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Research Article

Study on changes in tourism land and influence factors in mountain areas: A case study of Luanchuan country, China

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Abstract

The rapid development of the tourism industry in mountainous areas has resulted in intense changes in land use structure and has exerted a strong influence on terrestrial ecosystems. This paper takes Luanchuan County (with typical mountainous terrain in western Henan Province, China) as an example and employs land use data from different times and areas and the binary logistic method to study the spatial variation in tourism land and influencing factors in mountainous areas. The research shows that (1) the spatial variation in land use in scenic spots reveals a chain reaction of land use type transformation caused by construction land expansion, a key driving force of spatial variation in land use and land use type transformation, and (2) the changes in tourism land use types result from human utilization and development of land for economic benefits. The key influencing factors of the spatial variation in land use are elevation, gradient, and the distances to rivers, highways and villages. (3) A plan for tourism land management and control should be established with construction land as the key indicator.

Introduction

As an important component of terrestrial ecosystems, mountainous areas play an important role in regional ecological safety, and their rich natural resources are crucial to the development of society and the economy [1]. A wide range of mountains in China cover 46.11% of China's land area, and mountains constitute the most important ecosystem in China [2]. Therefore, the exploitation and ecological construction of mountain resources are at the top of the list for sustainable development in China [3]. The development of mountain tourism has led to continuous encroachment on the effective habitats of species in nature reserves [4-7], and the fragmentation of habitat patches constitutes the greatest threat to mountain biodiversity [8-10]. In China, more than 22% of the natural reserve area has been ruined due to unscientific tourism development, and 11% has shown resource degradation [11,12]. Land is the basis for tourism development, and exploiting tourism resources and constructing tourism infrastructure can change the surface structure, land, soil and vegetation; thus, the core change is in land use. Therefore, research on the spatial changes and influencing factors of tourism land in mountainous areas constitutes an important part of the research on the environmental impact of mountain tourism.

In researching the spatial variation in tourism land and the driving factors, scholars in China have employed geographic information system (GIS) and remote sensing (RS) technologies to interpret and compare two or more RS images to assess the changing trends of mountain tourism land variation. It is commonly agreed that with the development of the tourism industry, land use has undergone an increase in scenic spots, transportation and infrastructure and a decrease in farmland and ecosystems. Natural environmental experiences tend to cause changes. However, in different areas, the features and trends of changes in tourism land vary [13-18]. In terms of influencing factors, it is generally believed that

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the factors leading to changes in tourist land in mountainous areas are diverse, mainly including the increase in the area of transportation facilities and tourist facilities caused by the development of tourism [13-14, 19]. In addition to tourism, other factors, such as government decisions [20], demographic changes [21], natural factors, rapid urbanization [14], the coercive effect of residents on forest parks [22], feedback from weakening agricultural development, feedback from weakening industrial development [19], farmers abandoning agriculture for business, the increase in urban and village areas and industrial and mining land [15], the pioneering farmers in rural tourism have played a leading role in the evolution of land use [23].

In addition, some scholars believe that the large-scale construction of high-speed rail [24, 25] and the development of rural revitalization and rural tourism [26], may also lead to changes in land use related to mountain tourism. The change in tourism land results from both internal and external factors, as it is based on and driven by the internal driving factors of the tourism industry, with external driving factors as supporting forces [27-29].

Research on tourist land in mountainous areas in foreign countries predates that in China, and some results have been achieved. For instance, scholars have used multi-temporal terrestrial satellite images [27-30]. Spatial analysis [34-35], patch analysis [36] and other methods have been used to analyse the land use changes and influencing factors in the case of tourism areas. It is believed that in addition to the rapid development of tourism, global climate change and regional policies have also made certain contributions to changes in land use types and changes, including habitat loss and landscape fragmentation. The ecological perspective is also one of the methods commonly used by scholars to study mountain tourism land [37,38]. Some scholars have also studied disaster science. For example, Jaydip's research on Uttarakhand in India found that with the development of mountain tourism, land use is expanding from gentle slopes to steep slopes, and construction on steep slopes may easily cause natural disasters such as landslides [33]. In^es Boavida-Portugal and other scholars constructed different scene comparisons to compare the impact of tourism development on built-up areas [39]. Beautiful landscapes are the material basis for the development of rural tourism, and some scholars emphasize that the development and management of mountain tourism should pay attention to the analysis of the suitability of land use [40].

This research is inspired by the above work, but problems still exist. First, the existing documents are mainly analyses of specific scenic spots, and research on multiple scenic spots in a certain area is relatively lacking. The analysis of a single scenic spot reflects only the land use change in that individual scenic spot, while the study of multiple scenic spots in a region reflects the characteristics of the entire region. Second, for the analysis of influencing factors, model quantitative analysis is insufficient. Most previous studies focused on simple quantitative descriptions. Third, from the perspective of research, most of the previous studies have focused on the impact of human activities on land use, and little research has been done from physical and geographic perspectives, such as mountain height, direction, and slope. This paper's object is Luanchuan County in central China, which features a small population, rapid tourism development, a large share of the tourism industry and many scenic spots. This study employs methods such as land use data analysis, field microeconomic surveys, and logistic regression analysis to study tourism land spatial variation in mountainous areas and the influencing factors to enrich the related literature.

