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Spatio-temporal tourism land use changes: A case study of a typical tourism district in Song County, China

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ABSTRACT

The research aims to analyse the spatial and temporal changes in tourism land use based on the example of a typical region and to substantiate the possible environmental, economic, socio-cultural and other types of consequences of such modifications. The study was conducted using methods of cognition: system analysis, synthesis, specification, generalisation, abstraction, deduction and formalisation. Based on the research results, potential spatial and temporal changes in those territories involved in tourism activities were identified, the peculiarities of the dynamics and directions of such changes were analysed, and the most influential factors and methods of management identified. In addition, possibilities for resolving the consequences are studied and the effectiveness of risk management assessed. The practical significance of the results obtained lies in the opportunity to apply them to the process of forming decisions for tourism land use activities and further management of tourism processes. An effective analysis of spatial and temporal changes in a typical tourism district can serve as a guide for rational planning of tourism activities.

KEYWORDS

kernel density analysis, standard deviation ellipse, Song County of China, domestic tourism

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1. Introduction

The *Report on World Tourism Economy Trends (2023)* states that total global tourism arrivals reached $9.57 billion in 2023 and total global tourism revenues reached $4.6 trillion (World Tourism Cities Federation, 2023). Global international tourism revenue growth was much faster than that of global trade in 2022, and tourism is recovering rapidly and growing, with China developing more quickly than international tourism. China will enter the era of mass tourism with the implementation of the "14th Five-Year Plan" for tourism development. Reviewing the development process of China's tourism industry in recent years, although it has been affected by the impact of COVID-19, it has also brought opportunities (Shen et al., 2020). In the context of China's rural revitalization strategy, development has been promoted once again, and along with the rapid growth of the tourism economy, its physical scale has continued to expand, land used for tourism and industry are increasingly in conflict. At present, there are many issues with China's tourism land use management, such as its blind growth and irrational pattern which leads to difficulties in secondary development later and makes it difficult to adapt to new needs. Therefore, by analysing the transformation between tourism and other land uses, and mapping its spatial layout and evolution, it is important to plan its rational development and to strengthen high-quality tourism.

1.1. Study area

The earliest research on tourism land use in China can be traced back to 1988. With the development of tourism, the research on the land it occupied has tended to diversify into six main research areas: evaluation (Sun & Wang, 2022; Wang, 2022), change (Sweetman et al., 2019; Yang et al., 2015), property (Santana-Jiménez et al., 2019; Zhou & Li, 2018), resort land use (Boavida-Portugal et al., 2016), type and functional structure (Yu et al., 2019), management and sustainable development (Sun & Wang, 2022; Tang et al., 2021). Scholars have discussed in depth many issues in its management and classification process in terms of different aspects, giving reasoned explanations and further promoting its development. However, due to the specificity and complexity of such land use, there is no unified formulation among Chinese scholars as far as its definition is concerned. Tourism land use has been studied from various perspectives and several definitions have been proposed, synthesized into the following two views: it is generally considered that all the land within scenic areas at all levels identified by the government at or above the county level through approval and publication is recognized as 'tourism land'. The other view is in a broader sense, considering that it includes not only the land within a scenic area, but also the sum of land that meets tourism demand, providing direct or indirect services and management for tourists, and is related to tourism patterns. Although this definition of tourism land use goes beyond the narrow scope, it is still inconsistent with China's current land classification, and both this and tourism development are still limited.

At present, research on tourism land use mainly involves qualitative research, only a very few studies use quantitative methods, and some scholars apply aerial remote sensing technology to investigate and analyse such land (Magige et al., 2020; Rosalina et al., 2023; Zhang et al., 2021). The classification system, land use change and landscape pattern have been extensively and fruitfully researched, but there is still room for more on the depth and breadth of tourism and land use. Therefore, this paper selects Song County, Luoyang, in China as the study area, and uses current land use data from Song County as the data source to analyse changes in tourism land use in the past ten years, focusing on the transformation relationship between tourism land use and other types, and changes in the spatial pattern of tourism land use.

Song County is not only rich in mineral and plant resources, but also has a variety of natural wonders and historical buildings, its tourism resources are abundant, and the local government is committed to the development of local tourism. However, due to the current existence of different development entities in Song County, conflicts between them are prominent and obvious. Rural tourism in Song County also has an irrational allocation of resources, differing interests, infrastructure imperfections and other issues in the development process. Moreover, there are problems such as irrational use of land and insufficient environmental protection when developing tourism in Song County. However, up to now, due to its marginal nature, the study of tourism land use is still at the stage of academic exploration. Thus, this article classifies the types of land in Song County on the basis of existing research on tourism land use, mapping that land use, and analysing and researching its spatio-temporal changes in order to further enrich the development of tourism land use. It will also provide reference for the rational planning and management of tourism land use in Song County, while providing support for academic theoretical research. Song County is in Luoyang, China, located in its southwestern part.

It is 60 kilometres from the ancient capital of Luoyang. The geographical location of Song County is between 111°24′–112°22′E and 33°35′–34°21′N, about 62 km from east to west and 86 km from north to south, with a total area of 3009 km^2. Song County is located in the watershed area of the Yangtze, Huang Ho and

Huai Rivers, its topography is low in the northeast and high in the southwest. Song County is rich in tourism resources and is a large eco-tourism district with a scenic area of about 600 km^2. There are locations such as Baiyun Mountain and Muzaling Scenic Areas, Luhun Reservoir, Wolong Valley and the Millennium Ginkgo Forest. The gross regional product of the region reached 20,584 billion yuan in 2020, of which the total value of the tertiary sector is 10,705 billion yuan, accounting for 52.1%. The per capita disposable income of the residents reaches 19,887 yuan, an increase of 4%.

