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SWOT ANALYSIS ON TOURIST ECO-FOOTPRINT AND ECOLOGICAL CARRYING CAPACITY IN POVERTY-STRICKEN AREAS

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Abstract

Tourist cities are facing an ecological crisis due to population boom, pollution and environmental damage. To solve the crisis, this paper attempts to make an accurate evaluation of ecological carrying capacity of tourist cities, identify the factors affecting the eco-sustainability of such cities, and prepare a feasible solution to these factors. Specifically, the tourism ecological footprint theory was introduced into the evaluation of sustainable tourism development in tourist areas based on SWOT analysis and eco-footprint model. Then, a tourist eco-footprint and ecological carrying capacity model was constructed for tourist cities. The model has seven sub-models: transportation, accommodation, shopping, leisure, catering, sightseeing and garbage disposal. The proposed model was applied to quantify the tourism sustainability of Suijiang County, Yunnan Province. The results were discussed comprehensively, and then the strategies on sustainable tourism were put forward. The results show that the eco-footprint model can not only effectively analyze the eco-sustainability of tourism environment in poverty-stricken areas, but also put forward the strategy of tourism sustainable development.

Keywords: ecological carrying capacity, poverty-stricken areas, sustainability, SWOT

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1. Introduction

With the advancement of social economy, tourism has gradually developed into one of the most powerful industries in the world (Song, 2006; Watson et al., 2010; Zhu et al., 2019). However, the rapid development of tourism has also brought about some negative effects such as extensive management of scenic spots and blind over-exploitation of tourism resources (Wang et al., 2014a). Meanwhile, the satisfaction of material life is no longer the seeking target by people (Gossling et al., 2002). On the contrary, ecosystems provide space for people's production, life and survival, and are closely related to human beings. The health and safety of ecosystems have the direct bearing on the long-term development of humans (Fiala, 2008; Hoekstra, 2009; Yang et al., 2020). In the 1980s, the concept of sustainable development was put forward. After continuous efforts, the concept of regional sustainable development has been increasingly improved. The sustainable development strategy means to formulate, select and plan the development strategy of a region from a new perspective, that is, from the comprehensive development system of human beings and society (Green et al., 2010). In recent years, the sustainable development has gradually become a universal goal pursued by all countries (Wang et al., 2014b).

The regional tourism sustainability can be evaluated in the methods of environmental carrying capacity, acceptable change limits, tourism eco-footprint, and environmental impact (Dang and Liu, 2012; Rabasa et al., 2018; Wu et al., 2009). Among these methods, the calculation method of tourism eco-footprint model can clearly, quantitatively and

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comprehensively reflect the impact of tourism activities on the sustainable development of regional ecosystems in a more intuitive and simple manner (Rajaram and Das, 2011; Zhu et al., 2010).

Since the introduction of SWOT analysis in 1980, many domestic and foreign scholars have conducted a lot of research on its specific analysis methods and processes. American management scientist Michael Porter (1980) proposed 4 types of strategies based on analysis in 1985, namely SO strategy, WO strategy, ST strategy, and WT strategy (Michael, 1980), where S refers to various strength that affect the development of research objects, generally various factors giving the research object the development advantages; W is the weakness that has certain adverse effects on the research objects; O refers to the opportunity to promote the development of research objects; T is the threat or challenge faced by the research subjects (Kheirkhah et al., 2009; Yuan et al., 2012; Zorpas et al., 2015). SWOT analysis as a strategic decision analysis method has been applied in many aspects in recent years, ranging from individual enterprises to large-scale national development strategic decisions. The analysis method provides valuable reference for the final decision.

Therefore, taking certain poverty-stricken areas as examples, this paper aims to study and explore the sustainable development of tourism eco-footprint and ecological carrying capacity. The research results demonstrate the feasibility of the tourism eco-footprint and ecological carrying capacity model for the sustainable development assessment of tourism; based on the ecological deficit or surplus, it can be clearly judged whether different tourism areas are sustainable under different stages, different levels of development and scale of tourism, thus opening up a new way of thinking for sustainable development of tourism (Salerno et al., 2013; Wang et al., 2014c).