The studied areas, data sources, and methods of research

The studied areas: Luanchuan County lies in the southwest part of Henan Province with geographic coordinates 111°11′~112°01′E, 33°39′~34°11′N and is bordered by the Funiu Mountains on the southwestern corner of Luoyang city. Luanchuan County covers a total area of approximately 2478 km^2 and contains 14 townships and 209 administrative villages with a total population of approximately 350,000 according to Luoyang City Statistics Bureau [41]. Luanchuan County is 150 km from Luoyang city and 300 km from the capital of Henan Province, Zhengzhou city; provincial and national highways intersect in Luanchuan County, making transportation easy. It is a classic mountainous area with mountains of varying height. The highest elevation is 2212.5 m, and the lowest elevation is 450 m, with an elevation difference of 1762.5 m, creating a typical undulating mountain topography. It is the highest county in Henan Province, and its urban area is 750 m above sea level. Luanchuan County has many rich and high-ranking tourism resources. There are 8 main classes, 26 subclasses and 84 primary classes of sightseeing resources, constituting 54.2% of the national tourism resources. Luanchuan County boasts two 5A scenic spots, five 4A scenic spots, and thirteen A-level sightseeing zones. The tourism industry is the key industry in Luanchuan County.

Data sources and processing

Data on land use and variation were collected from the first and second land use status surveys by the local government in 1991 and 2010, respectively. Data on land use in 2018 were collected by the author on the basis of a Google satellite field investigation. First, 0.6 m high-resolution satellite map tile data were downloaded from Map Down and used to form a satellite map of Luanchuan County. Then, land use data from 2001 were collected by remote sensing image data in the study area, land use data from 2018 were collected by Erdas, and land use distribution data were collected by field investigation for comparison.

The effect factors of land use changes are based on the authors' analysis of the sampling point map. In view of the centrality of land use conversion, this paper focuses on four types of conversion, namely, woodland to farmland, woodland to construction land, woodland to water areas, and farmland to construction land; these four types of conversion constitute 81.25% of the land area. This paper employs balanced stratified sampling to choose sampling points and employs

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more than 2000 sampling points to ensure that the research is representative. After the sampling points were chosen, type maps of land use changes overlapped with distribution maps of topography, slope direction, villages and rivers, and the attributes of the sampling points were read manually.

Methods of research

Plane divergence rate: The plane divergence rate, usually studied in association with the land use expansion rate (dynamic degree), refers to the expansion speed of different types of land in different research periods in the same area [42].

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

As indicated in Formula 1, K represents the land use divergence rate in the research period; U_b and U_a refer to the portions of tourism land at the beginning and end of the research period, respectively; and T is the length of the research. When T is set to one year, K is the annual rate of land use variation in Luanchuan County.

Logistic regression analysis

This paper analyses geographic spatial factors that affect tourism land by multiple logistic regression. Assuming that X is a response variable and P is the response probability of the model, then the regression model can be given as follows:

$$\ln\left[\frac{P_1}{1-P_1}\right] = \alpha + \sum_{t-1}^{k} \beta_k x_{kt} \quad (2)$$

In Formula 2, $P_1=P(y_i=x_{1i}, x_{2i}, \ldots, x_{ki})$ is the occurrence rate of the event in the given series of independent variables x_{1i}, x_{2i}, ..., x_{ki}, with β as the slope and α as the intercept. For the actual calculation, the logistic function in SPSS 16.0 statistical software is recommended.

Classification of tourist land types

In view of the lack of a complete classification system for domestic tourism land, for the convenience of research, this article adheres to the principles of combining the natural attributes and use attributes of the land and combining the universality and uniqueness, referring to Su Kun, Zhou Yong [43], Wang Jinye [44], Lu Weimin, Liu Yang [45], Peng Hui, Bi Yuzhu [46], Yu Zhongyuan and Li Bo [47], etc. This article combines the universality and uniqueness of tourism land and defines and classifies the concept from the development characteristics of mountain tourism and the structural types of mountain tourism land. Tourism land is set as a first-class category, and it includes 5 second categories (tourism construction land, tourist agricultural land, tourist woodland, tourist water body land, and tourist unused land), 8 three-class categories (land for scenery viewing and recreation, tourist facilities and engineering facilities, land for tourism and commercial service facilities, land for management services, residential and social comprehensive land, agricultural land, water body land, and unused land), 16 four-level categories (land for natural landscape viewing, landscape green space, cultural landscape viewing land, tourist facility land, engineering facilities land, tourism shopping land, tourism catering land, tourism accommodation land, tourism and entertainment land, management service land, residential area, integrated service land, cultivated land, garden land, water body land, and unused land).

Tourism land spatial variation

Over the past 28 years (1991-2018), both the number of scenic spots and the area of tourism land have increased remarkably. The number of scenic spots increased from 1 to 13, and the area of tourism land grew from 2.11 km² to 159.69 km², a 74.7-fold increase. With the expansion of the scale of tourism land use, the spatial structure of tourism land experienced great changes.

Significant tourism land expansion in scenic spots

Tourism resource development and scenic spot construction include the construction and operation of various infrastructure and production facilities, namely, the spatial expansion of construction land. In the early stage of the development of scenic spots, there were a small number of necessary facilities, such as roads, gates, service centres, restaurants, cable cars, and cableways. When scenic spots become famous and experience a surge of visitors, the old facilities can no longer satisfy consumers' needs, leading to support for the expansion of related facilities or the development of farmhouse resorts, restaurants and new scenic spots. In addition to construction projects, the construction of landscapes and afforested areas are high priorities.

The plane divergence rate of internal construction in scenic spots is proportional to the location and ranking of scenic spots. As shown in Table 1, all 13 scenic spots show an increase in area, while their speed of change differs. Scenic spots with higher rankings near major towns, such as Laojun Mountain, Longyuwan National Forest Park, Hudie Valley, the scenic Yangzigou region, and the ski resort, have developed rapidly. Lower-ranked scenic spots far from major towns and highways, such as the Chongdugou scenic spot and the Hongdoushan scenic spot, have developed more slowly.