2. Methods

The data sources of the study area are mainly for land use, including for Song County in 2010 and land use data in 2020, mainly from the Natural Resources Bureau of Song County. All land use types are divided into seven major categories: arable, forest, grassland, water, construction, tourism and other; digital elevation mapping for Song County, is mainly from the public data resources of the Geospatial Data Platform (2023); administrative division data, including China's national boundaries, administrative boundaries of cities in China, of districts and counties in Luoyang and of Song County, from China Standard Maps; socio-economic data, including Song County population, economic and tourism data, were obtained from the *Song County Yearbook 2010* and *Song County Yearbook 2020*, as well as the Song County Culture, Radio, Film and Tourism Bureau.

The land use transfer matrix is a two-dimensional mathematical matrix, which can both reflect increasing and decreasing changes of different land use types in the study area at a specific time visually and in detail, and can also clearly show the characteristics of the pattern and size of land use types in a specific time period (Wang et al., 2021). The mathematical formula for the land use transfer matrix is (1):

$$B_{jj} = \begin{bmatrix} B_{11} & B_{12} \ldots & B_{1n} \\ B_{21} & B_{22} \ldots & B_{2n} \\ B_{n1} & B_{n2} \ldots & B_{nn} \end{bmatrix} \quad (1)$$

where: B_{jj} denotes the area of the use type transformed into j land use type; n – the number of land use types.

By constructing a land use transfer matrix and analysing changes to different types, the authors explore tourism land use changes in the last 10 years, using 2010–2020 as the time period. The specific processing method is to take spatial land use data in the study area for two years, overlaying using ArcGIS, and then importing the intersected data into Excel for statistical presentation. Taking the land use data for 2010 as the columns, and the data for 2020 as the rows, sum for the areas and as a result the land use transfer matrix is generated.

Kernel density is a visualization tool in geostatistical studies. The basic principle of which is to study the distribution characteristics of a sample by analysing the spatial variation of the density of sample points in the study area. The greater the density of sample points, the greater the concentration, and the less, the more dispersed. The kernel density estimation (KDE) method is used to analyse the clustering characteristics of the spatial distribution of tourism land use in Song County. In the analysis, the search is generally performed in a circular area by setting appropriate 'bandwidth' values centred on each grid point to be calculated. Locations falling into the search area for tourism use have different weights, with points near the centre of the search being given greater weight and, conversely, less to the more distant (Tan et al., 2021). The distribution function of the sample is as follows (2):

$$f(x) = \frac{1}{n}(x_1, x_2, \ldots, x_n) \quad (2)$$

where: $f(x)$ is the kernel density estimate; n is the number of tourist land; x is spatial point.

The density estimation function equation is as follows (3):

$$f(x) = \frac{1}{nd}\sum_{i=1}^{n} K\left(\frac{x - x_i}{h}\right) \quad (3)$$

where: K is the kernel function indicating the spatial weight; d is the bandwidth threshold, i.e., the distance decay threshold with the estimated point as the centre point, $h > 0$; $K((x - x_i)/h)$ is the kernel function, where $(x - x_i)$ is the distance from the estimated value point x to the measured point x_i. It reflects the aggregation state of point elements in the study area, the larger it is, the denser the distribution of point elements.

The principle of standard deviation ellipse (SDE) analysis is to construct the centre of standard deviation ellipse, the rotation angle, and the distance to the X and Y-axes respectively from the geospatial coordinates of sample points, to precisely reveal the centre, dispersion and direction of the spatial distribution of elements (Wei et al., 2021).

By calculating the standard deviation ellipse, its ellipse rotation angle indicates the main direction of the spatial distribution of each tourism land; the X-axis and Y-axis characterize the degree of deviation from the centre of the distribution of tourism land use in both main and secondary directions, reflecting the centripetal and discrete nature of its spatial distribution. The magnitude of the difference between the X-axis and the Y-axis is related to the strength of the directionality; the larger the difference, the stronger the directionality. When the lengths of the X and Y axes are exactly equal, it means

that there is no directional feature. The area and the centre of the standard deviation ellipse characterize the breadth and the centre of the distribution of tourism land use in the region.

3. Results

3.1. Analysis of land use change

The land use transfer matrix reflects the overall change of different land use types in Song County during the 10 years from 2010 to 2020. Each column indicates the area of a land use type converted to other types, and each row indicates the area of a land use type converted to another land use type. It can be seen from the Table 1 that there is an area conversion between tourism land use and other types in Song County. During the 10 years, tourism land use in Song County increased from 0.63 km^2 in 2010 to 2.59 km^2 in 2020, an increase of 304.72%. Among them, the main sources for conversion are construction, arable and forest, with 1.05 km^2, 0.45 km^2 and 0.34 km^2 respectively, and the conversion of these three types reached 70.93% of total tourism land use in 2020. At the same time, a small amount under tourism has been converted to other types during the decade, mainly to forest.