2. Materials and methods

2.1. SWOT analysis method

Table 1 shows the framework of SWOT analysis. Fig. 1 shows the SWOT analysis process

2.2. Eco-footprint model

Wackernagel defines the eco-footprint of any known population (individual, city or country) as the total amount of biologically produced land needed to produce all the resources consumed by these populations and absorb all the waste generated by them (Wackernagel et al., 1996). The concepts used in the ecological footprint model were defined below.

(1) Eco-footprint: total area of ecological and industrial land required to absorb all waste generated by the population and produce all resources consumed by them (Lehtonen, 2004).

(2) Ecological carrying capacity: the total area of ecological and industrial land that a region can provide for humans without destroying the productivity and integrity of related ecosystem (Termorshuizen and Opdam, 2009). It can be understood as the largest ecological and industrial land that a region can provide under certain natural, social, economic and technological conditions.

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Table 1. Framework of SWOT analysis

		Internal factors	
		Strength(S)	***Weakness (W)***
external conditions	Opportunities (O)	SO Strategy	WO Strategy
	Threat (T)	ST Strategy	WT Strategy

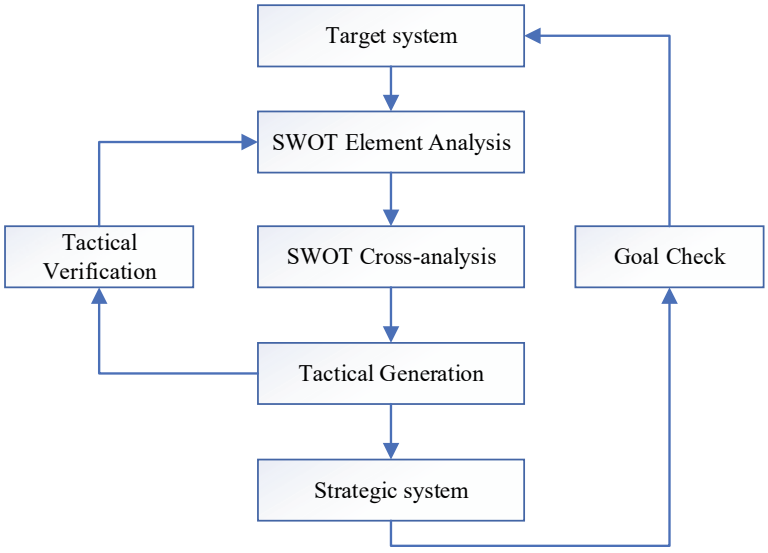

Fig. 1. SWOT analysis process

(3) Eco-footprint model: First, classify the main items consumed by people; then calculate the ecological carrying capacity of the ecological industrial area and convert it into corresponding ecological; finally, compare the results of both to determine that the ecology is a surplus or deficit (Tsai and Chou, 2009). The calculation process of the model is shown in Fig. 2.

Due to the large difference in productivity of bio-production land per unit area (Zorpas et al., 2017), it is necessary to add an equilibrium factor to the area of each bio-production land and then convert it into a uniform and comparable dimension of the biological production land area. The total amount of eco-footprint is calculated as (Eq. 1):

$$E_f = \sum_{j=1}^{6}\left(r_j * \sum_{i=1}^{n} aa_i\right) = \sum_{j=1}^{6}\left(r_j * \sum_{i=1}^{n}(c_i / p_i)\right) \quad (1)$$

where, r_j is the equilibrium factor; j is the type of industrial land; c_i is the consumption of the i type of consumer goods; aa_i is the area of the land for biological production converted by the i type of consumer goods; p_i is the world average production capacity of the i type of consumer goods.

