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Original Research

Spatiotemporal Evolution and the Driving Force of Tourism Ecosystem Health in the Yangtze River Economic Belt, China

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Abstract

The Yangtze River Economic Belt (YREB) is China's golden tourism belt, while also serving as a demonstration model for the construction of an ecological civilization. Therefore, tourism ecosystem health (TEH) is a key consideration for the promotion of sustainable development in the YREB. In this study, we explored the meaning and application of the TEH concept and developed a five-dimensional TEH evaluation index system based on a framework encompassing "vigor-organizational structure-resilience-ecological service functions-residents' health and education level" (VORSH). Taking the YREB as an illustrative case study, we used a coupling-coordination model and the geographic detector method to analyze the spatiotemporal evolution and driving forces of TEH in this region. Key results of the analysis were as follows: (1) Overall, TEH and its five dimensions in the YREB showed steady improvement during the period 2000-2019. (2) The spatial distribution of TEH was high in the eastern part of YREB and low in the western part, with a gradual transference of TEH grades. From 2000 to 2019, transfers of TEH states occurred mainly in two directions. The first entailed transference to a higher-level neighboring state, and the second entailed retention of the original health state. (3) From 2000 to 2019, the coupling-coordination types associated with the five dimensions of TEH in the YREB gradually evolved from a state of being uncoordinated to one of coordination, and the degree of coupling-coordination revealed spatial distribution pattern of east > center > west. (4) The leading factors driving the spatial differentiation of TEH in the YREB were identified as development of the tourism industry and regional economy, urbanization, residents' health conditions, and urban greening. The interactive relationships among these factors indicated a trend of nonlinear enhancement and bi-factor enhancement. In addition, differences in the main driving factors of TEH were found for particular years. This study provides useful inputs for promoting the

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development of a high-quality tourism economy and a high level of protection of the tourism ecology that can guide coordinated and sustainable development of TEH.

Keywords: tourism ecosystem health, VORSH model, spatiotemporal evolution, driving force, Yangtze River Economic Belt

Introduction

Past decades have witnessed the rapid development of China's economy. However, the pursuit of a pattern of intensive economic development has been associated with extensive damage inflicted on ecological environments and biodiversity in the country. The escalating gravity of environmental problems is attracting increasing attention and concern within the government and among researchers, scholars, and the public. In 2015, the government of China introduced the concept of innovative, coordinated, green, open, and shared development. In recent years, China has consistently prioritized ecological progress, integrating it into every dimension and phase of its economic and social development programs, while pursuing a philosophy based on the core tenet that "clear waters and lush mountains are invaluable assets." In light of its unremitting efforts, China has made a notable progress in improving its water quality, restoring aquatic biodiversity, and controlling pollution. Concurrently, it has demonstrated its commitment to strengthening international cooperation and engaging in collective initiatives to advance global ecological and environmental governance.

Compared with other types of industry, tourism is considered a relatively environmentally-friendly industry. Given its potential to generate low levels of pollution and high levels of community welfare, tourism has attracted considerable attention in many regions. However, irrational tourism development along with excessive numbers of tourists, and their uncivil behavior, have imposed a heavy burden on tourism ecosystems. Therefore, ensuring the health of tourism ecosystems is of long-term significance for promoting sustainable regional development.

The tourism ecological environment in the YREB evidences spatial differentiation, which is associated with the geographical environment, tourism resources, economic development and other factors. This situation raises several questions. How can tourism ecosystem health (TEH) be evaluated? What are its temporal and spatial evolution characteristics? What are the driving forces of TEH? All of these questions require further investigation. In this study, we constructed a five-dimensional TEH evaluation index system based on the VORSH model and analyzed the spatiotemporal evolution and driving factors of TEH in the YREB during the period 2000-2019.

We selected the YREB (Fig. 1) as the study area for the following reasons. First, from the perspective of development, the YREB is a major region of strategic importance in China. "The Outline of the Development Plan for the Yangtze River Economic Belt" issued in 2016 emphasized the strategic positioning of ecological prioritization and green development. Second, the geographical location of the YREB is vital, given that this region connects East, Central, and West China, encompassing the golden waterways of the Yangtze River, nine provinces, and two municipalities. Third, this region is an important economic development belt and also a "golden tourism" belt in China. According to China statistical yearbook, the GDP of the YREB in 2019 was 45.78 trillion yuan, accounting for 46.31% of the national GDP. Tourism has played a prominent role in the development of the YREB. In 2019, the revenue generated from domestic tourism in the YREB was approximately 10.19 trillion yuan, accounting for 22.25% of the region's GDP. Tourism is also an important component of the region's ecological civilization construction and sustainable development initiatives. A final consideration is the acute contradiction between development and ecological protection in the YREB. Successful strategies for addressing ecological problems in the YREB will provide a model for the harmonious coexistence of humans and nature in other regions. Therefore, improving the TEH of the YREB is of strategic significance for promoting China's ecological civilization, economic upgrading, and the sustainable development of its eastern, central and western regions.

This study contributes to the literature in several ways. First, previous studies have mainly focused on ecosystem health, with relatively few studies examining TEH. Our combined approach, bringing together the knowledge fields of tourism, ecology and health geography thus expands existing research on

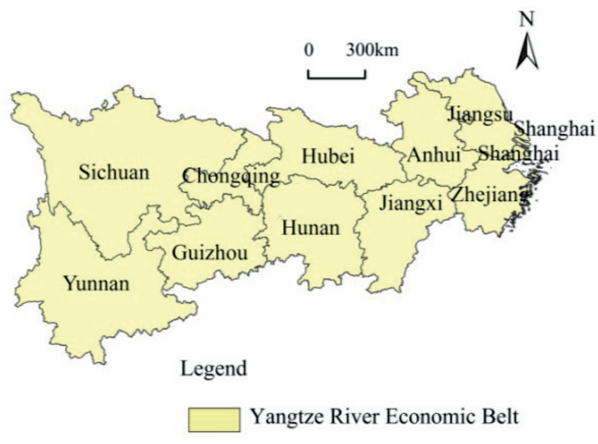

Fig.1. The study area.

ecosystem health. Second, models of evaluation index systems constructed in previous studies were mostly based on the Pressure-State-Response (PSR) and Vigor-Organization-Resilience (VOR) models, with little attention paid to ecological service functions and residents' health. We extracted the five dimensions of TEH, considered as a composite system, and explored their interactions with tourism ecosystems and TEH. This systematic and comprehensive approach used to examine TEH has rarely been applied in past studies. Third, previous studies have considered the overall development of TEH but have ignored the coupling and coordination relationships among its different dimensions. In this study, we applied a coupling-coordination model to analyze the evolution of these relationships among the five dimensions of TEH. Last, previous studies that analyzed the factors influencing TEH did not consider the evolution of the driving force of TEH during different time periods. In this study, we addressed this gap using the geographical detector method to analyze the spatial evolution of the driving force of TEH from a dynamic perspective.

The remainder of the paper is organized as follows. Section 2 presents a literature review, exploring the concept of TEH as well as advances and gaps in related studies. Section 3 presents the study methodology, introducing the index system, research methods, and sources of data on TEH. The results of the analysis are presented in section 4, and conclusions emerging from the findings are discussed in section 5. The theoretical and practical implications of the study, and its limitations, are explored in the final section.