In addition, the expansion rate of scenic spot construction land is related to the level and nature of development. Construction land expands at high speed in the beginning during development in scenic spots, while it slows down or even stops in well-developed scenic spots because of the development of adequate facilities. Some scenic spots, such as Jiulong Mountain Springs, are unlikely to expand rapidly due to restricted resources and the influence of nature. The Jiulong Mountain Spring resources are exploited to the limit, so it is impossible and unnecessary to expand further. Jiguandong scenic spot, featuring karst caves, has reached maximum development and requires no more construction land. For the two rafting scenic spots, no further construction projects are needed, so there is little increase in construction land.

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Diversified functions of scenic spots land

With the intensive development of tourism, the land use types of scenic spots change from a single type to compound and diversified types, and the number of land use types increases. As the main land use type of scenic spots, construction land becomes more diversified in its functions. At the beginning of the development of some scenic spots, the types of construction land that cater to sightseeing and accommodation are simple. When scenic spots are developed, the types of construction land increase to meet most tourism needs. This investigation shows that among the 13 scenic spots in Luanchuan County, most appear to be diversified in land use types, except for single-function spots such as ski areas, Great Canyon rafting, and the Chongdugou scenic spot. Laojun Mountain has a planned high starting level, and the Hongdoushan scenic spot has lagging development (Table 2). At the classic Chongdugou scenic spot, residential areas, farmland, woodland and water areas are being converted to various types of tourism land. Traditional farmland is used to cultivate fruits, herbs, flowers, etc. Construction land originally designated for roads, urbanization, and residential areas is transformed into commercial tourist services land (accommodation, restaurants and recreational facilities), tourism production land, and infrastructure land. In short, in the tourism development process, the diversified service functions of scenic spots become increasingly prominent. The land service function develops from residence and production to entertainment.

Rapid transformation of land use types

As the tourism industry expands and the number of scenic spots increases, tourism land areas undergo a significant increase, and land use types in scenic spots change greatly.

Table 1: Scenic spot construction land expansion at the beginning and end of the study.

Scenic spot	Area at the beginning of the research (hm^2)	Area at the end of the research (hm^2)	Expanded area (hm^2)	Dynamic degree (%)
Chongdugou scenic spot	29.98	48.66	18.68	62.29
Yangzigou scenic spot	28.42	48.22	19.81	69.7
Longyuwan National Forest Park	47.3	92.13	44.82	94.76
Laojun Mountain	34.39	60.42	26.02	75.67
Jiguandong	6.69	8.35	1.65	24.71
Ski Resort	5.99	92.13	32.2	53.75
Jiulong Mountain	2.29	2.32	0.02	1.01
Daohuigou	28.92	34.85	5.93	20.52
Baoduzhai	39.15	41.17	2.02	5.17
Hudie Valley	2.98	34.8	31.82	1.12
Hongdoushan scenic spot	6.87	6.93	0.07	0.98
Great Canyon rafting	15.22	15.79	0.58	3.82
Chongdugou rafting	14.39	14.61	0.22	1.56

Table 2: Changes in types of tourism land in various scenic spots.

Scenic spot	1991	2001	2010	2018
Chongdugou scenic spot	*	5	9	9
Yangzigou scenic spot	*	4	6	7
Longyuwan National Forest Park	*	4	9	9
Laojun Mountain	*	8	8	8
Jiguandong	4	9	9	9
Ski Resort	*	9	9	9
Jiulong Mountain	3	5	6	6
Daohuigou	*	3	8	8
Baoduzhai	*	6	7	7
Hudie Valley	*	1	5	5
Hongdoushan scenic spot	*	*	4	4
Great Canyon rafting	*	*	6	6
Chongdugou rafting	*	*	3	3

Note: * indicates that the scenic spot is in an undeveloped state.

During 1991-2018, the structural changes in tourism land in Luanchuan County featured a sharp increase in construction land, a slight increase in water areas and a decrease in farmland. From the beginning period to the development period (1991-2010), the main types of land in Luanchuan County scenic spots were woodland and farmland, which together made up over 90% of the total. The development of the tourism industry has not affected local people's traditional life and production style. Some land use types in scenic spots, especially farmland, are used mainly to satisfy local needs and are not completely taken over by scenic spots. Locals in scenic spots still pursue agriculture and forestry as their main ways to make a living, with tourism as a minor way. The tourism industry reached a certain scale in the development period to the transformation period, 2010-2018 (except for two rafting scenic spots built in 2010). Consequently, all land in scenic spots is used to develop tourism, and many types of land are changing to construction land. A small amount of remaining farmland serves mainly as picking gardens or to cultivate flowers. Luanchuan County has been following an economic strategy of a county rich in tourism since 2000, so water areas have increased gradually due to a series of policies designed to protect woodlands and expand water areas (Table 3).

Although the development time of each scenic spot is different, with the continuous development of the scenic spot and the upgrading and improvement of facilities, the types of land use in the scenic spot have undergone major changes. The change in agricultural land was the most obvious, and the agricultural land in all scenic spots showed a decreasing trend annually. The scenic spots with large changes in agricultural land are mainly areas with higher scenic spots and areas with a large number of residential areas in the scenic spots. The change in woodland showed an overall upward trend, with only the Yew Scenic Area and Butterfly Valley Scenic Area decreasing slightly. However, the increase in the area of woodland in each scenic spot was relatively small. The main reason for the increase in the area at the initial stage of development is the implementation of the national policy of

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Table 3: Luanchuan County tourism land areas during 1991-2018 (hm^2).