The ecological carrying capacity is calculated as (Eq. 2):

$$E_c = \sum_{j=1}^{6}\left(a_j * r_j * y_j\right) \quad (j = 1,2,3,4,5,6) \quad (2)$$

where, j is the type of industrial land; a_j is the actual area of the land type j; y_j is the yield factor.

(4) Equilibrium factor: In the calculation, it is necessary to multiply the standard area of different land types by their respective equilibrium factors and convert them into direct comparable areas.

The calculation formula for the average national yield factor for various types of biological products is shown in (Eq. 3). The equivalence factor of a certain type of eco-productive land is derived by dividing the average ecological productivity of this type of eco-productive land by that of various types of eco-productive land worldwide, the calculation formula is shown in (Eq. 4) (Rader et al., 1979).

$$EP_i = \frac{P_i}{A_i} \quad (3)$$

$$q_i = \frac{P_i}{P} = \frac{Q_i}{S_i} / \frac{\sum Q_i}{\sum S_i} = \frac{\sum_k r_i^k * p_i^k}{S_i} / \frac{\sum_i \sum_k r_i^k * p_i^k}{S_i} \quad (4)$$

where: P_i, Q_i are the average productivity and the total biological yield of the i type of land respectively; A_i and S_i are the annual national area of the i type of products, and the area of the i type of land; p_i^k is the yield of the k -th biological product of the i land; r_i^k is the unit calorific value of the k -th biological product on land type i.