Literature Review

It is widely acknowledged that James Hutton was the first to theorize ecosystem health. In the 1980s and 1990s, many scholars made important contributions to the conceptualization and study of ecosystem health. Using the analogy of human and animal organisms, Schaeffer et al. considered a healthy ecosystem to be one in which there is an absence of disease. He also noted that knowledge of ecosystem diseases was still at an exploratory stage because of the lack of methods for analyzing ecosystems, extracting data and information, and diagnosing ecosystem diseases using verified procedures. Consequently, accurately defining ecosystem health, let alone characterizing different states of ecosystem health and establishing standard parameters of ecosystem health, was difficult to accomplish [1].

Rapport et al. characterized a healthy ecosystem according to its structure, function, and ecological integrity [2]. Costanza identified the following key characteristics of a healthy ecosystem: stability, sustainability, stress resistance, and autonomy [3]. In addition to the work of the above scholars, the establishment of the International Society for Ecosystem Health in 1994 prompted heightened attention to the concept of ecosystem health within the international academic community [4].

Some scholars adopted a critical perspective on the concept of ecosystem health. Calow believed that the organic health analogy was helpful for gaining a better understanding of this concept but that ecosystem health was difficult to define, as the principles underlying each of these concepts differed. Moreover, the concept of ecosystem health was misleading and defective in a strong sense of analogy [5]. Wilkins also believed that the concept of ecosystem health entailed certain defects. In particular, Wilkins argued that the assumption that ecosystem health is similar to and contributes to human health was debatable. Moreover, the health of an ecosystem could not be simply defined by a single term [6].

In recent years, the concept of ecosystem health has gained widespread acceptance, and researchers and scholars in China as well as internationally have contributed significantly to advancing understanding. Studies have included analyses of ecosystem health and related concepts [7], evaluations of ecosystem health [8,9], the characteristics of temporal and spatial evolution of ecosystem health [10,11], driving factors of ecosystem health [12], risk assessments [13], and literature review on ecosystem health [14]. Assessments of ecosystem health have been widely applied in studies conducted on lakes [15, 16], wetlands [17, 18], landscapes [19], oceans [20], forests [21, 22], land [23], and many other natural systems. The indicator species and indicator system methods are the two main methods used to evaluate ecosystem health [24], with the latter being widely used in ecosystem health assessments, because it is appropriate for analyzing complex systems and is not restricted by a single species [25]. Many scholars have constructed ecosystem health evaluation index systems using various models: PSR [26, 27], Drive-Pressure-State-Impact-Response [28], VOR [29], and Basic-Pressure-State-Response [30]. In addition, multi-scale studies to evaluate ecosystem health have been carried out at global, provincial, and municipal scales [31-34].

With the ongoing advancement of ecosystem health research, scholars from different disciplines have examined this topic in combination with tourism and landscape science. These studies have led to the emergence of the research fields of TEH and landscape ecosystem health. Some scholars have attempted to analyze and evaluate the concept of TEH. Fan and Sun applied the PSR model to construct a TEH evaluation index system [35]. Zhou et al. conducted an evaluation of TEH focusing on white-headed crane Nature Reserve [36]. Xu et al. constructed an index evaluation system from the perspective of stakeholders to measure the state of the TEH state of the Yarlung Zangbo Grand Canyon National Park [37]. Weng et al. evaluated the TEH of the Silk Road and analyzed its spatiotemporal evolution characteristics [38].

Materials and Methods

Tourism Ecosystem Health

It is widely acknowledged that the concept of TEH covers the dimensions of vigor, organization, stability, and the ability to self-regulate. In this study, TEH indicated the health status of a tourism ecosystem, which is a composite system comprising a tourism system, an ecosystem, an economic system, and a social system. This type of ecosystem can provide products and services that contribute to the development of the composite system, while maintaining the internal vigor and organizational structure of the system and remaining strongly connected to residents' health and education levels [39]. Based on the concept of TEH and the interactive relationship of the composite system, TEH can be decomposed into five dimensions according to the interactive relationships within the composite system, namely "vigor–organizational structure–resilience–ecological service function–residents' health and education levels" (Fig. 2).

An ecosystem provides the sites, resources, and services required for the development of other systems, stimulating the formation of vigor and ecological service functions. On the one hand, economic development and tourism activities disturb an ecosystem. On the other hand, these also generate funds for investment in environmental protection and pollution control and prompt efforts to restore the ecosystem, giving rise to the dimension of resilience of the TEH.

The development of tourism generates significant economic, social, and ecological benefits. It enhances the position of the tourism economy within the national economy, thereby contributing to the optimization of the economic structure. From a societal perspective, tourism creates employment opportunities, leading to adjustments in the structure of social employment. Moreover, it strengthens the urbanization process and contributes to the optimization of the urban and rural population structures. Ecological benefits promoted by the development of tourism include land greening, ecological purification, and environmental beautification along with the improvement of natural structures, thus contributing to the organizational structure of TEH. Economic development can lead to enhanced livelihoods. For example, the investment of funds to strengthen medical and educational facilities and services contributes to improving medical conditions as well as citizens' scientific and cultural literacy, thereby generating the dimension of TEH relating to residents' health and education levels. To sum up, complex multi-dimensional interactions occur among tourism, ecological, economic, and societal systems, which give rise to the five dimensions of TEH.

These five dimensions play different roles in the development of TEH. Vigor is the engine that promotes the rapid development of TEH. Organizational structure is an internal characteristic, the continuous optimization of which is required for the steady and systematic advancement of TEH. Resilience is a necessary supporting factor, without which the development of TEH would be unsustainable. The ecological service function acts as a bridge, linking the tourism ecosystem with people. Residents' education levels constitute an important factor influencing the sustainable development of TEH, and their health levels affect not only the development of TEH but also, importantly, reflect TEH.

Complex interactions occur among the five dimensions. Vigor is an important force driving the optimization and adjustment of the organizational structure. It is also an important guarantee of improving resilience, ecological service functions, and residents' education and health levels. A reasonable organizational structure serves as a stabilizer, enabling the vigor, resilience, and sustainable development of ecological service functions to continue. Resilience is the fundamental guarantee of the continued vigor and organizational structure of the tourism ecosystem, ensuring the provision of service functions and the improvement of residents' education and health levels. Residents' health levels are an important factor affecting vitality, resilience, and the organizational

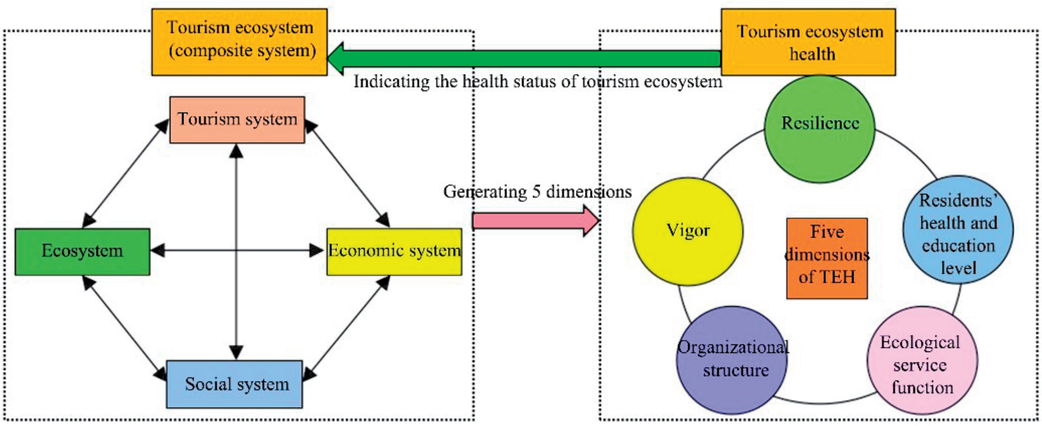

Fig. 2. Framework comprising a five-dimensional composite system for analyzing tourism ecosystem health.

structure, while also being a prerequisite for the effective development of ecological services.

