Farmland	Forestland	Water land	Construction land	Shrub land	Grassland	Bare land
2004	Area/km^2	24.32	132.62	4.16	9.19	7.31	3.54	1.73
	Proportion/%	13.30	72.52	2.27	5.03	4.00	1.93	0.95
2014	Area/km^2	28.07	126.20	4.31	8.80	8.94	4.48	2.02
	Proportion/%	15.35	69.04	2.36	4.81	4.89	2.45	1.11
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

Table 6. Table of dynamic changes of land use in Yanyang Town from 2004 to 2020 (Source: Authors)

Period	Land Type	Farm land	Forestland	Water land	Construction land	Shrub land	Grass land	Bare land	Lc
2004-2014	Area Variation/m^2	3744527	-6412283	156817	-395565	1625306	938094	292405	0.371
	K/%	1.540	-0.484	0.377	-0.430	2.223	2.652	1.692	
2014-2020	Area Variation /m^2	-729842	7779401	-149298	383533	-4635493	-1911280	-689994	0.742
	K/%	-0.433	1.028	-0.577	0.727	-8.648	-7.119	-5.692	
2004-2020	Area Variation /m^2	3014685	1367118	7518.67	-1032.6	-3010187	-973168	-397590	0.400
	K/%	2.066	0.172	0.030	-0.022	-6.864	-4.586	-3.835	

Table 6 shows that the overall land type change in Yangyan Town is the increase of farmland, forestland and water land, and the decrease of other land types during the 16 years from 2004 to 2020. However, in different periods of the development of rural tourism, the dynamic change trend of land types showed an obvious stage characteristic, such as all land types had increased except forestland and construction land decreased during the decade from 2004 to 2014. But the change trend of each land use type is just the opposite to that of the previous period from 2014 to 2020. As far as the area variation of land use types in each stage is concerned, the area change of forestland is the largest, followed by farmland, and farmland is the main direction of forestland transformation. From the perspective of the comprehensive dynamic index of land type (Lc) indicators, the Lc was 0.742% in 2014-2020, which was twice as much as that of 2004-2014. It indicated that the dynamic change intensity of land use types in Yanyang Town has been greatly intensified. The increase of land intervention intensity is consistent with the strengthening of various local economic activities. According to the government work report of Yanyang Town, the Gross National Product (GDP) of Yanyang Town increased from 2.69 billion yuan to 10.72 billion yuan, and the per capita annual income also increased from 4,860 yuan to 28,780 yuan in these 16 years.

2.2 Spatial difference of land type change

In order to observe the spatial difference of land type change, and analyze the difference of intervention intensity of traditional agriculture and rural tourism on rural land, this study selected six tourism villages and six traditional agricultural villages respectively, and calculated the Lc of each village in different periods. The results were shown in Figure 4. On this basis, the average value of Lc for the tourism villages, traditional agricultural villages and all villages in Yanyang Town in different periods were calculated and compared, and the results were shown in Figure 5. It could be seen from Figure 4 and Figure 5 that the Lc for six tourism villages in each period were lower than that of six traditional agricultural villages. As far as the average value of Lc was concerned, tourism villages were lower than the average level of all villages in each period, while traditional agricultural villages were higher. Additionally, based on the area data of forestland and farmland in each village from 2004 to 2020, it is calculated that the forestland area of six tourism villages has only decreased by 0.119% in the past 16 years, and the farmland has increased by 9.541%, while the forestland area of six agriculture villages has decreased by 4.998% and the farmland area has increased by 51.143%. All these showed that the interference intensity of tourism activities on land, especially the damage to forest land, is far less than that of traditional agricultural activities in Yangyan Town.

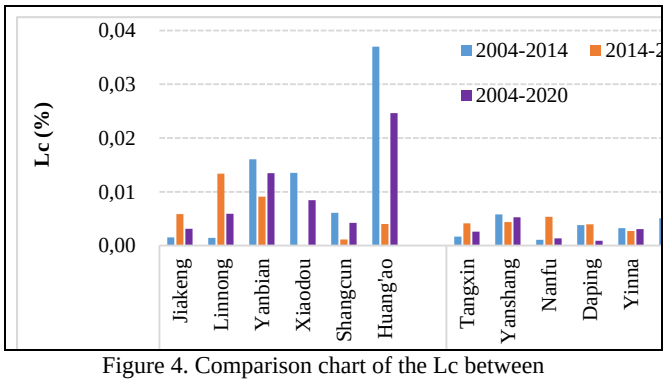

Figure 4. Comparison chart of the Lc between agricultural villages and tourism villages in different periods