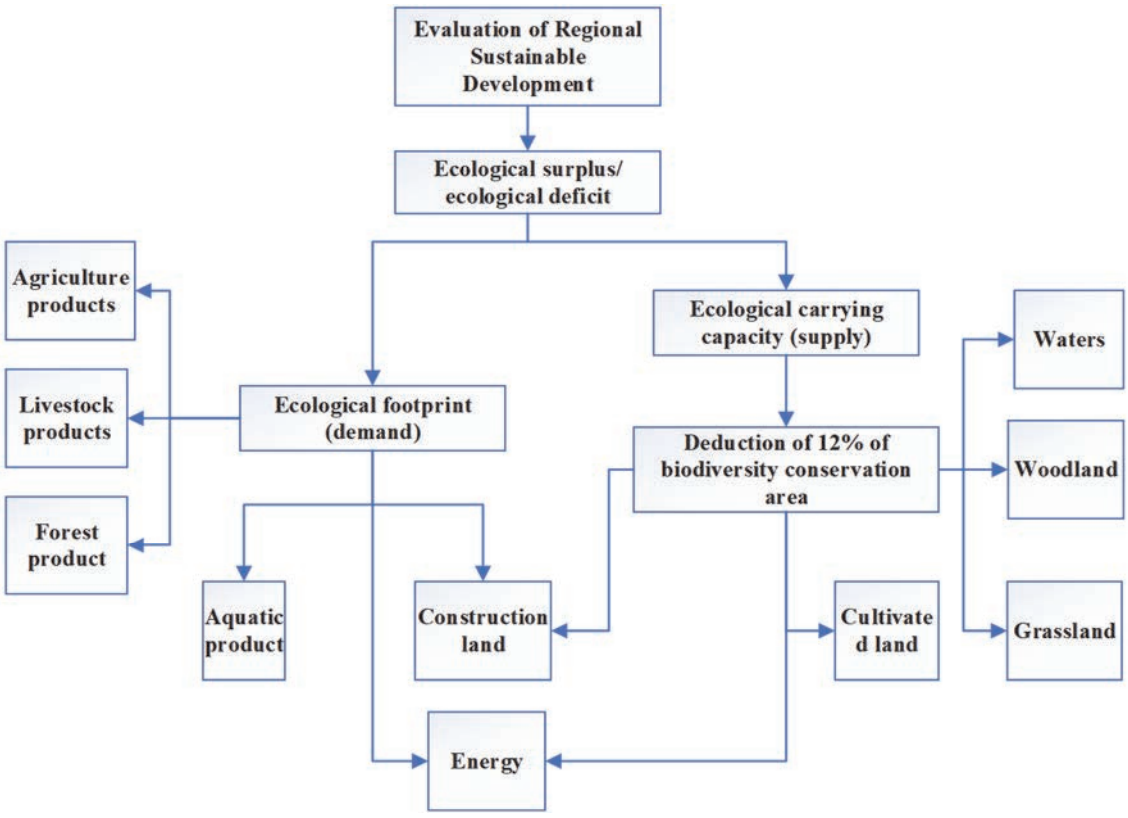

Fig. 2. Technical flow chart of eco-footprint model

(5) Yield factor: Yield factor of a certain type of eco-productive land refers to the ratio of the average productivity of this type of eco-productive land in the region to the world's average productivity. The yield factors of different countries or regions also vary (Rader et al., 1979). In order to eliminate the difference in productivity of the same type of ecological industrial land in different regions, both the same type of ecological industrial land and yield factor must be taken into account. The equilibrium factors and yield factors of various types of ecological industrial land are shown in Table 2.

2.3. SWOT analysis framework for evaluation of tourism eco-footprint sustainable development

According to the principles of regional sustainable development and SWOT analysis method, these two were linked together to form a SWOT analysis framework for regional sustainable development (Fig. 3). The following steps are as follows:

(1) Identification and analysis of various factors affecting regional sustainable development. Based on the basic survey data, the four factors in the SWOT analysis were identified and analyzed separately (Tian et al., 2013).

(2) Cross analysis of each factor in SWOT analysis. Relative to the general decision-making behaviors such as general corporate strategic decision, the decision-making object of a regional sustainable development strategy is the research area, and the complexity of the region leads to more connections between various factors affecting its development. That is, the four factors in SWOT analysis have great overlap.

Thus, after specific analysis of each factor, cross-analysis between factors was performed to make the results more comprehensive.

(3) Combination of qualitative and quantitative analysis. A simple analysis of each influential factor in the SWOT analysis cannot show which of these factors has a greater impact on the regional sustainable development strategy (Longato et al., 2019). Therefore, while performing qualitative analysis, AHP method was introduced to carry out relevant quantitative analysis, to reduce the subjectivity of pure SWOT qualitative analysis.

(4) Analysis for the construction of strategic quadrilaterals and development strategies. According to the results of qualitative and quantitative analysis, a strategic quadrilateral of strengths, weaknesses, opportunities, and threats was established in the same coordinate system, and then a feasible development strategy was analyzed based on the quadrant of the center of gravity in this quadrilateral, so as to draw the conclusion of the regional sustainable development. This provides a reference for the final strategy decision of regional sustainable development.

3. Results

The sustainable development of tourism not only needs to protect the ecological environment on which tourism develops, coordinate the interests of tourists and local residents, but also empahsis on the fairness of the intergenerational distribution of tourism resources to ensure future tourism development opportunities. Therefore, in tourist activities, it is necessary to consider the sustainable development of specific tourism activities from both the micro and macro level.

Table 2. Equilibrium factors and yield factors for various types of ecological industrial land

Eco-productive Land Type	*Equilibrium Factor and Yield Factor*	*Equilibrium Factor and Yield Factor*
Cultivated land	2.94	1.8
Grassland	0.64	0.33
woodland	1.24	1.05
waters	0.34	1.8
land used for building	2.94	1.14
Fossil Energy Land	1.24	0.14