Construction of an Index System and Data Resources

The index evaluation system was constructed using the VORSH model, and 31 indicators were selected, following the principles of rationality, measurability, and availability (Table 1). From an ecological perspective, the first dimension in this model, vigor, reflects the metabolic capacity and primary productivity of an ecology. Within this composite system, vigor is mainly evidenced as the social and economic development of tourism, indicated by the economic development of tourism industry, the scale of the tourism market, the growth rate of tourism, regional economic development, and resource consumption.

From an ecological perspective, the organizational structure in the VORSH model pertains to biodiversity and the relationship between and system elements. However, within the composite system, the primary dimensions of the organizational structure are the economic, social, population, and natural structures.

Resilience, considered from an ecological perspective, refers to the capacity of an ecosystem to preserve its structure and function, withstanding external disturbances. Within a composite system, resilience is manifested as the abilities of ecological systems to withstand human activities and restore themselves and in human environmental protection measures implemented by people, such as waste water treatment, waste recycling, and capital investment in environmental protection.

Ecological service functions refer to the supply of tourism products and services and are prominently manifested as tourist attractions, hotels, travel agencies, parks, leisure and recreation services, and transportation services provided for tourists. Service functions of the tourism ecosystem are constrained to a certain extent by the deterioration of the ecological environment.

Table 1. Evaluation indicators of TEH.

Dimension	Sub-dimension	Index (unit)	Positive / negative	Weight
Vigor	Development of tourism economy	Domestic tourism revenue (100 million yuan)	+	0.0789
		Foreign exchange income from tourism (USD 100 million)	+	0.0811
	Number of tourists	Domestic tourist arrivals (10,000 people)	+	0.0605
		Inbound Tourists (10,000 person)	+	0.0571
	Growth rate of tourism	Growth rate of total tourism revenue (%)	+	0.0045
		Growth rate of total number of tourists (%)	+	0.0092
	Local economic development	GDP per capita (yuan)	+	0.0503
	Resource	Daily domestic water consumption per capita (liter)	+	0.0223
Organizational structure	Economic structure	Proportion of tourism revenue in GDP (%)	+	0.0335
	Natural structure	Green coverage rate in built-up area (%)	+	0.0123
	Employment structure	Proportion of employees in the tertiary industry (%)	+	0.0136
	Population structure	Proportion of urban population in total permanent population (%)	+	0.0286
		Population density (person/km^2)	-	0.0091
		Proportion of tourist arrivals in the population (%)	+	0.0638
Resilience	Wastewater and waste treatment	Harmless treatment rate of municipal solid waste (%)	+	0.0129
		Urban sewage treatment rate (%)	+	0.0146
	Waste recycling	Comprehensive utilization rate of general industrial solid waste (%)	+	0.0129
		Product output value of comprehensive utilization of industrial wastes (100 million yuan)	+	0.0843
	Environmental protection investment	Investment in environmental pollution control as a percentage of GDP (%)	+	0.0302

Table 1. Continued.

Ecological service function	Tourism service function	Number of travel agencies (number)	+	0.0379
		Number of star-rated hotels (number)	+	0.0227
		Passenger volume (100 million people)	+	0.0310
		Passenger turnover (100 million person-kilometers)	+	0.0332
		Number of parks (number)	+	0.0463
		Park green area per capita (m^2)	+	0.0139
	Ecological environment condition	Sulfur dioxide emissions (10,000 tons)	-	0.0135
		Wastewater discharge (100 million tons)	-	0.0111
Residents' health and education level	Health status of the residents	Number of doctors per 10,000 people (number)	+	0.0323
		Number of beds in hospitals and health centers per 10,000 people (pieces)	+	0.0351
	Education status of residents	Number of college students per 10,000 population (person)	+	0.0225
		National fiscal education expenditure as a proportion of GDP (%)	+	0.0207

For example, environmental pollution has a negative impact on the ecological environments of tourist attractions, spoiling their beauty and prompting fewer visits by tourists and less tourism income as a result.

Residents' health and education levels are measured by indicators, such as the number of doctors and beds per 10,000 people and the number of university students per 10,000 people. The entropy method was used to calculate the index weight, and the comprehensive evaluation method was used to measure the TEH in the YREB from 2000 to 2019.

The data used in this study were mainly derived from statistical yearbooks and bulletins issued by the Chinese government including China environment statistical yearbook, China tourism statistical yearbook and China Regional Economic Statistical Yearbook. Missing data were supplemented using the interpolation and trend prediction methods. The vector map of the YREB was sourced from the official website of Ministry of Natural Resources of China, and the base map has been retained without modification.

Methods

In this study, three steps were applied. First, a Markov chain was used to analyze the probability of grade transitions of TEH during different periods. The following formula was used:

$$P_{ij}\ \ (E_i \rightarrow E_j) = \frac{n_{ij}}{n_i}\,, \tag{1}$$

where E_i denotes the original state of TEH in t_0, E_j denotes the state of TEH in t_1, P_{ij} denotes the probability of a shift in TEH from grade i to grade j during the period t_0 to t_1, n_{ij} refers to the number of provinces and cities whose TEH grades changed from i to j between t_0 and and t_1, and n_i refers to the number of provinces and cities whose TEH grade was i at t_0.

Second, the coupling-coordination model was used to analyze the modes of coordinated development of the five dimensions of TEH.

$$C = 5 \times \sqrt[5]{U_1U_2U_3U_4U_5}/(U_1 + U_2 + U_3 + U_4 + U_5), \tag{2}$$

$$T = \textstyle\sum_{i=1}^{5} \alpha_i \times U_i\,, \sum_{i=1}^{5} \alpha_i = 1\,, \text{and} \tag{3}$$

$$D = \sqrt{C \times T}. \tag{4}$$

In the above formula, C denotes the degree of coupling of the five dimensions of TEH, with a value range of 0-1; U_i denotes the value of the dimensions of TEH, ranging from 0 to 1; represents the comprehensive evaluation value of TEH; denotes the weight of the dimension of TEH; denotes the degree of coupling coordination of the five dimensions of TEH [40]. Table 2 shows the various categories associated with the coupling-coordination degree [41-46].

Lastly, a geographical detector was used to diagnose the driving factors of TEH.

The geographic detector, which was invented by Wang and colleagues at the Chinese Academy of Sciences, is an effective model for detecting the driving factors of spatial differentiation. This model, which has been widely used in research on tourism geography, has the advantages of providing clear meanings relating to physical characteristics and requiring few assumptions. It includes four detectors,

Table 2. Categories associated with the coupling-coordination degree for the five dimensions of TEH.