Land use type	1991	2001	2010	2018
Construction land	8.98	358.97	390.64	411.78
Farmland	4.57	689.39	218.78	133.07
Woodland	186.38	13809.06	15100	15217.12
Water area	1.04	169.54	152.04	158.49
Untouched land	10.13	59.77	115.61	90.56
Total	211.1	15086.73	15977.07	16011.02

returning farmland to forest. During the implementation of the policy, the random development and use of woodland were strictly restricted, and most of the steep slopes in the scenic area were strictly restricted. Cultivated land was converted to woodland, which played a positive role in protecting the woodland. Subsequently, the country implemented the policy of closing hills for afforestation and continued to increase the intensity of returning farmland to forests, especially the conversion of barren sloping farmland. All these have made woodland better protected. In addition, as a mountainous tourist attraction, woodlands and grasslands in scenic areas are important natural landscapes. Scenic area managers also attach great importance to the protection of woodland, which is also an important reason why the area of woodland has been increasing. Construction land also shows an overall upward trend. The several scenic spots with the largest increase in area are concentrated in 5 4A scenic spots and 2 5A scenic spots. Due to the rapid development of these scenic spots and the high level of scenic spots, a large number of supporting tourist facilities and service facilities are required, so a large amount of construction land has been added. In some high-level scenic spots, more residents have been added, which has led to an increase in housing demand and more new construction land. Except for the Funiu Mountain skiing scene area and the Chongdugou rafting area, the water area used in the water area has shown an increasing trend, and the water area in most other scenic spots has shown a decreasing trend. The main reason for the decrease was the decrease in natural precipitation in a certain period of time, which led to the decrease in river water surface area. The main reason for the increase is that the scenic area is designed to beautify the environment, build dams to block water, form artificial water surfaces or expand natural water surfaces (Table 4).

Influence factors of tourism land spatial variation

Variation designs: The changes in tourism land use types result from human utilization and the development of land for economic benefits. In the short term, land use type changes outside the natural environment make no difference. If people crave a greater economic return through utilization and development, they must take into account the natural factor of the land, which directly determines the cost and profits of exploitation. Therefore, in regard to various designs, the elevation, gradient and direction affect tourism land changes. To secure better earnings, people must also consider location factors. Because there are great differences in development necessity and earnings between different locations, land utilization is not absolutely balanced in space. Some areas are worth developing (economically and technically) and can be developed, while other places are not. Therefore, the influencing factors of land use types include distances to villages, roads, rivers and centres of a certain area. Different types of scenic spots have different construction land features and development histories, so the scales of land use and structures may vary greatly, reflecting a particular scenic spot's construction demand. As a result, attributes such as scenic spot rankings and development themes exert a strong influence on the transformation of land use types. Scenic spot exploitation is subject to regional economic and social conditions. Different regional conditions and features affect the importance attached to scenic spot exploitation, policies, investment and the necessity of development. Therefore, population density, speed of economic growth and the level of urbanization of the towns where scenic spots are located might affect the transformation of land use types. This paper analyses the influence of 14 factors and four types of indexes: natural attributes, location attributes, scenic spot attributes and township social attributes (Table 5).

Analysis of influence factors of main transformation types

At the first level of tourism land, there are five land types. Therefore, there should be 20 types of any two types of mutual conversion, but the actual number of conversion types cannot reach the upper limit. The four common types of land conversion areas accounted for 76.8% of the total conversion area. Therefore, considering the limitation of paper space, this study mainly analyses four types of land conversion.

Farmland to construction land

A value of 1 is used for land use transformation types caused by variations, such as farmland to construction land, and 0 is used for other types. The logistic analysis results shown in Table 2 indicate that factors such as elevation, gradient, distance to rivers, highways, and distance to villages are significant (Table 6, Model 1).

- **Elevation:** Farmland, such as cultivated land, which spreads over the flat areas along riverbanks, is converted to tourism villages, such as farmhouse resorts. Farmland at low elevations is adjacent to traffic routes, so traffic facilities are spread around it. The land use transformation type mostly seen in mountainous areas is farmland to construction land, which means the farmland area decreases as it is used to accommodate infrastructure for the development of tourism.

- **Gradient:** Owing to cost and technological issues, common construction projects are not usually situated on steep slopes. Therefore, gradient is a main influencing factor when farmland is transformed into construction land. The infrastructure of scenic spots and tourism villages is built on farmland with a slight slope, on river terraces, or near rivers, highways and villages. Gradient is also considered when choosing a tourism route.

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Table 4: Changes in various tourism land areas in scenic spots (1991-2018) hm².

Scenic spot	Year	Farmland	Woodland	Construction land	Water area	Untouched land
Chongdugou scenic spot	2001	5.59	2851.69	29.99	7.35	44.98
	2010	1.76	2876.39	47.33	7.94	6.17
	2018	1.49	2876.08	48.66	7.86	5.49
Yangzigou scenic spot	2001	27.80	1459.07	28.42	1.38	19.35
	2010	14.93	1468.74	35.18	1.57	15.61
	2018	14.41	1459.96	48.22	1.67	9.55
Longyuwan National Forest Park	2001	110.37	4274.40	47.30	16.23	56.76
	2010	56.76	4319.45	91.45	12.16	25.22
	2018	55.89	4319.24	92.13	12.13	23.11
Laojun Mountain	2001	22.56	2138.73	34.39	4.69	32.83
	2010	8.71	2159.72	57.17	4.02	3.57
	2018	6.75	2159.23	60.42	4.07	2.72
Jiguandong	1991	4.57	170.44	6.69	1.04	9.56
	2001	3.75	172.53	7.33	0.98	7.71
	2010	3.63	172.38	8.35	1.04	6.90
	2018	3.45	172.03	8.41	1.05	6.14
Ski Resort	2001	16.73	562.51	5.99	1.60	6.46
	2010	7.59	569.63	11.21	1.60	3.26
	2018	0.21	550.01	34.80	3.99	4.29
Jiulong Mountain	1991	0.00	16.05	2.29	0.00	0.57
	2001	0.00	16.04	2.31	0.00	0.56
	2010	0.04	16.01	2.31	0.00	0.56
	2018	0.00	16.04	2.32	0.00	0.56
Daohuigou	2001	34.34	2181.72	28.92	3.84	10.39
	2010	31.40	2181.27	33.89	3.84	8.81
	2018	30.85	2181.23	34.85	3.80	8.48
Baoduzhai	2001	16.06	740.59	39.15	3.23	8.15
	2010	15.42	740.59	40.84	3.23	7.10
	2018	15.19	740.49	41.17	3.24	7.08
Hudie Valley	2001	0.32	149.54	2.98	0.08	7.53
	2010	0.21	149.68	3.38	0.08	7.09
	2018	0.18	149.67	3.48	0.07	7.08
Hongdoushan scenic spot	2010	0.00	457.09	6.87	0.00	0.00
	2018	0.00	457.03	6.93	0.00	0.00
Great Canyon Rafting	2010	4.72	29.48	15.24	6.34	2.20
	2018	4.63	29.36	15.79	6.34	1.83
Chongdugou Rafting	2010	0.00	61.07	14.39	114.27	14.04
	2018	0.00	60.66	14.61	114.27	14.24