Spatially, the conversion of tourism to other land use types forms two core areas in the northeast and southwest of Song County (Figure 1). The north-eastern part of which is mainly concentrated around Luhun reservoir, mostly for the conversion of land used for construction into tourism, but also a small amount of water and forest. In the southwest, the conversion of land use types is mainly concentrated in the vicinity of Wumasi Forestry in Baihe, where land used for tourism has been mainly converted from forest and construction. The conversion from tourism to other land use types is mainly concentrated in Tonghe and Gem in Checun, and Beiyuan in Chengguan. Among them, Tonghe has two types of conversion: tourism into forest and tourism into construction, while there are also a small number of cases of conversion into water. Baoshi is mainly a case of the conversion of tourism into forest; Beiyuan into farmland, with a small amount into construction found as well.

Overall, the spatial distribution of tourism land use in Song County in 2020 is still largely aggregated, but with

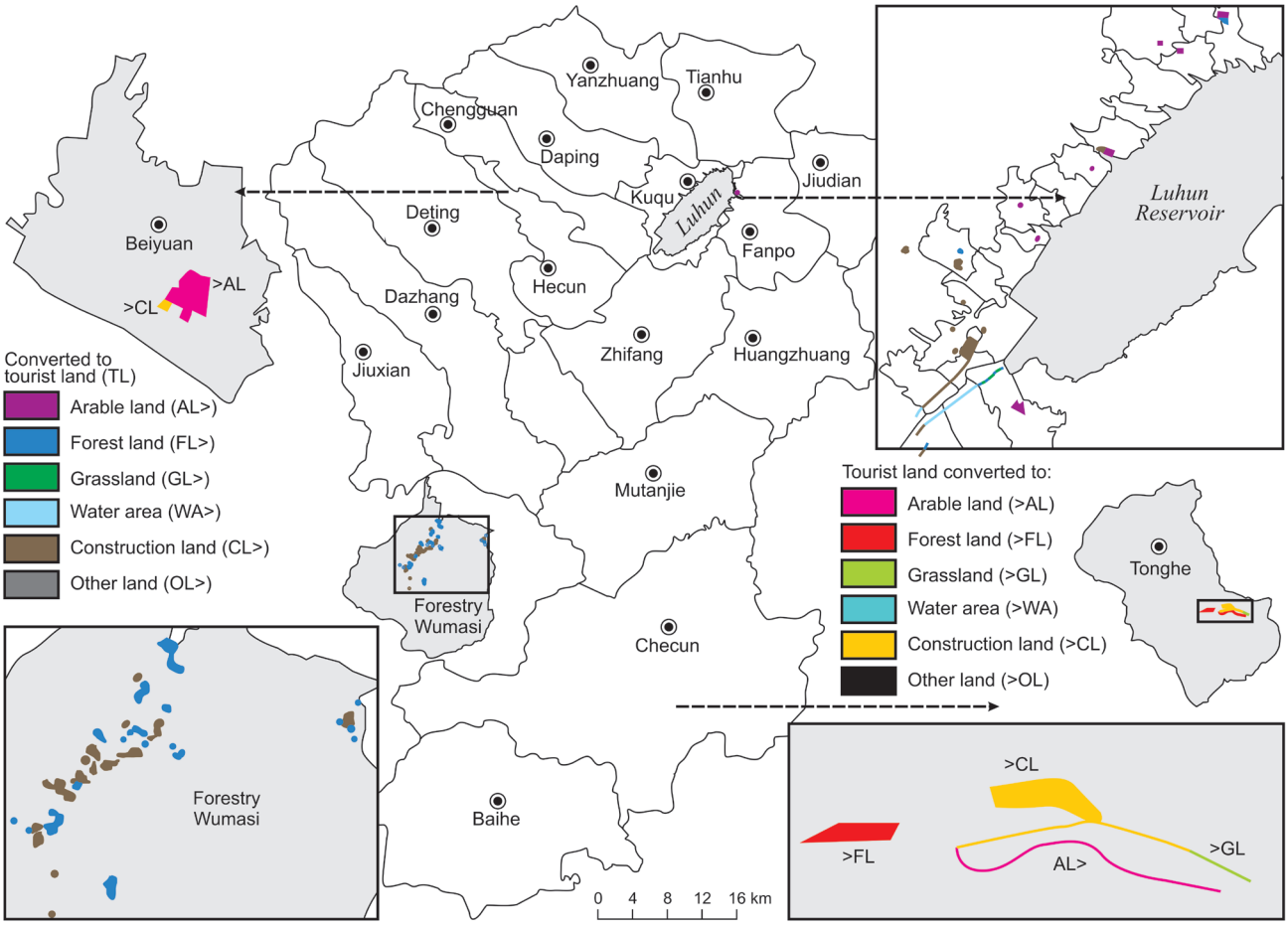

Figure 1. Transformation between tourism and other land use types
Notes: AL – arable, FL – forest, GL – grassland, WA – water, CL – construction, TL – tourism, OL – other
Source: Geospatial Data Cloud (2023)

Table 1. The land use conversion matrix for Song County from 2010 to 2020 (km²)