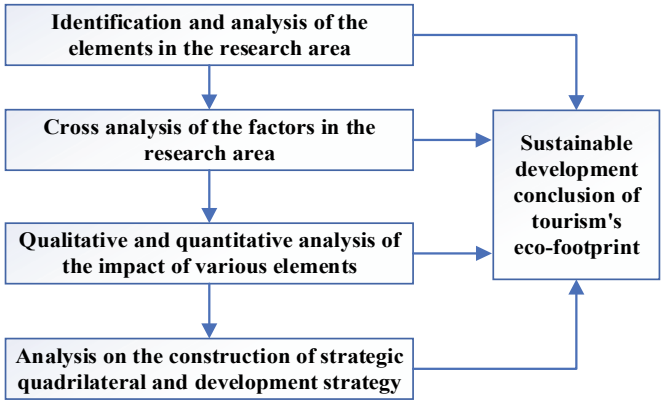

Fig. 3. SWOT analysis framework for tourism eco-footprint sustainable development evaluation

A case study was conducted by taking Suijiang County, Yunnan Province as an example in order to discuss the practicability of the theoretical method described above. This county is subordinated to Zhaotong City, Yunnan Province, and located in the northeastern edge of Yunnan Province. Its geographical coordinates are 103°47′-104°16′east longitude and 28°21′-28°40′ north latitude. It connects Shuifu County in the east and Yanjin County in the south; it borders Yongshan County in the southwest and borders Jinsha River in the north with Pingshan County and Leibo County in Sichuan Province. The county's east-west distance is 48.5 kilometers, the north-south distance is 36 kilometers, and the total area is 882 square kilometers. It is one of the province's key ecological function areas in Yunnan. Suijiang has always been an important ecological barrier in the upper reaches of the Yangtze River. Therefore, it is very importation to ensure the sustainable development of the tourism eco-footprint and ecological carrying capacity in this area.

The statistic data includes the area of Suijiang County National Forest Park, the number of tourists in the past years, the types and quantity of food consumed per capita by tourists each year, and the local productivity levels of various types of biologically productive land in those year. These data come from *China Statistical Yearbook* and *Yunnan Statistical Yearbook.*

3.1. SWOT analysis results

The basic information of the survey area was obtained through on-site surveys and data collection. Also, experts were invited to score the impact intensity of each factor listed. Finally the SWOT analysis was conducted on the influence factors, as shown in Table 3. According to the expert's evaluation results, it's concluded that the four influence factors on the sustainable development of the region were sequenced as weakness> threat> strength> opportunity in terms of the influence degree. The quadrilateral of the region's sustainable development strategy is shown in Fig. 4.

3.2. Comprehensive analysis of tourism eco-footprint in poverty-stricken areas

The ecological footprint of the region from 2013 to 2018 was calculated using the eco-footprint model described above, the results are shown in Table 4.

Table 3. Influence factors in SWOT analysis

Index	***Influence factor***
Strength(S)	S1: it has regional advantages and is located in the middle of the economic prosperity zone of the Yangtze River Delta and the Pearl River Delta; S2: good economic foundation in the region; S3: various resource advantages
Weakness (W)	W1: limited port resources； W2: the plain area is small, which is not conducive to large-scale development； W3: inadequate infrastructure construction such as sewage treatment and living facilities；
Opportunities (O)	O1: great support from the Party Central Committee and historical opportunities； O2: opportunities such as investment by overseas Chinese from Hong Kong, Macao and economic globalization；
Threat (T)	T1: compared with other similar ports, there is a certain gap in strength； T2: relatively serious environmental pollution；