Note: Since the development time of each scenic spot is different, the starting year of each scenic spot shown in the table is different

• **Distance to rivers:** Rivers are an important water source for human survival and development. In mountainous areas, the distribution of the population is consistent with that of rivers that run through the lower-elevation areas. The farmland along rivers is flat or has slight slopes. Therefore, the distance to rivers is related to the distribution of population, residential areas and farmland. During the scenic spot development process, tourism infrastructure, such as farmhouse resorts, hotels, restaurants, and shops, tends to be situated near rivers and spreads along riverbanks. The farther a site is from a river, the more unlikely it is that tourism infrastructure will be built there. In mountainous areas, tourism routes are built along rivers because rivers flow through flat areas with a longitudinal gradient.

• **Distance to highways:** In mountainous areas, the main roads follow the course of rivers, so distance to highways has the same influence as distance to rivers. To build main roads in mountainous areas, technology, cost and safety must be considered. The roads must follow a gentle slope and require small investment and easy construction, and riverbanks meet these criteria. Therefore, the direction of roads is related to that of rivers. During the tourism development process, the transformation of farmland to construction land is influenced by the distance to highways. The nearer a site is to a highway, the more likely this transformation is. The farther a site is from a highway, the more difficult this transformation is.

• **Distance to villages:** In mountainous areas, the location of villages is closely related to the natural environment, and the distribution of villages is an outcome of historical development. In the formation and development processes of villages, the natural environment must be considered. During the process of transforming farmland to construction land, tourism infrastructure tends to be built in or near existing villages. Therefore, the distance to villages is a crucial factor in transforming farmland to construction land. Many villages transform and rebuild houses in original residential areas into farmhouse resorts. Some tourism infrastructure, such as farmhouse resorts, is built on farmland near villages.

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Table 5: Variation designs.

Index	Code number of variation	Factor	Value unit	Connotation
Natural attribute	X_1	Elevation	1, ≤600 m; 2, (600 m, 1000 m); 3, (1000 m, 1400 m); 4, (1400 m, 1800 m); 5, (1800 m, 2200 m)	Elevation of sampling points
	X_2	Gradient	1, 0-10°; 2, 10-20°; 3, 20-30°; 4, 30-40°; 5, >40°	Gradient of sampling points
	X_3	Slope direction	0, flat ground; 1, sunny slopes; 2, semi-sunny slopes; 3, semi-shady slopes; 4, shady slopes	Slope direction classification of sampling points
Location attribute	X_4	Distance to rivers	Real value/m	Straight-line distance from sampling points to riverbanks
	X_5	Distance to highways	Real value/m	Distance from sampling points to highways
	X_6	Distance to villages	Real value/m	Distance from sampling points to edges of villages
	X_7	Distance to towns	Real value/km	Distance from sampling points to geometric centre of local government
	X_8	Distance to the county centre	Real value/km	Distance from sampling points to geometric centre of the county
Scenic spot attribute	X_9	Ranking of scenic spots	3, 3A; 4, 4A; 5, 5A	Assessed ranking of scenic spots according to "tourism division and assessment of quality grade of scenic spots"
	X_{10}	Development themes	1, sightseeing; 2, leisure and vacation; 3, convalescence	Classification of development themes according to scale of construction land
	X_{11}	Development cycle	0, growth stage; 1, developed stage	Classification of life cycles of scenic spots according to Luanchuan County features, scenic spot histories and development degrees
Economic and social attributes of township	X_{12}	Population density	Real value/persons/km^2	The number of permanent residents in each unit of the land area of the township
	X_{13}	Economic growth rate	Real value/%	Average economic growth rate of township in 1991-2018
	X_{14}	Urbanization level	Real value/%	The urbanization level of the township in 2018

Woodland to farmland

A value of 1 is used for land use transformation types caused by variations such as woodland to farmland, and 0 is used for other types. The logistic model results shown in Table 2 indicate that factors such as elevation; gradient; distance to rivers, highways, villages, and the county centre; and the scenic spot development cycle are significant (Table 2, Model 2).

The transformation of woodland to farmland in scenic spots is driven by the transformation of farmland to construction land. In the tourism development process, farmland decreases because it is transformed to construction land. To compensate for the loss of farmland, woodlands that are not far from rivers, highways and villages and have a low relative elevation and gentle slopes are transformed to farmland. Therefore, factors such as distances to rivers, highways, and villages; elevation; and gradient are deciding factors in transforming woodland to farmland.

In Model 2 (woodland to farmland), distance to the county centre is significant. As a regional centre, the county affects the exploitation of tourism resources. In Luanchuan County, scenic spots near the county centre have a long history of a high degree of mature exploitation on a large scale. These scenic spots have caused the loss of farmland, so most woodlands are converted to farmlands. The local industrial structure is improved by tourism development, but agriculture remains, and retaining farmland shows the feature of industrial diversification in Luanchuan County. In fact, the number of people engaged in tourism increases dramatically when the tourism industry expands. However, not all agricultural populations are engaged in tertiary industries.