Land use type	Arable	Forest	Grassland	Water	Construction	Tourism	Other	Total (2020)
Arable	389.44	38.79	33.65	3.60	11.35	0.054	2.76	479.64
Forest	111.88	1947.72	94.99	6.21	27.17	0.180	16.4	2204.55
Grassland	6.62	7.01	59.58	0.39	1.86	0.000	1.86	77.32
Water	3.01	6.08	0.97	84.74	1.29	0.020	0.09	96.20
Construction	19.60	16.36	2.70	3.09	82.46	0.070	0.87	125.15
Tourism	0.45	0.34	0.13	0.29	1.05	0.310	0.02	2.59
Other	3.87	1.83	1.54	0.31	4.30	0.000	10.64	22.49
Total (2010)	534.87	2018.13	193.56	98.63	129.48	0.630	32.64	3007.93

Source: World Tourism Cities Federation (2023).

the development of tourism, its distribution around Song County is gradually increasing. In northern Song County it is mainly distributed in Chengguan, Hecun and Kuqu as well as the northern part of Zhifang, in the south it is mainly located in the north-western part of Baihe, concentrated in some of the villages there. Tourism land use in Checun shows a trend of spreading from east to west in its central part, and concentrated in the middle.

3.2. Changes in spatial patterns of tourism land use

Kernel density estimation was conducted for tourism land use in Song County in 2010 and 2020, and the natural break method was used to classify the results of the density analysis, resulting in the tourism land use density distribution map of Song County (Figure 2). Overall, during the period from 2010 to 2020, concentration in Song County has grown rapidly, with

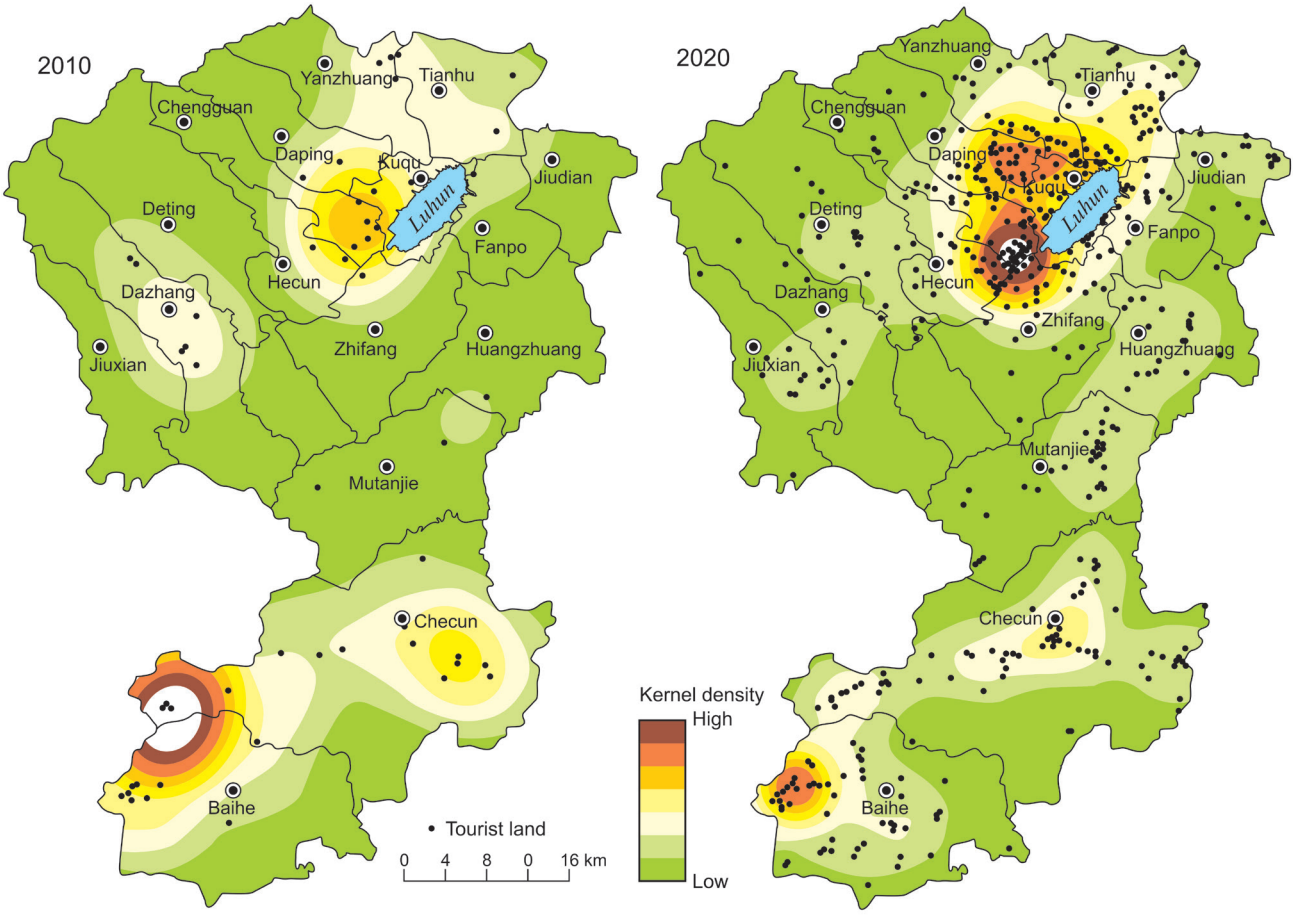

Figure 2. Distribution of kernel density of tourism land use in Song County: 2010 and 2020
Source: Geospatial Data Cloud (2023)

the highest density value increasing from 0.11 in 2010 to 1.07 in 2020.