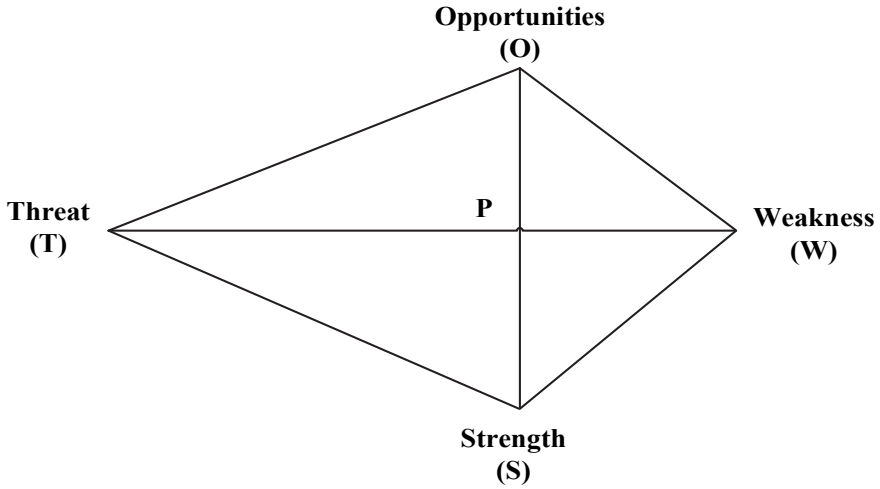

Fig. 4. Quadrilateral of the region's sustainable development strategy

Table 4. Summary of tourism eco-footprint 2013-2018

Year	*Items*	①	②	③	④	⑤	⑥	⑦	*Sum*
2013	Ecological footprint	1947	628	2071	10	5	5	810	5475
	Per capita ecological footprint	32	10	34	0	0	0	13	90
	Proportion (%)	35	12	38	0	0	0	15	100
2014	Ecological footprint	3101	806	2839	10	5	5	1238	8005
	Per capita ecological footprint	37	10	34	0	0	0	15	96
	Proportion (%)	38	10	35	0	0	0	15	100
2015	Ecological footprint	3504	899	3310	10	5	5	1427	9161
	Per capita ecological footprint	36	9	34	0	0	0	15	94
	Proportion (%)	38	10	36	0	0	0	16	100
2016	Ecological footprint	7954	943	7250	10	5	5	3539	19707
	Per capita ecological footprint	37	5	34	0	0	0	17	93
	Proportion (%)	40	5	36	0	0	0	18	100
2017	Ecological footprint	12437	1372	10560	10	5	5	5587	29977
	Per capita ecological footprint	40	5	34	0	0	0	18	97
	Proportion (%)	41	5	35	0	0	0	19	100
2018	Ecological footprint	16278	2927	11703	10	5	5	7306	38235
	Per capita ecological footprint	47	9	34	0	0	0	21	111
	Proportion (%)	42	8	30	0	0	0	19	100

Note: The serial number 1-7 refer to Accommodation, Transportation, Sightseeing, Shopping, Catering, Leisure, and garbage disposal, respectively

According to the calculation results above, the development trend of the tourism eco-footprint in this poverty-stricken area has the following characteristics:

(1) The tourism eco-footprint is on the rise, due to the substantial increase in the total demand for tourism eco-footprint;

(2) The per capita eco-footprint is increasing. Compared with the total amount of tourism eco-footprint, the per capita ecological footprint growth is relatively small and stable;

(3) The vast majority of the tourism eco-footprint consists of the ecofootprints of tourism, transportation, accommodation, and garbage disposal, and the remaining four types of traffic footprints occupy a relatively small proportion.

3.3. Comprehensive analysis of tourism ecological carrying capacity in poverty-stricken areas

Further, the calculation results of the tourism ecological carrying capacity in this region from 2013 to 2018 were obtained, as shown in Table 5. Based on the above calculation results, the trend of tourism ecological carrying capacity in this region from 2013 to 2018 was comprehensively analysed.

(1) The ecological carrying capacity of tourism remained unchanged in 2013-2018. Due to the great efforts made in the protection of tourism ecology in poverty-stricken areas, land use has not changed much in recent years;

(2) In 2013-2018, the total value of tourism ecological carrying capacity remained unchanged, but the per capita tourism ecological carrying capacity showed a downward trend. The main reason is that the tourist reception volume in the poverty-stricken areas has increased year by year, resulting in a decline in the per capita tourism ecological carrying capacity.