The period of scenic spot development has a strong influence on the transformation of woodland to farmland and shows the overall feature of scenic spot development; that is, there is a great difference between developing scenic spots and developed ones. After long-term development, the transformation of types of land use in developed scenic spots is complex and diverse, especially in terms of woodland to farmland. Fully developing scenic spots is the main reason for turning woodland into farmland. The formation mechanism is based on the supplementary mechanism of farmland decrease. As farmland is turned into construction land increasingly quickly, the evolution of the regional industrial structure requires compensating for the loss of farmland to maintain a balanced local economic and social structure.

Woodland to construction land

A value of 1 is used for land use transformation types caused by variations such as woodland to construction land, and 0 is used for other types. The logistic model results shown in Table 2 indicate that factors such as elevation; gradient; distances to rivers, highways, villages, and the county centre; and scenic spot rankings are significant (Table 2, Model 3).

When more land is needed to construct scenic spots and there is not enough farmland, woodlands that are located on gentle slopes at low elevations and near rivers, villages and highways are transformed directly to construction land. Therefore, the above factors reach a high level. The nearer the county centre

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Table 6: Key indicators of model analysis results.

Variation	Model 1			Model 2			Model 3			Model 4		
	B	Sig.	Exp. (B)	B	Sig.	Exp. (B)	B	Sig.	Exp. (B)	B	Sig.	Exp. (B)
Constant	-5.471	0.044	0.004	1.610	0.031	5.005	-2.452	0.019	0.086	1.279	0.022	3.593
X_1	-0.179	0.014	1.196	-0.027	0.037	0.974	-0.190	0.016	0.827	-0.033	0.024	0.968
X_2	-0.572	0.018	0.564	-0.108	0.048	0.897	-0.078	0.036	1.081	-0.475	0.004	0.622
X_3	-0.490	0.122	0.613	0.122	0.517	1.129	0.105	0.592	1.111	0.004	0.98	1.004
X_4	-0.001	0.015	0.999	-0.002	0.007	0.998	-0.001	0.031	1.000	0.001	0.002	1.000
X_5	-0.008	0.016	0.992	-0.001	0.041	1.001	-0.001	0.003	1.001	0.002	0.882	1.000
X_6	-2.137	0.015	0.118	-0.848	0.003	2.335	-0.712	0.026	2.039	-0.205	0.897	0.815
X_7	-0.091	0.264	0.913	0.013	0.744	1.013	0.003	0.937	1.003	0.024	0.594	1.024
X_8	0.176	0.193	1.192	-0.007	0.045	0.993	-0.017	0.023	1.017	-0.037	0.249	0.964
X_9	0.229	0.844	1.257	0.080	0.885	1.083	0.104	0.008	0.902	-0.082	0.860	0.921
X_{10}	-1.572	0.180	0.208	0.054	0.844	1.055	-0.083	0.780	0.920	0.381	0.139	1.464
X_{11}	1.073	0.548	2.923	0.001	0.045	0.999	0.127	0.902	1.135	0.275	0.661	1.317
X_{12}	-0.038	0.818	0.963	-0.104	0.324	0.902	-0.033	0.733	0.968	-0.081	0.572	0.923
X_{13}	2.033	0.324	7.633	0.638	0.475	1.894	0.343	0.701	1.410	0.144	0.893	1.155
X_{14}	-0.291	0.451	0.747	0.099	0.591	1.104	0.043	0.843	1.044	0.208	0.261	1.232

Note: ① Model 1, farmland to construction land; Model 2, woodland to farmland; Model 3, woodland to construction land; Model 4, woodland to water area. ② Nagelkerke R^2 value of each model: Model 1, 0.548; Model 2, 0.489; Model 3, 0.445; Model 4, 0.524

and the more developed the scenic spots, the more land they cover and the more decisive the factor is. Rankings of scenic spots represent the operational scale and level of development. High rankings indicate higher development levels, larger areas and a greater possibility of woodland being converted to construction land.

Woodland to water area

A value of 1 is used for land use transformation types caused by variations such as woodland to water area, and 0 is used for other types. The logistic analysis results of Model 4 shown in Table 2 indicate that factors such as elevation, gradient, and distance to rivers are significant (Table 2, Model 4).

Woodlands are transformed to water areas by damming to store water. To build landscapes and restore the natural ecology, dams are built to store water with the original watercourse at the centre, or a reservoir is built on low terrain. Thus, woodlands are transformed into water areas. Factors such as elevation, gradient, and distance to rivers are significant. This transformation is rare in natural environments but constitutes a large proportion of land use type conversion.

Results and Discussion

Results

The rapid development of mountain tourism has caused drastic changes in the structure of land use and has had an important impact on terrestrial ecosystems. Based on the land use data from four periods in the past 30 years, namely, 1991, 2001, 2010, and 2018, along with adoption of the land use expansion index and the spatial binary logistic, research is conducted to study the spatial changes and influencing factors of mountain tourism land, and the following conclusions have been obtained.

(1) Spatial variation in land use in scenic spots shows the chain reaction of land use type transformation caused by construction land expansion, a key driving force of spatial variation in land use and land use type transformation. To satisfy the growing needs of tourism, more land is used to accommodate tourism facilities, resulting in the transformation of farmland to construction land, woodland to construction land, and woodland to farmland. Furthermore, woodland is converted to water areas to improve the environment and build landscapes. In addition, with the intensive development of tourism, the land use types of scenic spots change from a single type to compound and diversified types, and the number of land use types increases. As the main land use type of scenic spots, construction land becomes more diversified in its functions.

