Evaluation on Sustainable Development of Plateau Wetland Tourism Based on Ecological Footprint Model -- Take Zoige County as an Example

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Abstract: with the emergence of the drought, desertification, soil degradation and other ecological problems in plateau wetland, the global climate and environment change. Under the background of the two mountains theory (green development makes economy grow), realizing the sustainable development of plateau wetland ethnic tourism has become an important proposition to promote the economic development of minority areas. This paper set the ecological footprint model of tourism to quantitatively evaluate the sustainable development of tourism in Zoige County, calculate and evaluate the dynamic changes of tourism ecological footprint and tourism ecological carrying capacity in Zoige County from 2013 to 2017. The results showed that the tourism ecological footprint of Zoige County increased year by year from 432,517.17 hm2 in 2013 to 1071,866.96 hm2 in 2017. The tourism ecological carrying capacity showed a declining trend, from 18772.22hm2 in 2013 to 18759.44hm2 in 2017. The ecological surplus value decreased from 1876.79 hm2 in 2013 to 1874.87 hm2 in 2017. Therefore, the regional tourism development in Zoige County is in a sustainable development state.

1. Introduction

Zoige plateau wetland is the largest plateau wetland in China and the largest peat swamp in the world. The plateau wetland in Zoige plays an important role in the water conservation and replenishment of the upper reaches of the Yellow River and the maintenance of ecological balance. However, there is a frequent occurrence of ecological problems such as the drought, desertification and soil degradation of the plateau wetland, which lead to cause global climate and environmental changes. It is necessary to promote the development of ecological tourism of the plateau area in the ethnic region in order to promote the economic development of ethnic minority areas, help people who live in the ethnic area get rid of poverty, and take the path of economic and ecological sustainable development under the circumstance of protecting the ecological environment of the plateau wetland.

The promulgations of *Several Opinions of the State Council on Promoting the Reform and Development of Tourism* and *The Plan for the Development of the National Eco-tourism (2016-2025)* have pointed out the direction of the country's tourism development. With the rapid development of the plateau wetland tourism in minority areas, it will bring more and more serious environmental problems to tourist destinations. The imbalance of ecological environment in tourist destinations will restrict the sustainable development of tourism. Therefore, it is an important basis for promoting the theory of sustainable development to practice to measure the state of sustainable development of tourist destinations effectively. It is also an important issue for the study of sustainable development of tourism. This paper uses the time series data of Zoige county for 5 consecutive years to measure the ecological footprint and ecological carrying capacity of tourism, in order to obtain the development trend of Zoige county's ecological footprint, and to provide certain reference for the sustainable development of regional tourism in the plateau wetland of the minority areas.

2. Tourism Ecological Footprint Theory and Related Models

After Dr. William Rees first proposed the theory and method of ecological footprint [1,2] in 1992, professor Colin Hunter from the department of Geography and Environment of University of Aberdeen introduced the theory and method of ecological footprint into the field of tourism and proposed the concept of tourism ecological footprint. In this paper, the tourism ecological footprint model was used to calculate six elements of tourism, as well as the tourism waste disposal. Then the tourism industry in Zoige county is taken as the research object for empirical analysis. The dynamic changes of tourism ecological footprint, tourism ecological carrying capacity and ecological surplus/deficit in Zoige county from 2013 to 2017 were calculated and analyzed to make a scientific evaluation on whether the tourism industry of Zoige is sustainable.

2.1 Tourism Ecological Footprint Calculation Model

Throughout the domestic and foreign scholars in the calculation of the ecological footprint of tourism, the calculation of the ecological footprint of tourism is usually based on the six elements of tourism activities which are tourism food, accommodation, transport, visiting, shopping and entertainment. Tourism waste is also comprehensively calculated. Based on the development status of plateau wetland tourism, the overall model of tourism ecological footprint in Zoige county is written down as formula (1).

$$TEF = TEF_{food} + TEF_{accommodation} + TEF_{transport} + TEF_{visiting} + $$
$$TEF_{shopping} + TEF_{entertainment} + TEF_{waste} \quad (1)$$

In formula (1): TEF represents the ecological footprint of tourism; TEF_{food} represents the ecological footprint of tourism food; $TEF_{accommodation}$ represents the ecological footprint of tourism accommodation; $TEF_{transport}$ represents the ecological footprint of tourism transport; $TEF_{visiting}$ represents the ecological footprint of tourism visiting; $TEF_{shopping}$ represents the ecological footprint of tourism shopping; $TEF_{entertainment}$ represents the ecological footprint of tourism entertainment; TEF_{waste} represents the ecological footprint of tourism waste.