4. Discussions

Fig. 5 and Fig. 6 show the ecological surplus of the tourism ecological footprint in the poverty-stricken area and that of per capita tourism ecological footprint in 2013-2018 respectively.

Based on the above calculation results, a comprehensive analysis was conducted about the tourism ecological surplus in the region from 2013 to 2018. It's found that: (1) From 2013 to 2018, the region's ecological surplus, tourism development was sustainable; (2) From 2013 to 2018, the tourism ecological surplus and per capita ecological surplus of the region showed a rapid decline, indicating that the degree of tourism "sustainable development" in this region has been declining year by year.

Table 5. 2013-2018 Summary of tourism ecological carrying capacity

Year	*Regional Area*	*Equilibrium Factor*	*Yield Factor*	*Ecological carrying Capacity*	*Biodiversity Conservation*	*Per Capita Ecological carrying Capacity*
2013	38215	1.23	1.04	40521.98	5612.09	680.22
2014	38215	1.23	1.04	40541.98	5632.09	502.64
2015	38215	1.23	1.04	40641.98	5732.09	434.61
2016	38215	1.23	1.04	40841.98	5932.09	212.08
2017	38215	1.23	1.04	41041.98	6132.09	153.54
2018	38215	1.23	1.04	41419.98	6510.09	141.02