In 2010, tourism land use in Song County was concentrated in the northeast and southern regions. The northeast region was mainly centred around Chengguan, while the southern region had two concentrated areas of tourism land use, one in the northwest of Baihe and the other in the east of Checun. The northwest of Baihe had the highest density value, while other areas had relatively less, most of the villages within Checun are have tourism land use. In 2020, the spatial clustering in Song County was significant, mainly concentrated in the northern and south-western parts and was distributed in all parts of the county, showing a trend of spreading from cores to the periphery. Among them, Chengguan, Hecun and Luhun in the north, and the northwest of Baihe in the south, had the highest number of distributions, gradually expanding into the surrounding areas.

Based on the density distribution map of tourism land use in Song County, the characteristics of changes in the spatial layout over the past 10 years can be analysed as follows:

1. In 2010, tourist land use in Song County was concentrated in two core areas in the northeast and southwest regions. By 2020, it had developed into a pattern of distribution in all towns and villages in the county, with two new core areas in the northwest and central regions, in addition to the existing ones in the northeast and southwest.
2. In terms of direction, the northern region of Song County has seen the most significant growth. In 2010, in Song County it was concentrated in Chengguan and Hecun but by 2020, tourist land use in Song County had expanded widely, with Chengguan, Hecun, Luhun and Zhifang as the central distribution areas, showing a trend of spreading towards the periphery. In the western region of Song County, tourism land use was concentrated in the southern part of Jiuxian in 2010, and by 2020, it had developed into a situation where it was found in Dazhang, Deting and Jiuxian. In the southern region of Song County, tourism land use, which was concentrated in the eastern part of Checun and the northwest part of Baihe in 2010, had developed into a situation where it was found in various towns in the northwest region by 2020.

3.3. Directional characteristics of tourist land use in Song County

By analysing the standard deviation ellipses of tourism land use in Song County in 2010 and 2020, the directional characteristics in the past 10 years can be determined (Figure 3). The rotation angles of the standard deviation ellipses of tourism land use in Song County in 2010 and 2020 are 16.37 degrees and 16.69 degrees, respectively, with a small difference between them, indicating that the main direction in Song County in its entire area is "southwest-northeast", and it is basically consistent. In terms of ellipse area, the standard deviation ellipses in 2010 and 2020 are 1620.22 km^2 and 1577.3 km^2, respectively, indicating that by 2020, development in Song County has become more concentrated, and the area has become more centralized.

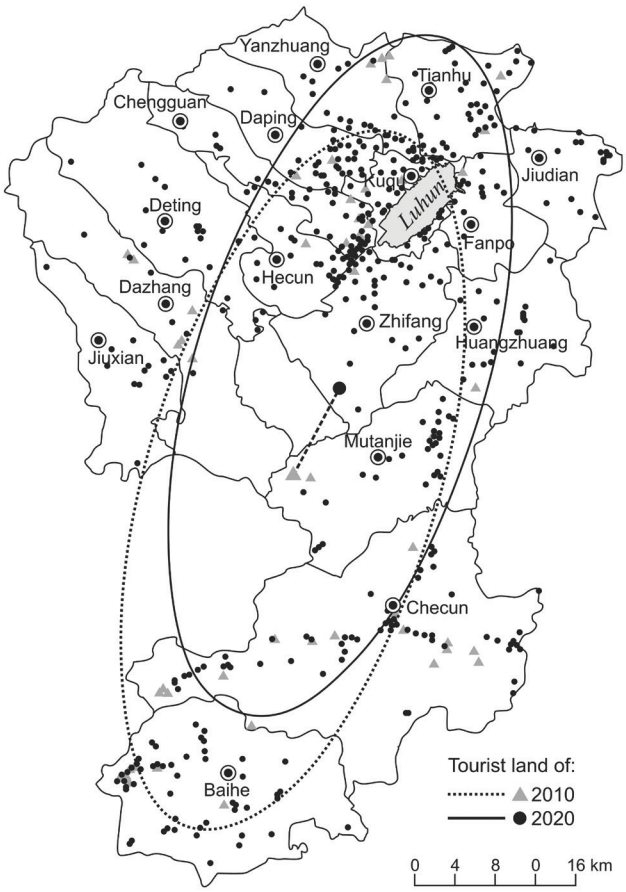

Figure 3. Analysis of standard deviation ellipses of tourism land use in Song County
Source: Geospatial Data Cloud (2023)

The geometric centre of tourist land use in Song County in 2020 is located to the northeast of the centre in 2010, with a distance of 11.41 km between the two centre points. This indicates that by 2020, it has become more concentrated in the northeast, and tourism resources in this part of Song County have become more centralized.

This study mainly analyses and discusses the spatio-temporal changes of tourism land use in Song County from 2010 to 2020. Over this period, its area in Song County has shown rapid growth over the past ten years. In terms of space, it is mainly clustered. The advancement of urbanization has provided opportunities for the increase in tourism land use. From 2010 to 2020, the urbanization rate of Song County increased from 20.14% to 41.35%. The continuous development of urbanization has promoted rural economic development,

the transfer of rural labour force to non-agricultural sectors, and a large amount of arable land lying idle, providing conditions for the intensive use of land and the construction of basic tourism facilities. The take-off of the tourism industry is inseparable from the favourable development environment formed by China's economic and social development. From 2010 to 2020, China's per capita disposable income increased from 12,500 yuan to 32,200 yuan, and the domestic tourism revenue increased from 1.26 trillion yuan to 2.23 trillion yuan.