Range	Value	Classification	Range	Value	Classification
Uncoordinated	0≤D≤0.1	Highly uncoordinated	Transitional coordinated	0.5<D≤0.6	Approaching coordinated
	0.1<D≤0.2	Seriously uncoordinated		0.6<D≤0.7	Slightly coordinated
	0.2<D≤0.3	Moderately uncoordinated	Coordinated	0.7<D≤0.8	Moderately coordinated
	0.3<D≤0.4	Slightly uncoordinated		0.8<D≤0.9	Favorably coordinated
	0.4<D≤0.5	Approaching uncoordinated		0.9<D≤1	Highly coordinated

namely factor, interactive, risk, and ecological detectors. In this study, we used the factor detector to analyze the degree of interpretation of the independent variable X to the dependent variable Y by calculating the value of q. The following formula was used:

$$SSW = \sum_{h=1}^{L} N_h \sigma_h^2 \qquad SST = N\sigma^2, \text{ and } \quad q = 1 - \frac{SSW}{SST} \tag{5}$$

In this formula, h = 1, 2, … L denotes the classification of driving factors X, and σ_h^2 and σ^2 respectively denote the variance of the driving factor classification and that of the TEH in the YREB. *SSW* and *SST* represent the within sum of squares and the total sum of squares, respectively.

The value range of q was 0-1. A larger value of q indicated stronger interpretation ability, and conversely, a smaller value indicated weaker interpretation ability. In addition, the interactive detector was used to determine whether an interactive relationship existed among the driving factors and to identify what type of interactive relationship this was [47-50].

Results

Temporal Evolution Characteristics of the Five Dimensions of TEH in the YREB

The comprehensive evaluation method was used to measure the value of TEH in the YREB, and a line chart was plotted using EVIEWS software (Fig. 3). The overall values of TEH and its five dimensions showed an upward trend from 2000 to 2019. The most advanced dimension was vigor, which increased in value from 0.0254 in 2000 to 0.1819 in 2019, revealing an average annual growth rate of 10.91%. The boom in domestic tourism and in the regional economy during the study period led to significant increases in the number of tourists and in incomes.

The organizational structure also underwent rapid development, with its value increasing from 0.0255 in 2000 to 0.0852 in 2019, with an average annual growth rate of 6.54%. Urbanization, ecological construction, and the optimization of the industrial structure were all accelerated by advancing tourism. Adjustments of the natural, social, population, and economic structures contributed to the steady growth of the organizational structure.

The value for the resilience of TEH rose from 0.0235 in 2000 to 0.0807 in 2019, with an average annual growth rate of 6.72%. As a result of the government paying more attention to the ecological environment, the capacity for treating waste water and its comprehensive utilization improved significantly, and the proportions of investments in environmental pollution control in relation to the GDPs of most provinces and cities increased substantially. However, the proportion of investments in environmental protection in relation to the regional GDP showed a declining trend because the economic growth rate exceeded that of investments in environmental protection in some of the provinces and cities.

Of the five dimensions, ecological service functions developed at the slowest pace, increasing in value from 0.0412 to 0.0980 in 2019, with an average annual growth rate of 4.66%. Improvements in the tourism supply also satisfied the demands of residents for leisure and tourism activities. However, economic development and population growth led to significant increases in sulfur dioxide and wastewater emissions, thereby increasing the ecological environment load. Consequently, they exerted a negative impact on tourism activities, hindering the rapid development of tourism ecological services.

The residents' health and education levels increased in value from 0.0193 in 2000 to 0.0756 in 2019, with an average annual growth rate of 7.45%. The number of doctors and beds per 10,000 persons increased significantly, and residents' health status improved significantly. Moreover, increased investments in education in all of the provinces and cities led to a marked increase in residents' environmental awareness, which was of great significance for the sustainable development of TEH.

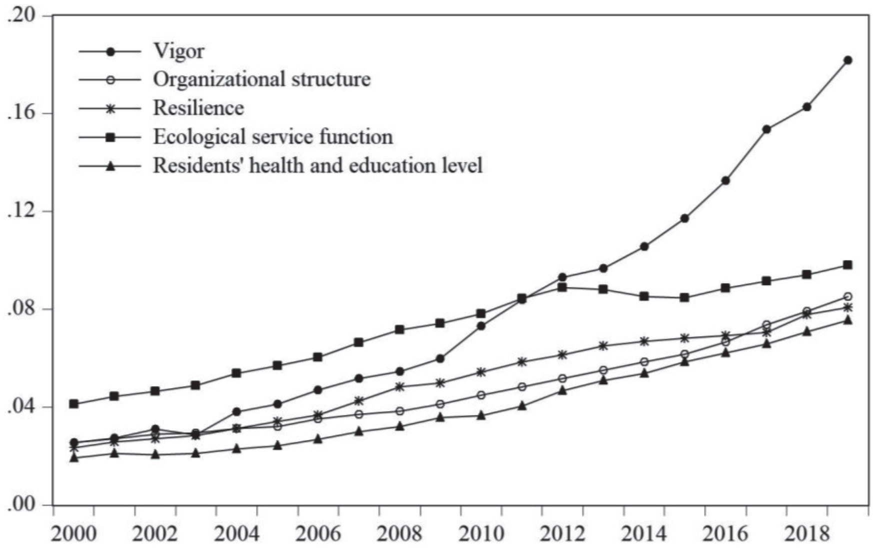

Fig. 3. The five dimensions of TEH.

Temporal and Spatial Evolution of TEH in the YREB

Five grades were established for TEH using the equipartition method (Table 3). The ArcGIS10.2 software was used to map the spatial distribution of TEH in the YREB from 2000 to 2019. As shown in Fig. 4, the mean value of TEH in the YREB increased from 0.13 to 0.52 from 2000 to 2019, indicating that the state of TEH in this region had improved.

A Markov chain was used to calculate the probability of a transition occurring in the state of TEH. To enable a clear depiction of the transition process, we calculated the transition probability matrices from 2000 to 2019 (Table 4). The results showed a gradual change in TEH states in provinces and cities located in the YREB. In the period from 2000 to 2019, the change in the state of TEH generally revealed a transitional pattern occurring in one of two directions: transfer to the neighboring higher-level state or preservation of the original TEH state.

From 2000 to 2006, Shanghai achieved the highest TEH grade in the YREB. However, from 2007 to 2019, the highest TEH grade shifted from Shanghai to neighboring provinces, namely Jiangsu and Zhejiang. From 2000 to 2016, the TEH grade of Guizhou Province was the lowest. However, since 2017, the grades of Jiangxi and Hubei Provinces have been the lowest, revealing a shifting pattern moving from Western to Central China. Zhejiang Province evidenced the greatest interannual fluctuations of TEH, whereas Shanghai had the least fluctuations. The statistical value of TEH in Zhejiang Province increased from 0.1871 in 2000 to 0.6188 in 2019, whereas that of Shanghai increased from 0.2437 in 2000 to 0.5387 in 2019.