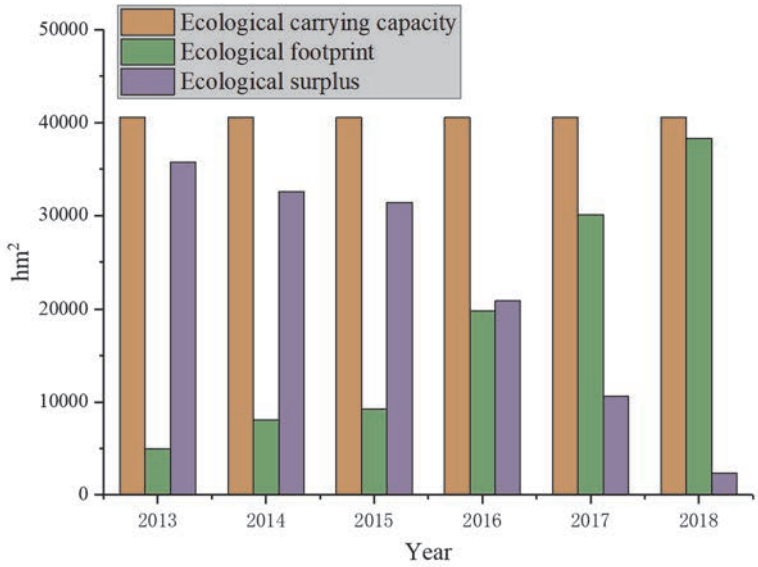

Fig. 5. Tourism ecological surplus of the poverty-stricken areas in 2013-2018

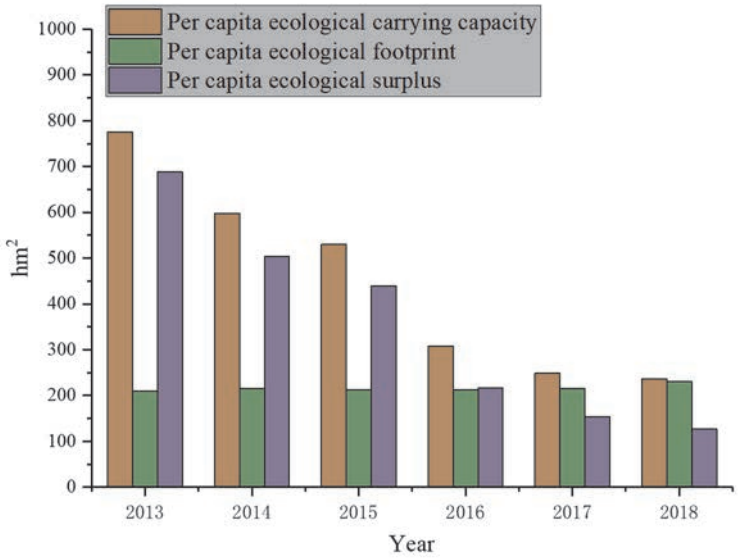

Fig. 6. Ecological surplus of per capita tourism in 2013-2018

Therefore, if appropriate measures are not taken to reduce the ecological footprint of this tourism city, its ecological surplus of tourism will continue to decrease in the next few years, eventually leading to the eco-footprint of tourism exceeding the ecological carrying capacity of tourism, that is, the unsustainable state of ecosystems. Further, the functional relationship between the tourism eco-footprint and the increasing number of tourist receptions is shown in Fig. 7. The results showed that the number of tourist receptions was 3.95 million. Based on the current average growth rate of 28.25 %, the number of tourist receptions in this region will soon exceed the threshold for sustainable development.

Thus, in order to ensure the sustainable development of tourism in the region, relevant measures should be taken from the following four aspects:

(1) Reduce the tourism eco-footprint by controlling the number of tourists to be less than 3.95 million, and ensure the sustainability of tourism development;

(2) Improve the ecological carrying capacity of tourism: increase the total population of tourism carrying capacity by increasing the area of three-dimensional space. Specifically, a green lawn can be set at the top of the construction facility, green plants such as mountain tigers can be planted on facilities such as fences, or an ecological parking lot can also be used.

(3) Accelerate the establishment and improvement of eco-compensation mechanisms. According to the eco-compensation principles of "who develops, who protects; who destroys, who restores; who benefits, who compensates; who pollutes, who pays", accelerate the introduction of eco-compensation mechanisms, improve relevant policies and regulations, and explore the appropriate Long-term mechanism of ecological compensation for production and supply of ecological products;

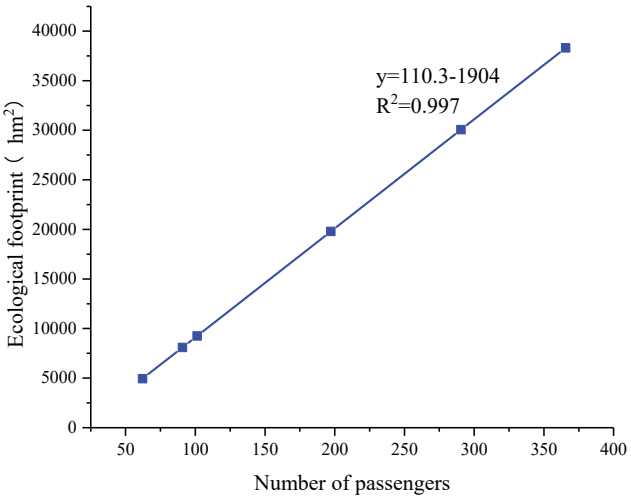

Fig. 7. Relationship between tourist reception volume and tourism eco-footprint

(4) Establish a normalized monitoring and monitoring system of the ecological environment covering the region: integrate various resources, establish and improve monitoring points, comprehensively build an ecological environment monitoring network system, and incorporate ecological deficits into local assessment index systems, thereby achieving the maintenance, construction and management of the ecological environment in a comprehensive manner.

5. Conclusions

The main conclusions are drawn as follows:

(1) The eco-footprint model was used to quantify the sustainable development of the tourism ecological environment in poverty-stricken areas, and reveal the impact of existing tourism activities on the regional ecological environment and ecological carrying capacity;

(2) The vast majority of tourism ecological footprint consists of three parts: tourism catering, transportation and garbage disposal;

(3) Taking the sustainable development of tourism footprint and ecological carrying capacity in a poverty-stricken area as an example, the evaluation results were obtained, which can provide reference and scientific basis for diagnosing and improving the sustainable development of tourism eco-footprint and ecological carrying capacity in poverty-stricken areas.

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