In August 2021, China's NBC released the data of the third national land survey, which is mostly based on remote sensing or unmanned aerial vehicle (UAV) images with a resolution above one metre, combined with professional manual interpretation and field sampling verification to obtain highly accurate land use data. After statistical analysis, the difference between China's cultivated land area in widely used remote sensing datasets and the data published in the third land survey, is more than 10%. Thus, official land management data can more accurately and truthfully reflect the status of cultivated land resources.

Today, China is in a period of "three peaks": population, industrialisation and urbanisation. Social development is facing serious challenges, such as maintaining high-quality green economic development, ensuring green construction, protecting cultivated land and food security, and achieving the goal of carbon peaking and carbon neutrality. At the same time, the international situation is complex and volatile, with the COVID-19 epidemic intertwined with wars, and the food crisis in many countries worsening. The protection of cultivated land is therefore facing unprecedented pressure. Looking to the future, the protection of cultivated land in China should focus on quantity, quality and ecology. The demand for outbound tourism continues to increase, and the requirements for supporting facilities at tourist attractions continue to improve. This is a general trend to maintain the sustainable and healthy development of the tourism economy on the basis of improving the overall efficiency of land use. The Song County government has seized the opportunity, actively implementing the concept of "green mountains and clear waters are as valuable as mountains of gold and silver", and promoting the high-quality development of the local tourism industry.

During the study period, arable, forest and construction in Song County became the main land types encroached upon by tourism. Song County has flat arable land and good soil conditions, which results in lower development and utilization costs, making it conducive to the construction of tourism infrastructure. The development of tourism is characterized by beautiful mountain scenery, with a high forest coverage rate throughout the county and a rich variety of rare plant species, which itself has a certain tourism value, promoting the transformation of forest into tourism land use. In the current situation of continuous development of the local tourism industry, some rural residential areas are gradually transitioning to tourism supporting facilities such as farmhouse restaurants and homestays. With the continuous encroachment on arable land, forest and rural residential land, land occupied by tourism continues to increase.

The overall layout presents a "southwest-northeast" direction, mainly influenced by the topography of Song County. The terrain rises from northeast to southwest, with an altitude ranging from 245 to 2212 meters. Many tourist attractions have been built along the mountains in Song County and well-known scenic spots, such as Baiyun Mountain Yuhuangding, Longchi Manfeng and Tianchi Mountain Park, have all been built relying on the main mountain ranges. With the increase in the number of tourists, the construction of tourist attraction infrastructure has been carried out on the basis of existing attractions, basically in the "southwest-northeast" direction. On the other hand, since ancient times, the population, economic and administrative centre of Song County has been located in the northern part of the county along with historical and cultural resources and related cultural relics. In addition, transportation in the northern part is more convenient and therefore, tourist resources are also found there.

3.4. The process of creating tourism regions in the USA and Europe

The creation of tourism regions is a multifaceted undertaking that necessitates the involvement of diverse stakeholders, such as government entities, private enterprises and local communities. The process frequently seeks to advance economic development, safeguard cultural heritage and conserve the environment commencing by identifying potential areas that exhibit natural beauty, historical significance, cultural richness or unique experiences. Peripheral regions in Europe, such as the Scottish Highlands or the Greek Islands, have been specifically developed for tourism because of their natural and cultural attractions. Similarly, in the USA, regions like the Southwest or New England have been actively promoted for their distinctive landscapes and cultural histories (Nakipova et al., 2023; Shayakhmetova et al., 2020).

After identifying a region with tourism potential, the subsequent step typically involves the development of infrastructure. This entails the development of transportation, including roads, airports and train stations, as well as lodging establishments such as hotels, resorts and bed and breakfasts (Butler, 1980). The level of development is contingent upon the tourism strategy employed. Certain regions may prioritise high-volume tourism and construct extensive

infrastructure, whereas others may concentrate on sustainable tourism and only selectively develop infrastructure (Seken et al., 2019).

Once the essential infrastructure is established, the region is actively marketed and promoted to prospective tourists. Possible strategies may include implementing advertising campaigns, participating in travel trade shows, organising familiarisation trips for travel agents and journalists, and establishing partnerships with airlines and tour operators. The marketing strategy frequently emphasises the distinctive selling propositions for a region and focuses on specific demographic groups (Lesik et al., 2021).

With the expansion of tourism, it is imperative to implement effective management and regulation measures to guarantee the long-term viability of the industry. This may entail the establishment of regulations for tour operators, the enforcement of zoning regulations and the creation of protected areas. Within Europe, the European Union implements a range of policies and programmes to facilitate the advancement of sustainable tourism in outlying regions. Active participation from the community is essential in the development of tourist destinations. Residents can offer distinctive opportunities for tourists, including authentic gastronomy, indigenous handicrafts and cultural festivities. Furthermore, they can make a positive impact on the conservation of cultural heritage and the environment. Community-based tourism initiatives have, in certain instances, effectively facilitated economic development while simultaneously safeguarding local culture and the environment (Shahini et al., 2022).