In general, the variation coefficient of TEH in the YREB decreased from 0.39 during the period 2000-2019 to 0.12 in 2019, indicating that, although TEH in the YREB was spatially differentiated, regional differences showed a narrowing trend. The spatial distribution of TEH revealed a “high in the east and low in the west” pattern. From 2000 to 2019, the higher-

Table 3. Categories associated with the grade of TEH.

Grade	Ill	Unhealthy	Sub-healthy	General healthy	Very healthy
Value of TEH	[0,0.2]	(0.2, 0.4]	(0.4, 0.6]	(0.6, 0.8]	(0.8, 1]

Table 4. Transition probability matrix with tourism ecosystem health grades.

Period	Type	Iow	Slightly low	Moderately high	high
2000-2019	Low	0.33	0.53	0.14	0.00
	Slightly low	0.02	0.23	0.74	0.02
	Moderately high	0.00	0.04	0.63	0.33
	High	0.00	0.00	0.00	1.00

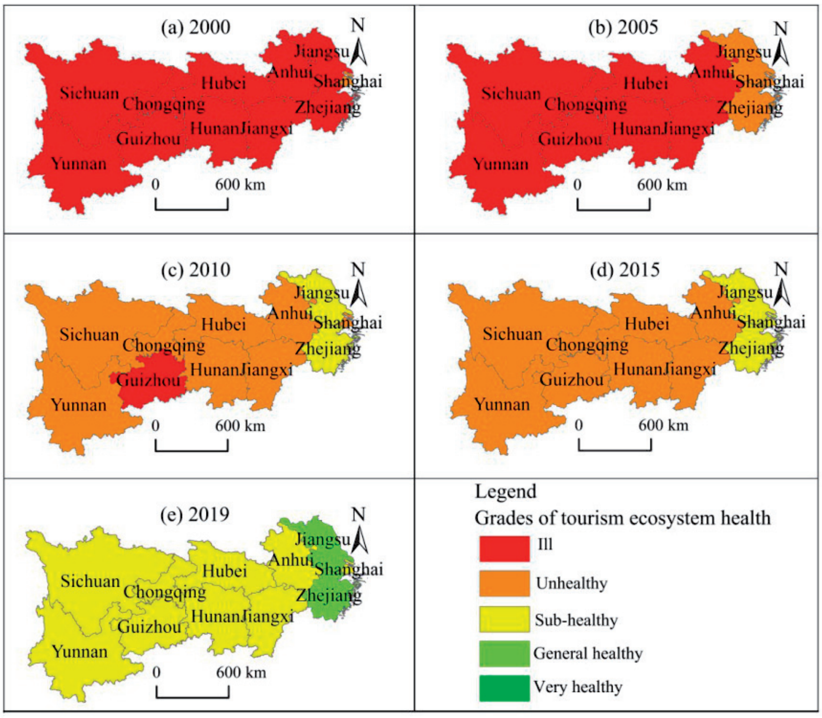

Fig. 4. TEH grades in the Yangtze River Economic Belt from 2000 to 2019.

level TEH state demonstrated stronger spatial diffusion and substitution effects, whereas the lower-level states evidenced stronger spatial attenuation effects.

Spatiotemporal Evolution of Coupling-Coordination Relationships Among five Dimensions of TEH in the YREB

To perform a deeper examination of the degree of coordination of the five dimensions of TEH in the YREB during the period 2000-2019, we used a coupling-coordination model. As we considered all five dimensions to be equally important, $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = 0.2$ in Formula (3). We used the ArcGIS10.2 software to visualize the coupling-coordination relationships among the five dimensions of TEH in the YREB region in 2000, 2005, 2010, 2015, and 2019 (Fig. 5). The results indicated that the mean value of the coupling coordination degree of the five dimensions of TEH increased from 0.36 in 2000 to 0.72 in 2019, with an annual growth rate of 3.74%. Referring to the categories associated with the coupling-coordination degree, we determined that the five dimensions of TEH in the YREB gradually changed from a state of being uncoordinated to one of coordination.

The variation coefficient of the coupling-coordination degree of the five dimensions of TEH in the YREB decreased from 0.21 in 2000 to 0.05 in 2019, indicating a reduction in spatial differences. Among all of the provinces and cities in the YREB, Shanghai evidenced the highest coupling-coordination degree from 2000 to 2006. However, from 2007, the highest value shifted to Jiangsu and Zhejiang Provinces. The coupling-coordination degree of Guizhou Province was the lowest during the period 2000-2017, whereas from 2018, Sichuan Province evidenced the lowest value. The coupling-coordination degree generally showed a spatial distribution pattern of easter>center>west. The inter-annual change in the coupling-coordination degree was highest in Guizhou Province, increasing from 0.227 in 2000 to 0.7074 in 2019 and transitioning from being moderately uncoordinated to being moderately coordinated. The coupling-coordination degree for Shanghai revealed the least inter-annual variation, increasing from 0.499 in 2000 to 0.7126 in 2019 and transitioning from a state approximating one of being uncoordinated to one of moderate coordination.

The Driving Force of Spatial Differentiation of TEH

The geographic detector model was used to analyze the driving force of the spatial differentiation of TEH. We first selected influencing factors of TEH from nine aspects: development of the tourism industry, regional economic development, consumption of natural resources, environmental protection, industrial structure, residents' educational status, greening status, urbanization, and level of medical care. Applying the principles of rationality and availability, we selected 12 independent variables (Table 5). Because the geographic detector requires the independent variable to be a type variable and not a numeric variable, we used the quintile method to arrange the value of each driving factor

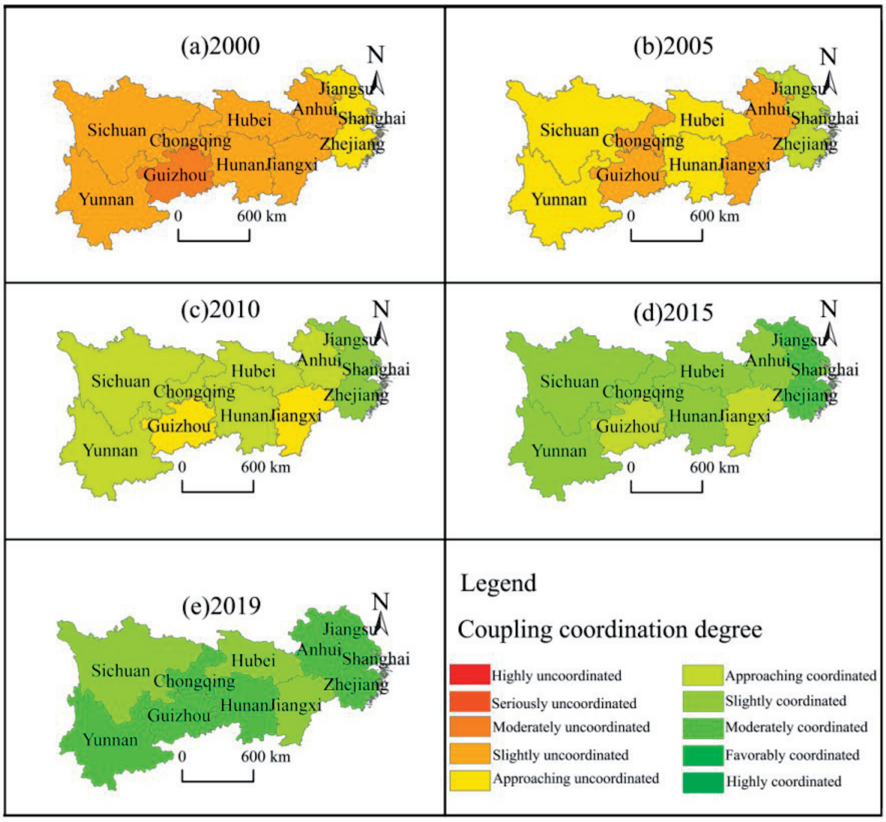

Fig. 5. The coupling and coordination of the five dimensions of tourism ecosystem health.

in ascending order: (0-20%], (20-40%], (40%-60%], (60-80%], and (80%-100%) and assigned values of 1, 2, 3, 4, and 5, respectively, to these values.