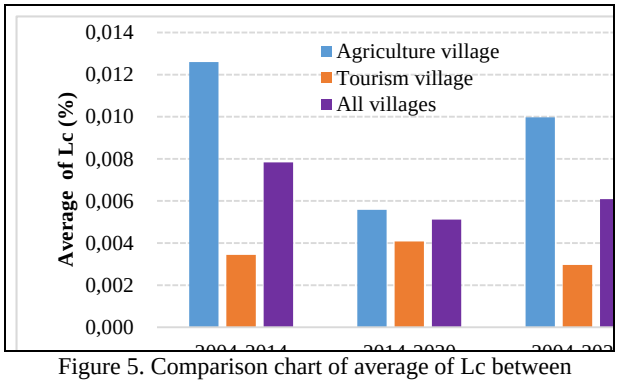

Figure 5. Comparison chart of average of Lc between agricultural villages and tourism villages in different periods

3. Dynamic changes of ESV

3.1. Temporal variation characteristics of ESV

The change of land use types, especially the change of forest lands, water areas, and grass lands with high VC_k, have greatly affect the ESV of Yanyang Town. According to the formula (3) and (4), the ESV and the dynamic change rate of ESV (K_{ESV}) of Yanyan Town in different years was calculated (Table 7).

It could be seen from Table 7 that the total ESV of Yanyang Town decreased by 7.19 million yuan in the 16 years, with a trend of first decreasing and then increasing. In terms of each land type, the ESV of forest land decreased significantly (50.85 million yuan), when the ESV of farmland, shrub land, grasslands and water land showed an increasing trend from 2004 to 2014. While from 2014 to 2020, the ESV of forest land showed an increasing trend, when other land types decreased to some extent. All those showed that the change trend of total ESV was consistent with that of forestland, forestland has the greatest influence on the change of total ESV in Yanyang Town.

Table 7. ESV and K_{ESV} of Different Land Use Types in Yanyang Town from 2004 to 2020 (Source: Authors)

Year	Item	Land Type						Total
		Farm land	Forest land	Shrub land	Class land	Water land	Bare land	
2004	ESV/million yuan	33.24	1051.67	38.45	24.07	180.42	0.12	1327.96
	Proportion/%	2.50	79.19	2.9	1.81	13.59	0.01	100
2014	ESV/million yuan	38.36	1000.82	46.99	30.45	187.23	0.14	1303.98
	Proportion/%	2.94	76.75	3.6	2.34	14.36	0.01	100
2020	ESV/million yuan	37.36	1062.51	22.61	17.45	180.75	0.09	1320.77
	Proportion/%	2.83	80.45	1.71	1.32	13.69	0.001	100
2004-2014	ESV Variation/million yuan	5.12	-50.85	8.55	6.38	6.81	0.02	-23.98
	K_{ESV} /%	1.54	-0.48	2.22	2.65	0.38	1.69	-0.18
2014-2020	ESV Variation/million yuan	-1.00	61.69	-24.38	-13.00	-6.48	-0.05	16.78
	K_{ESV} /%	-0.43	1.03	-8.65	-7.12	-0.58	-5.69	0.21
2004-2020	ESV Variation/million yuan	4.12	10.84	-15.83	-6.62	0.33	-0.03	-7.19
	K_{ESV} /%	0.77	0.06	-2.57	-1.72	0.01	-1.44	-0.03

3.2. Spatial Variation Characteristics of ESV

Based on the land use data of each village in Yanyang Town, the ESV and its variation of each village in 2004-2020 were calculated by using the calculation formula (4). Then, according to the changes of ESV, the villages were classified as follows, eco-preservation areas (ESV did not change), eco-increment areas (ESV increased) and eco-impairment areas (ESV decreased) (Figure 6).