(2) The changes in tourism land use types result from human utilization and development of land for economic benefits, and these changes are affected by many factors. The transformation of farmland to construction land is subject to elevation, gradient, and distances to rivers, highways, and villages. The transformation of woodland to farmland is affected by factors such as elevation; gradient; distances to rivers, highways, villages, and the county centre; and the scenic spot development cycle. The transformation of woodland to farmland is largely driven by that of farmland to construction land, and distance to the county centre and the scenic spot development cycle strongly influence land use. The transformation of woodland to construction land is greatly affected by factors such as elevation; gradient; distances to rivers, highways, villages, and the county centre; and scenic spot rankings. The transformation of woodland to water areas is affected by factors such as elevation, gradient, and distance to rivers.

(3) A plan for tourism land management and control should be established with construction land as the key indicator. According to the above research, regarding changes in tourism land use in mountainous areas, the change in construction land is the fundamental inducement, and construction land is the main driving mechanism leading to the change in various types of land use in the scenic area. Therefore, the planning and construction of tourist attractions should focus on the planning

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of tourism construction land. Construction land should match the development scale and development direction of the scenic spot and should be appropriately controlled to be in harmony with the natural environment. Once the tourist attraction plan is determined, development and construction should be carried out in strict accordance with the plan to avoid blind expansion of construction land in the scenic spot, thereby avoiding disorderly changes in other land types, such as woodland and agricultural land. Although the occupation of construction land is inevitable for the development of tourism, the excessive spread of construction land is the main cause of the deterioration of the ecological environment in the scenic area. Therefore, it is of practical significance to establish a scenic environment management system with construction land as the core. Due to its particularity, the ecological environment of mountainous areas is fragile. When pursuing economic and social benefits from the development of mountainous tourist attractions, importance should be attached to improving the ecological benefits to produce a solid foundation for sustainable development of mountain tourism. In addition, attention should be given to coordinating the relationship between tourism planning and overall land use planning. The tourism planning scheme should be based on overall land use planning, while land use planning should fully consider tourism land planning in tourism planning, especially tourism construction land planning.

Discussion

Exploring the impact of tourism development on land use change will help to better understand the impact of land use non-agriculturalization and will provide a basis for the adjustment of land use policies because land use/land cover change (LUCC) is the core of the tourism industry [39]. Mountain tourism development not only promotes the development of tourist attractions and tourism-related industries along the route but also causes changes in the ways, types, and purposes of land use, which also have an important impact on land use and management, urban development and productivity distribution. Although mountain tourism development often has abundant land, the land available for the construction of artificial facilities is very scarce and often overlaps with densely populated areas, such as residential areas. How to coordinate the relationship between them and establish scientific, reasonable and stable tourism land use structure is of great significance in the development of mountain tourism. At the same time, due to the strong constraints of land resources, which will continue for a long time, higher requirements have been put forward on the supply and use of mountain tourism land.

Research on the spatial change in mountain tourism land is a hot spot for scholars. Research on the Lushan Nature Reserve shows that the vegetation is undergoing positive secondary changes, and the fragmentation level of vegetation in the outer area is significantly higher than that in the inner area. The total amount of cultivated land, woodland and unused land in the reserve has decreased in 15 years, and the areas of garden plots, grasslands, urban villages, industrial and mining land, transportation land, water area and water conservancy facilities land have increased significantly [14]. Research on Yangshuo County, a famous mountain tourist destination, shows that with the development of tourism, the scale of tourism land continues to increase, the area of arable land generally decreases, and other non-agricultural land is increasing rapidly [15]. A study of Emeishan city found that the use of tourism land presents a spatial expansion pattern from scenic spots to urban areas along the transportation route, and the growth of tourism land in protected areas shows an increasing trend without restriction [16]. Some researchers have also found that after tourism development, the land use types of mountainous rural tourism destinations tend to be diversified, and the use of land functions becomes more complicated [17-18]. These studies show that with the development of tourism, the area of land for tourist attractions, land for tourism transportation and tourism infrastructure has increased, while the area of cultivated land and ecological land has decreased. However, the existing literature mainly analyses specific scenic spots, while research on multiple scenic spots in a certain area is relatively rare. The analysis of a single scenic spot reflects only the land use change in that individual scenic spot, while the study of multiple scenic spots in a region reflects the characteristics of the entire region. This paper takes 13 scenic spots in the western Henan Mountains in central China as examples and finds that over 28 years, both the number of scenic spots and the area of tourism land in the research area have increased significantly. The number of tourist attractions increased from 1 to 13, and the area of tourist land increased from 2.11 km^2 to 159.69 km^2, an increase of 74.7 times (Tables 1-3). With the expansion of the scale of tourism land, the spatial structure of tourism land has also undergone major changes. The tourism construction land in the scenic area has expanded significantly, the functions of the scenic area have diversified, and the land use type has changed rapidly. This article makes up for the lack of research on the change in tourism land in the field of mountainous areas in the central region by studying the mountain tourism land in underdeveloped areas in the central region where the tourism industry is developing rapidly. Analysis from the perspective of combining micro-scale (scenic area) and small area (county area) is performed, and in-depth and systematic analysis of research objects is conducive to the refinement of mountain tourism land research.