Finally, we analyzed the driving forces of the spatial differentiation of TEH in 2000, 2005, 2010, 2015, and 2019 using the factor detector. (Table 6). The results showed that the q values of X3, X1, and X2 in 2000 were 0.8511, 0.783, and 0.783, respectively. The latter two values passed the 95% significance level test, indicating that the development of the regional economy in 2000 explained the spatial differentiation of TEH to the greatest extent, and the development of the

Table 5. Selection of influencing factors.

Influencing factors	Independent variables		Unit
Development of tourism Industry	X1	Domestic tourism revenue	100 million yuan
	X2	Domestic tourist arrivals	10,000 person
Regional economic development	X3	GDP per capita	yuan
Natural resources consumption	X4	Daily domestic water consumption per capita	liter
Environmental protection	X5	Investment in environmental pollution control as a percentage of GDP	%
	X6	Comprehensive utilization rate of general industrial solid waste	%
Industrial structure	X7	Proportion of employees in the tertiary industry	%
	X8	Proportion of tourism revenue in GDP	%
Education status of residents	X9	National fiscal education expenditure as a proportion of GDP	%
Urban greening status	X10	Park green area per capita	m^2
Urbanization	X11	Proportion of urban population in total permanent population	%
Level of medical care	X12	Number of doctors per 10,000 people	Person

Table 6. The results of the factor detection.

Independent variables	2000	2005	2010	2015	2019
X1	0.7830 **	0.9687 ***	0.5311	0.8442*	0
X2	0.7830 **	0.6755	0.2745	0.2898	0.0086
X3	0.8511	0.8799 **	0.9178	0.7833**	0.1675
X4	0.3599	0.4043	0.3698	0.466	0.6137
X5	0.5617	0.4661	0.3561	0.1594	0.631
X6	0.7462	0.8401 ***	0.4709	0.8089**	0.4643
X7	0.4862	0.2962	0.4521	0.3174	0.18
X8	0.4631	0.2236	0.5226	0.3241	0.2395
X9	0.294	0.5292	0.4911	0.558	0.5562
X10	0.0197	0.9440 **	0.4243	0.3159	0.0621
X11	0.7806	0.748	0.9186 **	0.8200**	0.5613
X12	0.7062	0.8952 *	0.9517 ***	0.5422	0.085

Notes: *** means p<0.01, ** means p<0.05, * means p<0.1.

tourism industry had a significant impact on the spatial differentiation of TEH. The best performance was found for 2005. The q values of X1, X3, X6, X10, and X12, which passed the significance test, were 0.9687, 0.8799, 0.8401, 0.9440, and 0.8952, respectively, indicating that the development of the tourism industry, local economic development, environment protection, greening status, and the level of medical care had significant impacts on the spatial differentiation of TEH. The q values of X11 and X12 in 2010 were 0.9186 and 0.9517, respectively, which passed the significance test at the 95% and 99% levels, indicating that TEH in 2010 was mainly affected by urbanization and the level of medical care.

The q values of X1, X11, X6, and X3 in 2015 were 0.8442, 0.82, 0.8089, and 0.7833, respectively, indicating that the spatial differentiation of TEH in 2015 was significantly affected by the development of the tourism industry, urbanization, environmental protection, and regional economic development. The results for the factor detection in 2019 were not ideal. The q value of X4 was the largest, but it failed to pass the significance test. The reason why the driving factors did not have a significant impact on TEH was rapid development of the tourism industry and improvements in the regional economy and environmental protection of provinces and cities in the YREB. In addition, spatial differences in driving factors and TEH were reduced. Consequently, the original driving factors no longer had a significant impact on the spatial differentiation of TEH.

In addition, we used geographic detectors to detect the interactions of driving factors. We found that there was an interactive relationship between every two influencing factors, and the TEH interactive relationship was characterized by nonlinear enhancement and bi-factor enhancement, which meant that the combined actions of any two factors had an influence on TEH exceeding that of the two driving factors, that is, $q(X_i \cap X_j)>q(X_i) + q(X_j)$ or $q(X_i \cap X_j)>(q(X_i), q(X_j))max$.

In summary, the leading driving factors of the spatial differentiation of TEH were the development of the tourism industry, the regional economy, urbanization, residents' medical conditions, and urban greening. The spatial differentiation of TEH resulted from the interaction of multiple driving factors rather than being the independent effect of a single factor. The leading drivers of TEH varied for different years. As the spatial difference for driving factors and TEH continued to shrink, the impact of the driving factors on the spatial differentiation of TEH became insignificant.

Conclusion

In this study, we first explained the concept of TEH and established a five-dimensional analytic framework for investigating TEH. Next, we constructed an index system for evaluating TEH based on the VORSH model. Last, we analyzed the spatiotemporal evolution and driving factors of TEH in the YREB, using a Markov chain and applying the coupling-coordination and geographic detector models. The conclusions of the study were as follows.

First, TEH and its different dimensions showed an upward trend in the YREB during the period 2000-2019. However, there were considerable differences in the development and growth rates of the five dimensions of TEH. The vigor, organizational structure, resilience, and residents' health and education levels developed rapidly with the boom in the development of domestic tourism, adjustments in the organizational structure, the increasing attention paid by the government to the ecological environment, and increased educational investments in the YREB. At the same time, economic development and population growth led to a significant increase in emissions of waste gases and water, thereby increasing the burden on the ecological environment and hindering the rapid development of ecological service functions.

Second, our analysis of the temporal and spatial distribution of TEH in the YREB showed an upward trend in its mean values during the period 2000–2019. The TEH grade evidenced a slow transference process. At each stage, the TEH states mainly evidenced one of two directions of transference: to the neighboring higher-level state or no transference and the preservation of the original health state. The TEH grades evidenced significant spatial differentiation in their distribution; higher grades had strong spatial diffusion and substitution effects, whereas lower grades evidenced strong spatial attenuation effects, showing an overall spatial distribution pattern of "high in the east and low in the west."

Third, the coupling-coordination degree for the five dimensions of TEH showed a significant upward trend from 2000 to 2019, and the types of coupling coordination for the five dimensions in the YREB gradually changed from a state of being uncoordinated to one of being coordinated. The degree of coupling coordination showed an "eastern>central>western" pattern of spatial distribution but with decreasing regional differences.

Last, our results revealed that the spatial differentiation of TEH in the YREB from 2000 to 2019 was a combined effect of multiple driving factors, with the development of tourism industry, regional economy, urbanization, level of medical care, and urban greening being the leading driving factors. In addition, the main driving factors of TEH varied during different years.