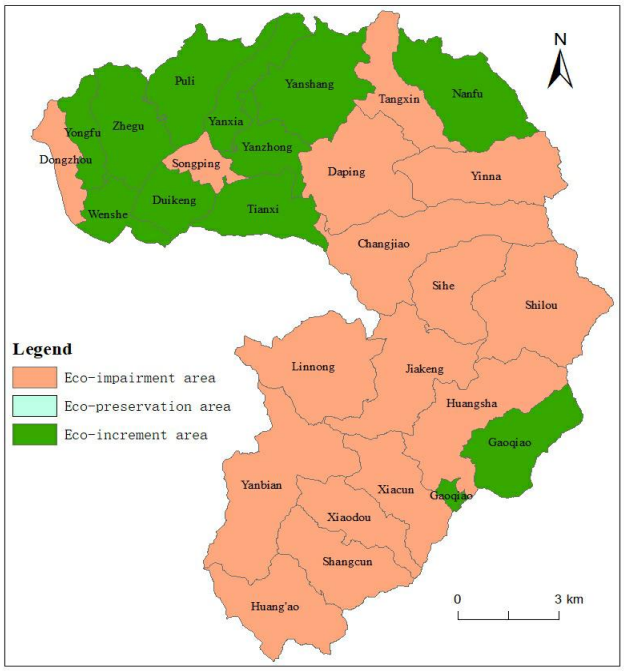

Figure 6. Spatial distribution map of ESV change in Yanyang Town from 2004 to 2020

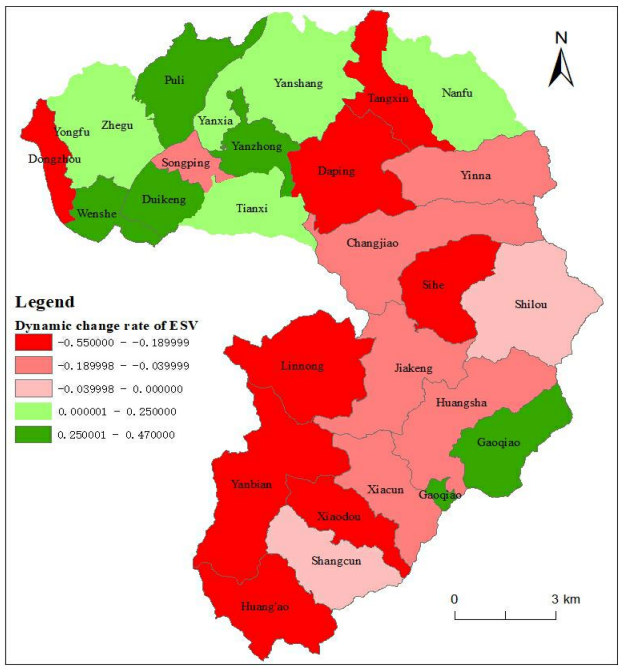

Figure 7. Spatial distribution map of K_{ESV} level in Yanyang Town

The Figure 6 showed that 16 villages were eco-impairment areas among the 27 villages in Yanyang Town, accounting for 67.2%, which also proved the conclusion that the total ESV of Yanyang Town had decreased. To further study the spatial distribution characteristics of the dynamic change rate of ESV from 2004 to 2020, the KESV was divided into five grades by using the natural breakpoint method of GIS based on the KESV value of each village (Wu

and Wan, 2020), and the spatial distribution map of the KESV was obtained (Figure 7). The figure 7 showed that there were obvious differences, such as the ESV of tourism villages located in the northwest tends to increase, while that of traditional agricultural villages in the southeast tends to decrease. In order to analyse the mechanism of the spatial difference of ESV, this paper made a comparative study on the changes of ESV between tourism villages and traditional agricultural villages, as well as among tourism villages with different development models. The research is as follows:

3.2.1. Comparative analysis of tourism villages and agriculture villages

To study the impact of different production modes on rural ecosystem, based on the average K_{ESV} of six traditional agricultural villages, six tourism villages and all villages in Yanyang Town in the 16 years from 2004 to 2020, Figure 8 was drawn. This figure showed that the average K_{ESV} of all villages decreased first and then increased. The dynamic change trend of ESV in tourism villages was consistent with that of Yanyang Town, but the traditional agricultural villages kept a decreasing trend all the time. Generally speaking, although rural tourism has different impacts on rural ecosystem at different stages of development, the negative impact of tourism activities on the ecosystem is far lower than that of agriculture. In addition, rural tourism at this stage has a positive impact on the ecosystem in Yang Yan town.

3.2.2. Comparative analysis of tourism villages with different development modes

To further analyze the impact of different tourism development modes on rural ecosystem, Figure 9 was drawn based on the K_{ESV} and its average of six tourism villages from 2004 to 2020. Figure 9 showed that the average K_{ESV} of six rural tourism villages was -0.07% during the 16 years. The ESV of the historical-culture tourism village (such as Yanshang) and eco-tourism village (such as Nanfu) showed a positive growth, with K_{ESV} of 0.18% and 0.07% respectively.

However, the ESV of agricultural-element tourism villages (such as Daping and Tangxin) showed a large negative growth, with K_{ESV} of -0.28% and-0.19% respectively. The ESV of service-oriented tourism villages around key scenic spots (such as Changjiao and Yinna) also showed a negative growth, but the rate was obviously lower than that of agricultural-element tourism villages. Generally speaking, rural tourism activities with different development models had different impacts on rural ecosystem. The main reason is that the rural tourism villages in different development modes depend on the ecosystem differently.