The change in mountain tourism land is the result of all internal and external factors. It is generally believed that the factors that lead to changes in tourist land in mountainous areas are diverse, mainly including the increase in the area of transportation facilities and tourist facilities caused by the development of tourism [13-14,19]. Of course, other factors are also included. For example, Liu Menghao and Xi Jianchao focused on Gougezhuang village in the Yesanpo tourist area in the suburbs of Beijing as an example. They believed that the evolution of rural settlements was obviously affected by government decisions [20]. Xu Man and Zheng Jingming believed that in Lushan, the change in land use in the nature reserve and its surroundings is the result of the dramatic population changes in the Lushan Mountainous area [21]. Xu Congrong and Hu Haisheng believed that the driving mechanism of the landscape pattern change in the Lushan

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Mountain Scenic Area is due to natural factors and the rapid advancement of urbanization [14]. Through research, Chen Zhigang found that the dynamic changes in land use in scenic cities and the development of tourism are the result of the weakened feedback of agricultural development and the weakened feedback of industrial development [19]. Research on the influencing factors and driving mechanism of the spatial change in tourism land in mountainous areas is important for research on the environmental impact of the mountain tourism industry. The above research has enriched the content of the driving mechanism of tourism land in mountainous areas. This paper takes the change in tourism land type as the starting point and believes that the change and type conversion of tourism land are affected by the natural attributes of the land (elevation, slope, and aspect) and location attributes (distance from the river, distance from the road, distance from the village, etc.). There are influences from 14 factors among four types of indicators, including distance from the town area, scenic attributes (distance from the county, scenic level, development theme, and development cycle), and township economic and social attributes (population density, economic growth rate, urbanization level, etc.). Combining the spatial change in land use and influencing factors will help to extend the research of land change to a wider range of fields. These studies provide a basis for clarifying the spatial layout, changes and sustainability of land use and provide a reference for future land use in the region.

In terms of research methods, scholars often use satellite imagery [27-30], spatial analysis [31-32], patch analysis [33] and other methods. In recent years, the study of tourism land from the perspective of ecology has become a new trend. For example, Kurniawan has studied the landscape change patterns of islands and mountains and found that land use/land cover tends to be based on routes, ports, coastlines, public services, rural centres, business districts, settlements, tourist accommodations, tourist centres, tourist attractions, and remote areas. The distance between the landfill area varies [37]. For another example, Mwalusepo's case study of the Unguja tourist area in Zanzibar, Tanzania, shows that tourism development, climate change, land use and land cover changes have had an important impact on human communities and human ecosystems [38]. These studies attach importance to the impact of land use changes on the ecological environment and advocate the construction of a sustainable ecosystem. Scholars such as In^es Boavida-Portugal have used an LUCC modelling method to explore the impact of tourism development in built-up areas. This method integrates the cellular automata model (CA) transition probability of the Markov model and the logistic regression transition applicability map. Three options are established to explore the impact of LUCC and tourism development in the coastal areas of Portugal. The results show that tourism and the growth of urban land use/cover are higher. Compared with other programmes, the focus is mainly on coastal areas (within 5000 m), and it is basically consistent with the land use policy guidelines. The land use/cover spatial model is considered to be a sustainable land use plan because it provides a tool that can evaluate future land use/cover scenarios [39]. However, the current related research has the problem of insufficient model quantitative analysis, and most studies focus on simple quantitative description. Shan H and other scholars used the Northeast region as the research object, calculated the weighted average travel time and daily accessibility using the data of transportation network, destination and economic factors, and established a tourism economy linkage model to study the city and ice and snow tourism after the implementation of the high-speed railway. The change of accessibility between destinations, the traffic accessibility of Shenyang has a huge impact on the development of the regional economy [24]. Scholars such as Jun Y used the accessibility coefficient and the social demand index to analyze the spatial fairness, which is of great significance for the study of the rational planning of urban land resources and transportation [25]. These research methods are very worthy of reference and learning. This paper mainly uses the degree of planar expansion to study the expansion speed of different land uses in different research periods in the region and uses binary logistic regression analysis to analyse the factors that affect the change in tourism land in geographic space. We describe the multi-dimensional changes in tourism land through time and space, analyse the changing patterns and trends of various types of land in different dimensions, build a driving force model for the evolution of tourism land, clarify the size and direction of the influence of each influencing factor, and propose and clarify the driving force framework for the evolution of tourism land. At the same time, the research perspective is carried out from the natural geographical perspectives of mountain height, aspect, and slope, which few other researchers have paid attention to, thereby enriching the relevant research results and providing a reference for local governments to regulate and control mountain tourism land.

Conclusion

Taking Luanchuan County as an example, this paper analyses many scenic spots in smaller geographical units. The conclusion is that the land use change associated with tourist attractions shows a chain reaction of land use type conversion due to the expansion of construction land, and the expansion of construction land has become the main driving force of land use change and land use type conversion. The change in the types of tourism land is mainly the result of human beings' pursuit of economic benefits and the use and development of land, which is affected by many factors. Changes in the type and spatial distributions of land uses are inevitable phenomena in the development process of mountain tourist attractions. Analysis from the perspectives of nature, location, economy and society is of great significance to understanding and regulating the change process of mountain tourist land use.

However, considering the availability of data and the time of research development, the division of research time intervals is not completely uniform. The types of land use conversion are complex and diverse. Considering the length of this article, only the five most important types are selected for analysis, and more conversion types could be studied in the next step. In addition, considering the data workload, in the selection of impact factor samples, this article considers only that the

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minimum number of samples be more than 2000. The next step could be to increase the number of samples for more accurate characterization and analysis. In terms of research methods, the latest mathematical model will also be considered to optimize the tourism land in the study area from an ecological perspective and to predict the future development of tourism land. The case area is located in the "One Belt, One Core, Three Mountains and Five Districts" area of Henan Province, China. The Funiu Mountain area in the tourism development layout has a significant strategic position. Through in-depth analysis of the tourism land in the study area, it is possible to determine the shortcomings and problems in the tourism land and the poorly managed and uncomfortable behaviours that interact with the environment. Scientific regulation of the structure of tourism land and the optimization of the entire region's land use structure are needed to provide a reference for the promotion of the healthy development of local and Henan-wide tourism, the improvement of the ecological environment, the innovation of tourism land management systems, and the overall planning of regional development.

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