Regular monitoring and evaluation of a region's tourism impact is essential. This may entail monitoring the number of tourists, quantifying the economic advantages, evaluating the environmental consequences, and assessing the level of tourist contentment. Modifications can be implemented to the tourism strategy to guarantee sustainable development, taking into account the obtained outcomes.

To summarise, the development of tourism regions necessitates a systematic approach that entails meticulous strategizing, active participation of stakeholders, and continuous supervision. While it can yield substantial economic advantages, tourism also poses difficulties in regard to safeguarding the environment and preserving cultural heritage.

4. Discussion

The study of the law of spatial and temporal changes and factors that influence cultivated land resources contributes to a comprehensive understanding of the current state of cultivated land use, disclosure of the driving mechanism of change, scientific justification of the rational use of land resources, policy formation and the forecasting of trends.

Despite the numerous publications on spatial and temporal dynamics in the tourism sector and the popularity of the industry today (Boavida-Portugal et al., 2016; Magige et al., 2020; Rosalina et al., 2023), a lack of research focusing on modifications in tourism due to the impact of spatial and temporal changes, and land use interrelationships within ecological and economic systems, is still present. The dynamism and scale of tourism, and its socio-economic consequences are the objective basis on which the social order for geographical tourism research has been formed, according to modern researchers Santana-Jiménez et al. (2019) and Shen et al. (2020). They interpret tourism as a continuous, dynamic and multifunctional phenomenon, characterised by a constant diversification of functions following changes in trends of socio-economic development, innovations in the scientific and technological sphere, and political fluctuations.

Sun and Wang (2022) define the tourism sector as a polylinear process with a clearly defined chronological vector of development, which determines the geospatial content of tourism as a phenomenon. The nature of this content, according to scientists, is the systemic and structural spatial and temporal coordination of processes taking place in this area. Sweetman et al. (2019) extend this idea, emphasising that the spatial and temporal properties of the process of formation of the tourism services market, as well as how the specifics of functioning and the impact of globalisation have led to the formation of certain patterns of geospatial organisation of tourism.

A group of researchers led by Tan et al. (2021) focused on the permanence of spatio-temporal coordination and on the structure of the tourism market. At the same time, they note that the imbalance lies in the inertia of the components of the market, which is measured by the time between the emergence of demand and the possibility of meeting it. Elimination of structural imbalances, temporal, territorial or component, is the essence of tourism policy. Tang et al. (2021) studied the factor of regional isomorphic motivation, which is manifested in the formation of specific tourist flows. They also emphasise the phenomenon of spatial centrality, which is the formation of hubs of tourist activity as a result of the synergy of financial, economic, information, innovation and technological processes. The dynamism of these processes causes change in the spatial hierarchy of the tourism market and, accordingly, creates the basis for spatial and temporal changes in tourism.

Wang et al. (2021), Wang (2022) and Wei et al. (2021) correlate with the conclusions of this study the fact

that tourism development and ecosystem services are a process of two-way interaction, complementing each other due to changes in land use patterns. By integrating tourism resources in the region, the effect of spreading tourism central hubs can be achieved. The development of the tourism sector is based on the ecosystem, so changes in the regional ecosystem affect the sustainability effect in the sectoral market. Comparing the results of this study with Yu et al. (2019), it is worth noting that it is obvious that among the numerous approaches to the study of tourism resources and their effective management, it is necessary to distinguish those that position them as a type and object of natural resources. Based on this, tourist resources are considered as a spatial part of the natural environment, which is the basic aggregate natural resource, soil cover, vegetation, subsoil, water, fauna and the community of natural recreational resources (Zhou & Li, 2018).

The specific direction of tourism research and its methodological basis have been formed relatively recently. However, currently, there is an increase in the involvement of methodological tools for the rational use of available resources, sustainable development in tourism land use planning, as well as the study of the dynamics of the latter and its modelling concerning the impact of various factors (Zhang et al., 2021). Based on the results obtained in this study, it is possible to form promising vectors for further optimisation of management in the tourism sector in the context of spatial and temporal analytics. Among them are the following:

1. It is necessary to adhere to a sustainable model of tourism development, while the trade-off between tourism revenues and environmental degradation should be taken into account in the process of tourism development in the region under study.
2. The introduction of a dynamic planning and monitoring system is optimal.
3. It is imperative to create a buffer zone in tourism locations, which helps to reduce the burden on the ecosystem, reduce emissions of pollutants and, in particular, greenhouse gases into the atmosphere, as well as improve connectivity between landscapes and increase biodiversity.

Effective rational development and allocation of tourism resources should be aimed at strengthening the role of ecological and environmental support, providing a stimulating force for urbanisation, and increasing the level of internal coordination between the tourism system, land use and the environment. Su et al. (2022) emphasise the need to consider the added value effect of ecosystem services at tourist destinations, which will effectively contribute to the coordinated and joint development of cities, preventive environmental protection and mitigation of destructive effects, development of the tourism sector in the region and community development.