Historical-cultural tourism villages and eco-tourism villages are the most dependent on the ecological environment, and their core competitiveness lies in their profound traditional culture and excellent ecological environment, so they pay special attention to the protection and construction of forest. The data show that the forest areas of Yanshang Village and Nanfu Village have increased by 9.994% and 4.656% respectively in the past 16 years, which are the two fastest growing villages among the six tourism villages, and the increase of forest area has improved ESV.

However, agricultural-element tourism villages need to develop characteristic agriculture and scale agriculture, the area of farmland is constantly expanding. For example, in Daping Village, the farmland has increased by 25.785% and the forestland has decreased by 6.483% in 16 years, large number of forestland have been reclaimed into farmland, resulting the ESV rapid declined. Service-oriented tourism villages not only need corresponding basic service facilities for scenic spots, such as transportation, parking lots, shops, hotels, etc., but also need their own tourism attractions, such as beautiful environment. Therefore, although the forest area and the ESV of such villages have decreased, the decline is obviously smaller than that of agricultural-element tourism villages.

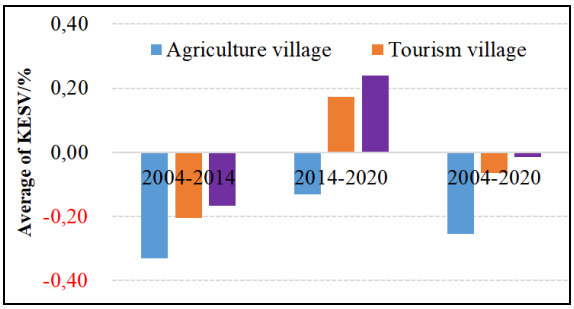

Figure 8. Comparison chart of average K_{ESV} among different type villages (Source: Authors)

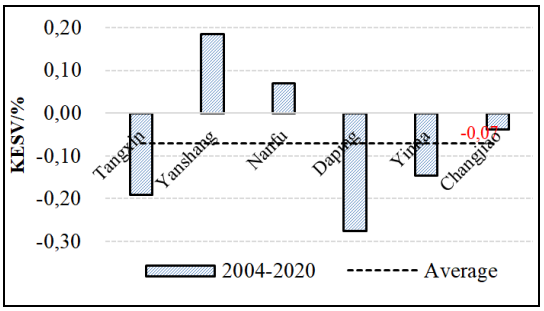

Figure 9. Comparison chart of K_{ESV} among tourism villages under different development modes

CONCLUSIONS

In order to explore the nature and intensity of the impact of rural tourism activities on rural ecosystem, the temporal and spatial variation characteristics of ESV in Yanyang Town were analyzed based on the LUCC data. The results showed as follows:

(1) Being a mountain town, forestland is the most important land use type in Yanyang Town, and it is the foundation of Yanyang Town's ecosystem and the main supplier of ESV. The change of forestland will determine the changing trend of Yanyang Town's ecosystem. As far as the dynamic change of ESV in Yanyang Town was concerned, the total ESV decreased by 7.19 million yuan in the 16 years, but it showed a trend of decreasing first and then increasing in time, which is consistent with the change trend of forestland area in the corresponding period. Those results show that the primary problem for the sustainable development of the ecosystem in Yanyang Town is to protect the forest.

(2) From the comparative study on the changes of land use types between rural tourism villages and traditional agricultural villages in Yanyang Town, it can be seen that the impact intensity of rural tourism activities on land, especially on forestland, is

much less than that of agricultural activities. Additionally, because the mature rural tourism development activities can realize the ecosystem value with less intervention on the land, thus increasing the rural income and enhancing the environmental awareness of residents and the government, which has positive impact on rural ecosystem. Therefore, rural tourism is an effective development path for rural revitalization and sustainable development if there are conditions for tourism development.

(3) According to the data comparison of K_{ESV} among tourism villages, it can be seen that the nature of the impact of tourism activities under different development modes on the ecosystem is also different because of the different dependence on the ecosystem. The historical-culture tourism village and eco-tourism village showed a positive effect, However, both agricultural-element tourism villages and service-oriented tourism villages showed negative effect. This result shows that, in order to achieve sustainable development of rural tourism, the tourism value of rural traditional culture and rural ecosystem must be deeply explored, land intervention should be reduced, and more attention should be paid to the protection of local ecosystem.

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