Study on Sustainable Development Evaluation of Mountain Scenic Spots Based on Ecological Footprint Composition – Take Chinese Mount Heng as an Example

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Abstract

The evaluation of sustainable development in mountain scenic spots can provide reference for the tourism development of in mountain scenic spots. This study takes mountain Heng as a case, collects relevant data through field investigation, and explores the ecological status by combining the tourism ecological footprint model, tourism ecological carrying model and tourism ecological footprint index model. The results show that the tourism ecological footprint of transportation and catering is relatively high. The overall ecological pressure value is -140813.2423 hm², the tourism ecological footprint index is -6.2477 hm², the TEFI value is ≤-1, and the sustainable level of tourism development is negative. The ecological footprint of Nanyue tourism area is severely depleted, and the sustainable level of tourism development obviously deviates from the normal track. Based on the loss ratio of ecological footprint account, the paper aims to strengthen the rectifying level of tourism ecology from the aspects of tourist capacity, practitioners, ecological development concept and business model, so as to promote its sustainable development.

Keywords: tourist spending, mountain-type scenic spots, tourism ecological footprint, footprint index

Introduction

The ecological footprint method aims to judge the sustainability level of current tourism development by analyzing the gap between the ecological consumption (ecological footprint) of regional natural resources and the ecological supply (ecological carrying capacity). Rees [1] (1992) proposed the calculation method of ecological footprint, believing that ecological footprint is the consumption state of maintaining material and energy flow in the economy. Then Hunter [2] (2007), based on multiple dimensions, expounded tourism ecological footprint. Combining the theory of tourism...
life cycle system, he explained tourism ecological footprint calculation model and its measuring value in the sustainable development of tourism, and New Zealand as a case he built index system of ecological footprint, revealed the influence of tourism on the ecological environment in detail. Stefan G. [3] (2002) investigated the tourism industry of Seychelles Islands in Africa, and the results showed that the ecological footprint was not sustainable. Peter Allan [4] (2003) empirically studied and compared the utilization of tourism ecological resources in Ontario, Canada. Valentina C. [5] (2008) studied the sustainability of tourism activities in Italy through the combination of ecological footprint model and LCA.


Based on the above research, it can be found that, firstly, the empirical research on tourism ecological footprint pays less attention to the special regions with higher ecological sensitivity, and the regional selection is mainly based on the urban tourist destination. Only a few sources have studied the rural tourism destinations, but the ecological loss of mountain scenic spots is ignored. In general, the threshold of ecological carrying capacity in ecological fragile zones is low, and the ecological footprints of tourism service providers are all in the core areas of scenic spots. They are more continuous in time than tourists, therefore, this part of the ecological footprint can not be ignored. Based on this, this paper selects the typical mountain scenic spot – Nanyue Mount Heng China (Nanyue) as the research target area. This paper made a comprehensive calculation of its tourists’ consumption and the ecological footprint account of tourism practitioners. Based on the ecological footprint index model, this paper evaluated the sustainable development level of tourism, and provided suggestions and references for the sustainable development of mountain scenic spots.

The method of ecological footprint analysis is a specific method to measure the balance state between ecological consumption and ecological supply in an area, which is not only suitable for mountain scenic spots, general scenic spots, and even modern urban living areas. The method can be used to measure the local ecological consumption and ecological supply balance state, and the fluctuation of both.

## Material and Methods

### Study Area Overview and Data Sources

**Hengshan General Situation of the Southern Mountain**

Mount Heng refers to the scenic area of Mount Heng, which belongs to the typical mountain tourism area of China. The geographical coordinates are located between 27°4′N and 27°20′N, 112°34′E and 112°44′E, with a northeast-to-southwest trend. Nanyue is a key scenic area and 5A tourist area, with unique tourism resources with natural and cultural landscapes. According to the national standard “Classification, Investigation and Evaluation of Tourism resources” (GB/T18972-2003), Nanyue tourism resources have 8 main categories, 17 subcategories and 29 basic types. From the total tourism income, ticket income, total tourist reception and group tourist reception of Nanyue from 2013 to 2019, it can be seen that the current development of tourism economy is in good condition (Table 1). However, the development and overuse of tourism resources lead to obvious changes in the ecological environment, and the influx of tourists and the increase in employees. All of them have a great impact on the local soil, atmosphere, water, vegetation, wildlife and landscape architecture.