2.2 Tourism Ecological Carrying Capacity Model

Tourism ecological carrying capacity refers to the amount (hm^2) of various productive land acreage that can support the tourism industry in all types of bio-productive land (cultivated land, grassland, forest land, building land, fossil energy land and water area) [3]. It is also the size of the bio-productive area provided by a tourist destination for tourist activities. The calculation formula is as follows:[4]

$$TEC = Ntec = N\sum_{i=}^{n}\left(a_i r_i y_i\right) \quad (2)$$

In formula (2): TEC represents the ecological carrying capacity of tourism; i represents six types of bio-productive land (including: arable land, grassland, forest land, building land, fossil energy land and water area); N represents population size; tec represents tourism ecological carrying capacity per capita; a_i represents bio-productive land acreage; r_i represents equilibrium factor; y_i represents production factor.

On the basis of (1) and (2):

TEF-TEC>0,ecological surplus, indicating that the region's tourism is in a sustainable development state.

TEF-TEC<0,ecological deficit, indicating that the region's tourism is in an unsustainable development state.

3. Empirical Analysis of Tourism Ecological Footprint in Zoige County

3.1 Survey Region Overview

Zoige county is located on the northeast edge of the Qinghai-Tibet plateau, in the northwest of Sichuan province, north of Aba Tibetan and Qiang autonomous prefecture. Its geographical position is between 33°3´12´´~34°18´19´´north latitude and 102°8´~103°48´east longitude, with an altitude of 3,400 ~ 3,900 m and an average altitude of 3,471 m, which belongs to typical plateau topography. It is adjacent to Maqu, Luqu, Zhuoni and Diebu in Gansu province. It borders Aba, Hongyuan, Songpan and Jiuzhaigou in the prefecture. It is the largest county in Aba Tibetan and Qiang autonomous prefecture. The county is divided into two geomorphologic types (the western hilly plateau and the eastern alpine valley) by the watershed from southeast to northwest of the Yangtze river and the Yellow River. Its maximum distance from east-west to north-south is about 150 kilometers, and its jurisdiction area is 10620 square kilometers, with an average elevation of 3500 meters, accounting for 12% of the prefecture area and 1.8% of the province. There are 4 towns, 13 townships, 2 rangelands, 96 villages, 3 communities and 101 distance graze bases in the county with a total population of 80,000. The furthest township (Zhanwa) is 140 kilometers away from the county, and the furthest distance graze bases (Aoqu and Ya'er) are 160 kilometers away from the county. There are 12 ethnic groups including Tibetan, Han, Hui, Qiang and Yi living in the area under its jurisdiction, with a total population of 78,000, including 12,603 pure agricultural and pastoral households with the population of 66,000. The Tibetan population is 72,000, accounting for 92%.

3.2 The Data Source

The first is the essential data. It includes the annual tourist reception, daily average consumption of living products, and the average productivity of six types of ecologically productive land, etc. The data mainly come from China statistical yearbook, Aba prefecture statistical yearbook, Zoige county yearbook and related websites.

The second is the survey data. It includes the utilization rate of all kinds of tourism facilities including food, transport, accommodation, shopping, solid waste and so on, which are involved in the sub-model of tourism ecological footprint, tourist consumption patterns, and average travel days of tourists. The objects of the survey are tourists, tourism bureau of Zoige county, and relevant employees of tourism enterprises within the scope of plateau wetland in Zoige county.

The third is the standard data. It includes the equalization factors and yield factors corresponding to five types of bio-productive land, the energy consumption per unit average distance of different vehicles, the average calorific value per unit productive land area of the world's fossil fuels and the convert coefficient and so on. Relevant data were obtained from existing research reports and related research literature. The relevant data come from existing research reports and related research literature.