Discussion

Theoretical and Practical Implications

This research is of considerable theoretical and practical significance. At the theoretical level, ecosystem health research on many natural systems, such as lakes, forests, oceans, and wetlands, has advanced significantly. However, there are relatively few studies on TEH, which can be considered as a branch of this research field. In this study, we explored the meaning of TEH, constructed an analytical framework for investigating TEH as a composite system, and established the VORSH model for its evaluation. This study is of theoretical significance for future research on the TEH concept as well as its driving forces and evaluation. From a practical perspective, we analyzed the temporal and spatial evolution characteristics of TEH and its five dimensions using a Markov chain and coupling-coordination model and applied the geographic (factor) detector to assess the driving force of TEH.

Our findings can provide inputs for policy makers in different regions that can improve the health of the regional tourism ecosystem and can be used as guidelines for the promotion of the coordinated and sustainable development of tourism, ecologies, the economy, and society. In order to improve the TEH In the YREB, the government should always stick to a path of green, low-carbon and sustainable development and formulate some policies to promote the development of tourism economy, stimulate the vitality of tourism ecosystem, and better improve the ecological services for tourists. Secondly, the government should enhance residents' awareness of environmental protection, improve the city's pollution treatment capacity, increase investment in environmental protection, and enhance the resilience of the tourism ecosystem. Finally, the government should improve the urban green coverage rate, beautify the tourism ecological environment, optimize the organizational structure of the tourism ecosystem. In addition, this study has implications for the global governance of the tourism ecosystem. Governments in different countries and regions can strengthen collaborative efforts aimed at jointly addressing tourism-associated ecological problems and improving the health of tourism ecosystems on a global scale.

Limitations and Future Research

A tourism ecosystem is a composite system comprising a tourism system, ecosystem, economic system, and a social system. The complexity and comprehensiveness of this system makes the definition and evaluation of TEH very challenging. In this study, we selected 31 indicators to evaluate TEH, considering many aspects relating to the environment, tourism, economy, and society. However, because of limited available data, many indicators closely related to TEH, such as biodiversity, habitat fragmentation, and air quality, could not be selected. Moreover, the rationality of the index selection requires further discussion, and the evaluation system also needs to be improved.

We selected the spatial scale of the YREB for evaluating the spatiotemporal evolution characteristics of TEH using the VORSH model. However, it is also important to construct indicator systems for evaluating TEH at different spatial scales in future studies. Moreover, a tourism ecosystem is dynamic, being open, interactive, and changeable. Accordingly, the evaluation standards and delineation of TEH states require moderate adjustments during different developmental stages.

Furthermore, at the theoretical level, TEH research has mainly focused on evaluation, with insufficient attention on theoretical innovation. Future studies should therefore seek to introduce theoretical innovations and breakthroughs. The research methods used to explore TEH also require innovation. In the future, studies could be conducted at different scales using different methods, such as Remote Sense and Geographic Information System.

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Conflict of Interest

The authors declare no conflict of interest.

References

1. SCHAEFFER D.J., HERRICKS E.E., KERSTER H.W. Ecosystem health: I. Measuring ecosystem health. Environmental Management, **12** (4), 445, **1988**.
2. RAPPORT D.J. Evaluating ecosystem health. Journal of Aquatic Ecosystem Health, **1** (1), 15, **1992**.
3. RAPPORT D.J., COSTANZA R., MCMICHAEL A.J. Assessing ecosystem health. Trends in Ecology and Evolution, **13** (10), 397, **1998**.
4. RAPPORT D.J., BÖHM G., BUCKINGHAM D., CAIRNS J., COSTANZA R., KARR J.R., de KRUIJF H.A.M., LEVINS R., MCMICHAEL A.J., NIELSEN N.O., WHITFORD W.G. Ecosystem Health: The Concept, the ISEH, and the Important Tasks Ahead. Ecosystem Health, **5** (2), 82, **1999**.
5. CALOW P. Can ecosystems be healthy? Critical consideration of concepts. Journal of Aquatic Ecosystem Health, **1** (1), 1, **1992**.
6. WILKINS D.A. Assessing ecosystem health. Trends in Ecology and Evolution, **14** (2), 69, **1999**.
7. BIAN D.H., CAO Y.H., HE C.G., GAO K. Conceptual distinction of ecosystem health, ecological risk and ecological security. Environmental Protection Science, **42** (5), 71, **2016** [In Chinese].
8. DAS M., DAS A., PEREIRA P., MANDAL A. Exploring the spatiotemporal dynamics of ecosystem health: A study on a rapidly urbanizing metropolitan area of Lower Gangetic Plain, India. Ecological Indicators, **125**, **2021**.
9. BEBIANNO M.J., PEREIRA C.G., REY F., CRAVO A., DUARTE D., D'ERRICO G., REGOLI F. Integrated approach to assess ecosystem health in harbor areas. Science of Total Environment, **514**, 92, **2015**.
10. HAN X., LIU C. S., HU J. L., WANG X. Y., LUO L., ZHAO Y.C., LI L., JI X.Y., YAN H., WANG Y. Dynamic evolution of landscape pattern and ecosystem health assessment of Tianshan Natural Heritage Site in Xinjiang. Arid Land Geography, **42** (5), 71, **2016** [In Chinese].
11. EKUMAH B., ARMAH F.A., AFRIFA E.K.A., AHETO D.W., ODOI J.O., ABDUL-RAHAMAN AFITIRI A.-R. Geospatial assessment of ecosystem health of coastal urban wetlands in Ghana. Ocean and Coastal Management, **193**, **2020**.
12. TAN J.J., DONG Z.C., FU X.H., XU W., LIU Q. Analysis of watershed landscape ecosystem health evolution and contribution of driving factors. Journal of Hohai University (Natural Sciences), **43** (2), 107, **2015** [In Chinese].
13. BAO L.R., DENG H., JIA Z.M., LI Y., DONG J.X., YAN M.S., ZHANG F.L. Ecological and health risk assessment of heavy metals in farmland soil of northwest Xiushan, Chongqing. Geology in China, **47** (6), 1625, **2020** [In Chinese].
14. LIU Y.X., PENG J., WANG A., XIE P., HAN Y.N. New research progress and trends in ecosystem health. Acta Ecologica Sinica, **35** (18), 5920, **2015** [In Chinese].
15. WU Y.W., LI Y.J., ZHANG L.Y., GUO L.G., LI H., XI B.D., WANG L., LI C.L. Assessment of lakes ecosystem health based on objective and subjective weighting combined with fuzzy comprehensive evaluation. Journal of Lake Sciences, **29** (5), 1091, **2017** [In Chinese].
16. ZHANG Y.H., YANG G.S., WAN R.R. Ecosystem health assessment indicators for lakes. Resources Science, **36** (6), 1306, **2014** [In Chinese].
17. SUN C Z., CHEN F.Q. Assessment on ecosystem health of landscape of the coastal wetlands in the mouth of the Yalu River. Wetland Science, **15** (1), 40, **2017** [In Chinese].
18. XU Y., YANG F., YAN C.Z. Ecosystem health assessment of urban wetland in Xiong'an based on landscape pattern. Acta Ecologica Sinica, **40** (20), 7132, **2020** [In Chinese].
19. SONG S., XU D.W., SHI M.X., HU S.S. Spatial and temporal evolution of landscape ecological health in Naolihe Basin. Journal of Nanjing Forestry University (Natural Sciences Edition), **45** (2), 177, **2021** [In Chinese].
20. DI Q.B., ZHANG J., WU J.L. Assessment of marine ecological carrying capacity in Liaoning province based on the ecosystem health. Journal of Natural Resources, **29** (2), 256, **2014** [In Chinese].
21. ISHTIAQUE A., MYINT S.W., WANG C.Y. Examining the ecosystem health and sustainability of the world's largest mangrove forest using multi-temporal MODIS products. Science of The Total Environment, **569-570**, 1241, **2016**.
22. YUAN F., ZHANG X.Y., LIANG J. Assessment indicators system of forest ecosystem health based on the disturbance in Wangqing forestry. Acta Ecologica Sinica, **33** (12), 3722, **2013** [In Chinese].
23. YANG Y.J., SONG G., LU S. Assessment of land ecosystem health with Monte Carlo simulation: A case study in Qiqihaer, China. Journal of Cleaner Production, **250**, **2020**.
24. MA K.M., KONG H.M., GUAN W.B., FU B.J. Ecosystem health assessment: methods and directions. Acta Ecologica Sinica. **21** (12), 2106, **2001** [In Chinese].
25. PENG J., WANG Y.L., WU J.S., ZHANG Y.Q. Evaluation for regional ecosystem health: methodology and research progress. Acta Ecologica Sinica, **27** (11), 4877, **2007** [In Chinese].
26. HUO Z.W., WANG J. Assessment on Ecosystem health in Northwest Conservation Area of Beijing City Based on PSR Model. China Land Science, **34** (9), 105, **2020** [In Chinese].
27. DU J., CHEN Y. Ecosystem health evaluation of oasis-desert ecotone in Minqin county based on PSR model.