Yang et al. (2022) considered various factors, including comfort, tourist experience and health, in their research to carry out a comprehensive assessment of the suitability of the environment of 684 cities in China for tourism, including a detailed comparative analysis of temporal and spatial models for the environmental suitability of cities, as well as factors of influence. The results of this study correlate with the conclusions of scientists and can be used to make effective decisions on further improving the tourist environment. In the spatio-temporal aspect, according to Liu et al. (2022) it is also necessary to consider the influence of a set of factors that have the pole position for the development of the tourism sector. Among them are climate change, an increase in the area of built-up land, anthropogenic reclamation and land pollution. At the same time, it is necessary to introduce effective buffer zones within areas of tourism land use, strict control over construction processes and an increase the number of green spaces. It is also necessary to introduce strict control over land use approvals and to seriously address misuse and illegal land use to reduce pressure on land in tourism regions. Implementation of dynamic scientific planning and monitoring norms is considered optimal.

The compromise between environmental protection and tourism development requires adherence to the model of sustainable tourism development in a region, as studied in this research. For further work, it seems advisable to develop effective innovative approaches to the spatial and temporal identification of changes in the tourism sector, as well as the use of innovative forecasting and modelling capabilities.

Figure 4 represents the domestic tourist arrivals from 2010 to 2020. The Y-axis displays arrivals in millions, while the X-axis shows the years.

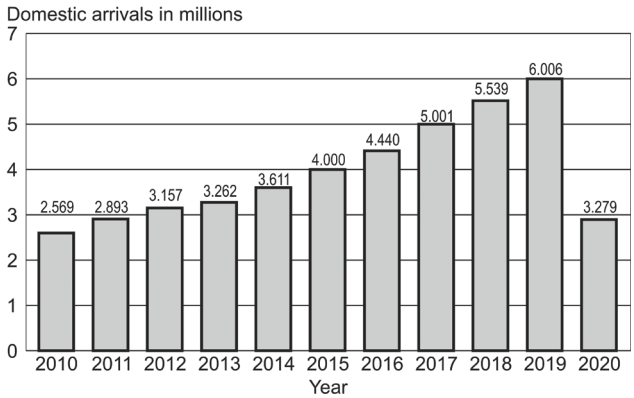

Figure 4. Arrivals of domestic tourists in 2010–2020
Source: Statista (n.d.)

The Figure 4 depicts an overall increasing trend in domestic tourist arrivals during the given period, with the highest value of 6,006,000 recorded in 2019. Subsequently, there was a significant decline in tourism for the year 2020.

Thus, effectively handling spatial and temporal fluctuations in tourist areas is a crucial element for promoting sustainable tourism growth. It entails tactics to regulate the movement of tourists, safeguard the environment and bolster local communities. Land use planning and zoning are effective strategies for managing spatial change. By delineating precise zones for tourism expansion and safeguarding other regions from excessive development, destinations can guarantee the sustainable management of growth. Carrying capacity assessments can aid in the management of spatial changes by establishing the upper limit of tourists that a destination can support without causing undesirable environmental, social or economic consequences (Shayakhmetova et al., 2020).

To effectively handle change over time, seasonal spread strategies to evenly distribute tourism activities throughout the year can be employed. One possible approach is to encourage tourism during periods of the year that are not typically popular, by implementing strategies such as marketing campaigns, reduced prices, or creating new attractions and activities that are attractive during different seasons. Visitor management systems can also facilitate the regulation of tourist influx by controlling the movement of visitors. This may entail implementing reservation systems for popular attractions, establishing quotas for the daily number of visitors permitted, or utilising technology to monitor and control visitor movements (Lesik et al., 2021).

Community-based tourism is an alternative method for handling spatial and temporal transformations. By engaging residents in the process of tourism planning and management, destinations can guarantee that development is both sustainable and advantageous for both tourists and local communities. Sustainable tourism practices can aid in the management of spatial and temporal changes by mitigating the environmental and societal effects of tourism. This may entail advocating environmentally sustainable lodging options, promoting activities that have minimal negative impact on the environment, and providing assistance to local enterprises. Regular monitoring and evaluation of tourism impacts can effectively manage spatial and temporal changes by providing accurate data on tourist numbers, environmental impacts and economic benefits. This data can be utilised to modify tourism strategies and policies as necessary.

To summarise, effectively handling spatial and temporal transformations in tourist destinations necessitates a holistic strategy that encompasses planning, regulation, community engagement, sustainable methodologies and continuous monitoring and assessment. By implementing these strategies, destinations can ensure that tourism development is both sustainable and advantageous for all stakeholders.

5. Conclusions

This study has selected Song County, a typical tourist county, as its research object. Based on land use data for Song County in 2010 and 2020, methods such as land use transfer matrix, kernel density analysis and standard deviation ellipses are used to analyse the changes in tourism land use in Song County over a period of 10 years. From 2010 to 2020, the tourism land area in Song County rapidly increased. The growth mainly derives from forest, construction and arable land. Due to the advantages of arable land, such as its own resource endowment and proximity to residential areas and main roads, it has become the main type encroached upon by tourism expansion. From 2010 to 2020, due to the advancement of urbanization, the concentration of tourism land use in Song County has rapidly increased. The highest kernel density value increased from 0.11 in 2010 to 1.07 in 2020. During the 10-year period, tourist land use increased throughout the county, with a concentration in the northern part. By 2020, a core increase area had been formed, mainly in the northern part of Chengguan, Hecun, Kuqu and the northwest part of Baihe. Due to the unique topographical influence of Song County, mainly created with natural landscape resources, it presents a "southwest-northeast" distribution throughout the county. From 2010 to 2020, tourism land use in Song County has become more concentrated, and its distribution centre has shifted significantly towards the northern part.

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