The fourth is the data processing. Because the data of the calculation of the tourism ecological footprint model data is highly comprehensive and complex, many data cannot be obtained directly through the statistical yearbook or related websites. It is also difficult to accurately obtain the value of goods from the actual survey. Therefore, it is necessary to carry out relevant calculation or standardized processing on the basis of obtained data to meet the needs of data model calculation.

3.3 Calculation Results and Analysis

Through the above methods, the tourism ecological carrying capacity and ecological footprint of Zoige county can be calculated, the demand of tourists and the supply condition for the ecological environment of Zoige county can be calculated, and finally the sustainable development of tourism in Zoige county can be calculated. The calculated results are shown in Table 1.

Table 1 the Tourism Demand and Supply Summary in Zoige County from 2013 to 2017

	2013	2014	2015	2016	2017
Tourism ecological footprint(hm^2)	432517.17	607973.99	760900.51	919502.43	1071866.96
Tourism ecological carrying capacity[①](hm^2)	18772.22	18772.55	18782.41	18745.61	18759.44
Ecological surplus(hm^2)	1876.79	1876.64	1877.48	1873.20	1874.87
Per capita ecological footprint of tourism($\times 10^4$hm^2)	326	351	386	420	481
Per capita ecological carrying capacity of tourism per capita(hm^2)	0.24	0.24	0.24	0.24	0.24
Per capita ecological surplus per capita($\times 10^6$hm2)	141.66	108.41	95.3	85.5	84.07

①Deduct 12% ecologically diverse acreage

(1) Dynamic changes of tourism ecological footprint, tourism ecological carrying capacity and tourism ecological surplus in Zoig county
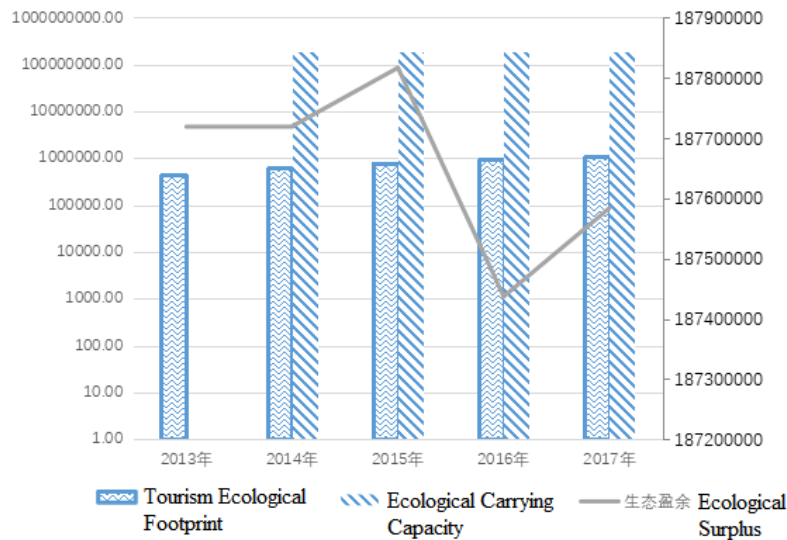

Fig.1 Dynamic changes of tourism ecological footprint, tourism ecological carrying capacity and tourism ecological surplus in Zoige county from 2013 to 2017

From a macro perspective, the tourism ecological footprint of Zoige county increased year by year from 432517.17hm^2 in 2013 to 1071866.96hm^2 in 2017, with an average annual added value of 159,837.45 hm^2. The increase trend over the past five years was relatively flat, and its dynamic changes are shown in fig.1. The tourism ecological carrying capacity of Zoige county decreased from 187722200hm^2 in 2013 to 187594400hm^2 in 2017, which was relatively flat. Since the ecological footprint data of tourism is much smaller than that of the ecological carrying capacity, there is an ecological surplus. From 2013 to 2017, the ecological surplus decreased from 187718700 hm^2 to 187583700 hm^2. The dynamic changes of tourism ecological footprint, tourism ecological carrying capacity and tourism ecological surplus in Zoige county are shown in fig.1.