Research of Soil and Water Conservation, **23** (1), 215, **2016** [In Chinese].
28. ZHOU B., ZHAO K., ZHONG L.S., CHEN T., YU H. Coordinated development evaluation of the ecosystem health and the tourism economy Zhoushan Islands. Acta Ecologica Sinica, **35** (10), 3437, **2015** [In Chinese].
29. WANG H., HOU P., JIANG J.B., XIAO R.L., ZHAI J., FU Z., HOU J. Ecosystem health assessment of Shennongjia national park, China. Sustainability, **12** (18), **2020**.
30. LI W.L., LIU C.L., SU W.L., MA X.L., ZHOU H.K., WANG W.Y., ZHU G.F. Spatiotemporal evaluation of alpine pastoral ecosystem health by using the Basic-Pressure-State-Response Framework: A case study of the Gannan region, northwest China. Ecological Indicators, **129**, **2021**.
31. RAN C., WANG S.J., BAI X.Y., QIU T., WU L.H., LUO X.L., CHEN H., XI H.P., LU Q. Evaluation of temporal and spatial changes of global ecosystem health. Land Degradation & Development, **32** (3), 1500, **2020**.
32. XU Z.Y. Spatial-temporal dynamics of ecosystem health in Sichuan Province based on PSR model. Remote Sensing for Land & Resources, **32** (2), 251, **2020** [In Chinese].
33. CHEN K.L., SU M.X., LI S C., LU J.H., CHEN Y.Y., ZHANG F., LIU Z.J. The health assessment of the urban ecosystem of Xining city. Geographical Research, **29** (2), 214, **2010** [In Chinese].
34. SU M.R., XIE H., YUE W.C., ZHANG L.X., YANG Z.F., Chen S.H. Urban ecosystem health evaluation for typical Chinese cities along the Belt and Road. Ecological Indicators, **101**, 572, **2019**.
35. SHEN W., ZHENG Z.C., PAN L., QIN Y.C., LI Y. AN integrated method for assessing the urban ecosystem health of rapid urbanized area in China based on SFPHD framework. Ecological Indicators, **121**, **2021**.
36. FAN Q.M., SUN T.H. The assessment indicators of tourism ecosystem health. Management Science and Engineering, **2** (4), 59, **2008**.
37. ZHOU B., ZHONG L.S., WANG L.E., ZHANG S.R. Assessment on tourism ecosystem health of the nature reserve – A case study of Xinqing Hooded Crane Nature Reserve in Heilongjiang Province. Forest Resources Management, **44** (5), 145, **2015** [In Chinese].
38. XU X.M., PINCUO Z.M., HU S.H. Assessment on health of ecological tourism-economy system of Yaruzampbo Grand Canyon National Park based on the perspective of information entropy. Ecological Economy, **33** (10), 139, **2017** [In Chinese].
39. WENG G.M., PAN Y., LI L.Y., SONG N. Research on dynamic evaluation of tourism eco-health condition in the silk road. Ecological Economy, **35** (5), 135, **2019** [In Chinese].
40. ZHOU B., ZHONG L.S., CHEN T., ZHAO K. Dynamic assessment on tourism ecosystem health in Zhoushan Islands. Geographical Research, **34** (2), 306, **2015** [In Chinese].
41. WANG S.J., KONG W., REN L., ZHI D.D., DAI B.T. Research on misuses and modification of coupling coordination degree model in China. Journal of Natural Resources, **36** (3), 793, **2021** [In Chinese].
42. CAO F.D., HUANG Z.F., HUANG R., XU M. Spatial correlation and coupling path between freeway flow and tourism flow of scenic spot in Jiangsu Province. Economic Geography, **41** (1), 232, **2021** [In Chinese].
43. ZHOU D., WANG X.Q. Research on coupling degree and coupling path between China's carbon emission efficiency and industrial structure upgrade. Journal of Natural Resources, **34** (11), 2305, **2019** [In Chinese].
44. GENG Y.Q., WANG Y., WEI Z.J., ZHAI Q.H. Temporal-spatial measurement and prediction between air environment and inbound tourism: Case of China, Journal of Cleaner Production, **287**, **2021**.
45. FEI J.H., LIN Y., JIANG Q.T., JIANG K.H., LI P.L., YE G.Q. Spatiotemporal coupling coordination measurement on islands' economy-environment-tourism system. Ocean & Coastal Management, **212**, **2021**.
46. TANG Z. An integrated approach to evaluating the coupling coordination between tourism and the environment. Tourism Management, **46**, 11, **2015**.
47. WANG J.F., XU C.D. Geodetector: Principle and prospective. Acta Geographica Sinica, **72** (1), 116, **2017** [In Chinese].
48. WANG H.Y., QIN F., XU C.D., LI B., GUO L.P., WANG Z. Evaluating the suitability of urban development land with a Geodetector. Ecological Indicators, **123**, **2021**.
49. HUO H., SUN C.P. Spatiotemporal variation and influencing factors of vegetation dynamics based on Geodetector: A case study of the northwestern Yunnan Plateau, China. Ecological Indicators, **130**, **2021**.
50. ZHAO R., ZHAN L.P, YAO M.X, YANG L.C. A geographically weighted regression model augmented by Geodetector analysis and principal component analysis for the spatial distribution of PM2.5. Sustainable Cities and Society, **56**, **2020**.