### Data Sources and Processing

The sustainable development level of Nanyue tourism is evaluated based on the ecological footprint account. The research time is 2019. The data range includes basic data, survey data, standard data and estimated data, which are explained in detail as follows:

1. **Basic data.** Nanyue tourism income, tourist reception of visitors, hotel, number of beds and the room occupancy, residents food consumption type and quantity, scenic sightseeing area, entertainment area, the scenic personnel, all data come from Hengyang city government's official website, such as Hengyang city bureau of statistics released by the Hengyang city statistics bulletin, and "Hengshan Tourism Development
Tourism is mainly based on various stakeholders in the tourism system as the main body, tourist attractions and behavior as the object, through the subject and object in a certain area, the interaction among the flow of tourist activities, production, management and consumption in the act of tourism. The six elements of tourism activities form a closed-loop structure of the tourism industry chain, which is transformed into the output value of land area through the resource consumption of specific links. After the balance, the specific value of tourism ecological footprint can be measured. A large number of practitioners should participate in the operation of tourism services, it needs calculating the six ecological footprint accounts of tourists, and the ecological footprint accounts of tourism practitioners are also added. The model is as follows:

\[
TEF = TEF_{food} + TEF_{accommodation} + TEF_{transport} + TEF_{purchase} + TEF_{visiting} + TEF_{entertainment} + TEF_{employee}
\] (1)

The variables in the equation represent the partial ecological footprint accounts of tourism catering, accommodation, transportation, shopping, sightseeing, entertainment and tourism practitioners in turn.

Measurement and Analysis of Ecological Footprint Account of Nanyue Tourism Consumers

Nanyue Tourism Traffic Ecological Footprint

The specific calculation model of tourism traffic ecological footprint is as follows:

\[
TEF_{transport} = \left[\sum (S_i \times R_i) + \sum (N_j \times D_j \times C_j)\right] \times F_v
\] (2)

\(S_i\) is the built-up area of the first type of transport; \(R_i\) is the tourist utilization rate of the i mode of transport; \(N_j\) is the number of tourists of the j mode of transport; \(D_j\) is the flat travel distance of tourists who choose the j type of transport; \(C_j\) represents the ecological footprint per capita of the j type of transportation. \(F_v\) (\(v = 1, 2, \ldots 6\)) is the corresponding land type equilibrium factor in six types of ecologically productive land.

The equilibrium factor is an important parameter in the calculation of ecological footprint, which converts the area of six biological productive land types into the area with the same biological productivity, thus, the sum of six types of land area is realized. Therefore, the accuracy of the equilibrium factor directly affects the reliability and comparability of the calculated results. Refer to Wackernagel [19] (1999).

The research group selected 100 tourists in Nanyue to conduct an interview survey, and found that tourists mainly arrive at the tourist destination by plane, train, coach and self-drive, accounting for 4.17%, 30.42%, 39.83% and 25.58% respectively. Since Nanyue has

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of visitors (Ten thousand)</th>
<th>Tourism revenue (Billion RMB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>648.59</td>
<td>49.77</td>
</tr>
<tr>
<td>2014</td>
<td>706.05</td>
<td>57.33</td>
</tr>
<tr>
<td>2015</td>
<td>794.98</td>
<td>63.45</td>
</tr>
<tr>
<td>2016</td>
<td>875.67</td>
<td>69.84</td>
</tr>
<tr>
<td>2017</td>
<td>1003.08</td>
<td>80.32</td>
</tr>
<tr>
<td>2018</td>
<td>1164.17</td>
<td>100.42</td>
</tr>
<tr>
<td>2019</td>
<td>1316.37</td>
<td>113.52</td>
</tr>
</tbody>
</table>

Master Detailed Plan", "Ticket briefing" and other official data.

(2) Survey data. Scenic traffic, catering, accommodation, sightseeing, shopping and entertainment facilities, average residence time, and its utilization, destination traffic tool selection, group composition and the average trip distance of tourism, tourist shopping preferences and their average consumption levels, price and market conditions and other all belong to the survey data. We get data mainly through the Nanyue tourists and various tourism enterprises and institutions.

(3) Standard data. Specifically, it includes the energy resource loss generated in the process of tourism behavior, yield factor, average calorific value and conversion coefficient used in this type of land consumption. There is the annual ecological productivity of food, the per unit built-up area of accommodation beds and the amount of energy used. The data were obtained from relevant international standards and authoritative literature.

(4) Estimated data. Due to the large and complex data required for ecological footprint calculation, estimation errors existed in statistical data, it is necessary to estimate and interpolate the missing data when obtaining actual data.

After data collection and sorting, excel software is mainly used to give variable meaning to the corresponding original data according to the calculation model, and the sustainable level of tourism development is determined according to the tourism ecological Footprint index (TEFI) value.

Construction and Calculation of Nanyue Tourism Ecological Footprint Model

**Overall Model of Tourism Ecological Footprint**

Tourism Ecological Footprint (TEF) is developed on the basis of the concept of ecological footprint. It is generally considered that tourism ecological footprint is productive land area needed by a certain region to support a certain number of tourist activities (Zhao [18], 2022).
not counted the number of tourists corresponding to various modes of transportation in the total number of tourists received by tourism, this part of data is estimated and analyzed by the method of scaling and shrinking. The calculation of tourist travel distance includes three segments: long range, medium range and short range. According to the distance attenuation law of tourism market and the economic effect principle of distance and cost, it is assumed that long range tourists use plane, medium range tourists use train and coach, and short range tourists use self-drive. Through the query of Hengyang Nanyue airport flight information, combined with Nanyue market data, it can determine the remote provinces including Shanghai, Hainan, Fujian and Shandong four provinces. Medium-haul tourists mainly come from neighboring provinces, with mature markets including Guangdong Province, Pingxiang in Jiangxi province, Guilin in Guangxi Province and Hubei province. The near distance tourist source is mainly distributed in Hengyang City and its neighboring areas in Hunan Province, including Hengyang, Zhuzhou, Shaoyang, Changsha, Yueyang, Chenzhou and other places. For the convenience of calculation, all provinces and regions are summarized according to the linear distance between the provincial capital city and Nanyue to take the average distance.