(2) Dynamic changes of per capita tourism ecological footprint, per capita ecological carrying capacity and per capita ecological surplus in Zoige county
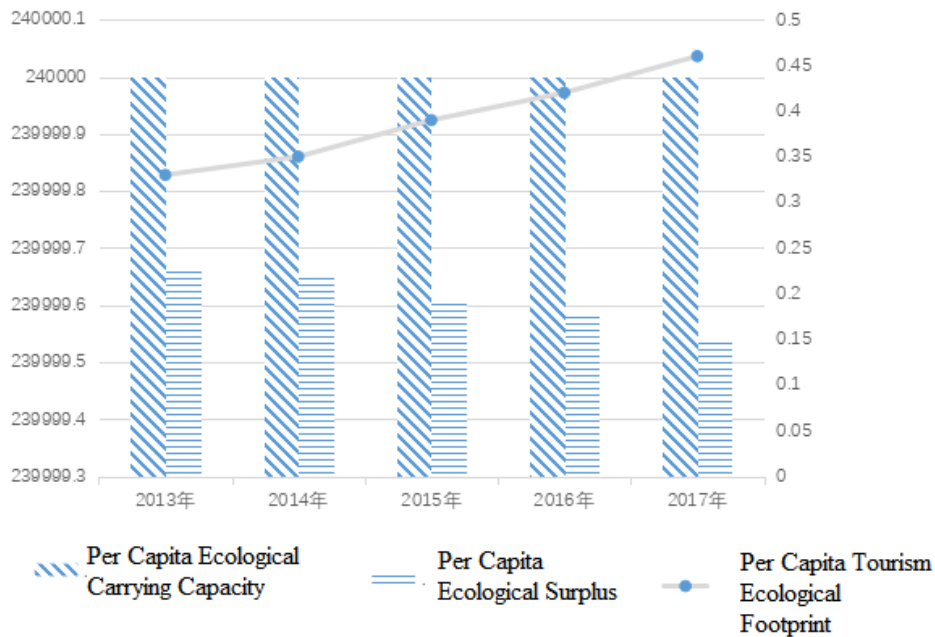
Fig. 2 Dynamic changes of per capita tourism ecological footprint, per capita ecological carrying capacity and per capita ecological surplus in Zoige county from 2013 to 2017

From the micro perspective, from 2013 to 2017, the per capita tourism ecological footprint curve of Zoige county increases to the right from 0.33hm^2 to 0.46hm^2, indicating that the tourist flow increased significantly and the per capita consumption of tourists also increased year on year. This is mainly because most tourists chose self-driving, resulting in the increase in the per capita tourism ecological footprint of Zoige county. The per capita tourism ecological carrying capacity of Zoige county was 240000hm^2, which was relatively stable from 2013 to 2017.The per capita ecological surplus of Zoige county decreased year by year, and its dynamic changes are shown in fig.2.

4. Conclusion and Discussion

(1) From 2013 to 2017, the total tourism ecological footprint and per capita tourism ecological footprint of Zoige county showed an increasing trend. It shows that the total demand of tourist footprints in Zoige county also increases year by year during the study period. This is mainly reflected in the increase in the popularity of tourist attractions in Zoige county, the large increase in tourist reception, the choice of convenient means of transportation and consumption behavior patterns of tourists.

(2) From 2013 to 2017, the tourism ecological carrying capacity of Zoige county decreased slightly. Although the core area of Zoige plateau wetland and the buffer zone are well protected, the plateau wetland marshes are reduced caused by overgrazing and the degree of desertification is gradually enhanced. In the process of tourism, some behaviors that are not conducive to the protection of the natural ecological environment also have an impact on the local ecological environment.

(3) From 2013 to 2017, the tourism ecological carrying capacity of Zoige county was larger than the tourism ecological footprint, showing an ecological surplus, which indicates that the region is currently in a sustainable development state. However, the ecological surplus value showed a downward trend, which is related to the rapid increase of ecological footprint and the decline of ecological carrying capacity.

5. Countermeasures and Suggestions

5.1 From the Perspective of Tourism Subject

The development of ecological civilization clearly requires the public to raise the awareness of

environmental protection. Therefore, it is necessary to carry out environmental protection education and ecological civilization education for tourists before they enter the scenic spots. Tourists, as the main body of tourism, bear the main responsibility of protecting natural ecological resources. The local government needs to strengthen publicity and education to guide tourists to conduct civilized tourism, low-carbon tourism and protect the ecological environment.

5.2 From the Perspective of Tourism Object

The natural ecological resources of the tourist destination have original ecological beauty, scarcity and non-reproducibility. Because of the fragility of plateau wetland ecological environment, the protection of tourism resources needs to be strengthened to ensure the sustainable use of tourism resources while developing tourism.

5.3 From the Perspective of Tourism Media

Tourism media is an intermediary and bridge to promote the interaction between ecotourism subject and ecotourism object. This requires relevant departments engaged in tourism to enhance the awareness of ecological and environmental protection. First, they should advocate low-carbon transportation. Using public transportation and new energy transportation to reduce the carbon footprint of tourism. Second, the tourism accommodation. The accommodation facilities should conform to the concept of ecotourism and use renewable resources to realize energy saving and consumption reduction of ecotourism accommodation facilities. The media should provide reasonable guidance and management for the homestay in the scenic area. Third, tourism food. The principle of low-carbon catering should be adopted. Food should meet the low-carbon environmental protection standards in the process of production, production and marketing. Fourth, the rational development of green tourism commodities. The development of tourist commodities in scenic spots is conducive to the promotion of scenic spots and the promotion of scenic spots' tourism economy. However, it is necessary to reduce the negative impact on the natural ecological environment in the landscape area during its production and sales. Fifthly, developing more attractive ecological tourist attractions and applying reasonable competition and cooperation mode among them. The sixth is about the disposal of tourism waste in scenic spots. Ecological toilets should be used in scenic spots. Tourism waste classification and pretreatment can effectively reduce the cost of tourism waste disposal and carbon emission value.

5.4 From the Perspective of Tourism Carrier

Tourism carrier is divided into tourism macro environment and micro environment. The macro environment of tourism refers to the guidelines and policies of tourism development at the national level. In November 2018, the State Council issued *The Guidelines on Promoting the Sustainable Development of Rural Tourism*, which shows that ethnic minority areas have a good opportunity to accelerate the development of tourism under the conditions advocated by the national tourism macro-environment. Tourism micro-environment refers to various resources and environments of tourist destinations. In the process of the development of the tourism industry, the tourism management organization realizes the overall planning and management of the tourism industry, promotes the sustainable development of the ecological tourism industry, and provides conditions for the sustainable development of the ecological tourism industry.

References

[1] Hunter C. Sustainable tourism and the touristic ecological footprint [J]. Environment,

Development and Sustainability, 2002,4:7-20.

[2] Rees W E. Ecological Footprints and Appropriated Carrying Capacity: What Urban Economics Leaves Out[J]. Environment and Urbanization, 1992, 4(2):121-130.

[3] WACKERNAGEL M, REES W. Our Ecological Footprint: Reducing Human Impact on the Earth[M]. Gabriola Island: New Society Publishers, 1996.

[4] Hui Wang, Jianguo Lin. The Calculation of Tourism Ecological Footprint Model to the Carrying Capacity of Tourism Environment[J]. Journal of Dalian Maritime University, 2005(3):57-61.

[5] Jinhe Zhang, Jie Zhang. Tourism Ecological Footprint Model and Empirical Analysis of Huangshan City [J]. Acta Geographica Sinica, 2004(5):763-771.

[6] Guihua Yang, Peng Li. Tourism Ecological Footprint: A New Method to Measure the Sustainable Development of Tourism [J]. Acta Ecologica Sinica, 2005(6):1475-1480.

[7] Xintian Liu,Yuquan Gao. Evaluation and Demonstration of Dynamic Changes and Sustainable Development of Tourism Ecological Footprint [J]. Statistics & Decision,2013(18):61-63.