According to the above data, the calculation results of Nanyue tourism traffic ecological footprint per capita in 2019 was 0.060724082 hm²/capita of tourism transportation in Nanyue in 2019 was summarized, and the ecological footprint per capita corresponding to the four transportation tools are shown in Table 2. The ecological footprint per capita of Nanyue tourism traffic ecological footprint account to take the average distance.

<table>
<thead>
<tr>
<th>Fuel type</th>
<th>Tourists (person)</th>
<th>Average travel distance (km)</th>
<th>Unit ecological footprint (hm²/km)</th>
<th>Equilibrium factor</th>
<th>Ecological footprint after equilibrium</th>
<th>Ecological footprint per capita (hm²/person)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plane</td>
<td>485459</td>
<td>1096.025</td>
<td>0.0000293</td>
<td>1.1</td>
<td>17148.793</td>
<td>0.035324886</td>
</tr>
<tr>
<td>Train</td>
<td>3541405</td>
<td>469.575</td>
<td>0.0000174</td>
<td>1.1</td>
<td>31828.963</td>
<td>0.008987666</td>
</tr>
<tr>
<td>Coach</td>
<td>4636889</td>
<td>469.575</td>
<td>0.0000174</td>
<td>1.1</td>
<td>40716.765</td>
<td>0.008781053</td>
</tr>
<tr>
<td>Car</td>
<td>2977947</td>
<td>152.4571</td>
<td>0.0000455</td>
<td>1.1</td>
<td>22723.158</td>
<td>0.007630478</td>
</tr>
</tbody>
</table>

Table 2. Nanyue Tourism transportation ecological footprint energy account in 2019.
The ecological footprint of tourism consists of two parts: the built-up area of catering facilities and the corresponding productive land area transformed by the consumption of food materials. Considering that most hotels provide catering and restaurants operating catering alone have limited footprint, the ecological footprint of this part of the built area has been included in the calculation of the ecological footprint of tourism accommodation, so the calculation will not be repeated. Considering that the catering industry in tourist destinations often uses local characteristic ingredients and recipes, there is no obvious spatial difference in the consumption of specific ingredients within the province, although there is a great difference in the taste of catering habits. Therefore, it can be assumed that the food consumption of tourists in scenic spots is the same as that of residents in the province. In view of this, this paper selected the per capita major food consumption in Hunan Province in 2019 as the original data, and the calculation results are shown in Table 4. According to the data processing results, the total ecological footprint of tourism and catering after the balance is 44122.40063 hm², and the per capita ecological footprint is 0.003790031 hm².

### Nanyue Tourism Tour Ecological Footprint

Tourism activities are the core elements of tourism behavior, and also an important link to reflect the value of scenic spots. The ecological footprint of tourism is an extremely important part of calculation, and its specific model is as follows:

\[
TEF_{visiting} = \left[ \sum S_{visiting} + \sum E_{visiting} \right] \times F_v
\]

\[
S_{visiting} \quad \text{is the built-up area of tourist facilities; } E_{visiting} \quad \text{is the energy consumption generated during the tour is converted into bio-ecological land area.}
\]

### Nanyue Tourism and Entertainment Ecological Footprint

The calculation of the ecological footprint of tourism and entertainment mainly includes the built-up area and total energy consumption of entertainment facilities such as chess and card rooms, song and dance halls, gyms, network gymnasiums and courts. In order to avoid double counting, the built area is not taken into account for entertainment items attached to the hotel. The calculation model is as follows:

\[
TEF_{entertainment} = \left[ \sum S_{entertainment} + \sum E_{entertainment} \right] \times F_e
\]

Table 3. Nanyue tourism accommodation ecological footprint energy account in 2019.

<table>
<thead>
<tr>
<th>Accommodation facilities</th>
<th>Land type</th>
<th>Composition of hotels</th>
<th>Beds</th>
<th>Total floor area of beds (hm²)</th>
<th>Average occupancy rate (%)</th>
<th>Ecological footprint after equilibrium (hm²)</th>
<th>Ecological footprint per capita after equilibrium (hm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A four-star hotel</td>
<td>Built</td>
<td>1</td>
<td>270</td>
<td>0.03</td>
<td>75</td>
<td>22.68</td>
<td>0.00015342</td>
</tr>
<tr>
<td></td>
<td>Fossil energy land</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>77.60</td>
<td>0.000525</td>
</tr>
<tr>
<td>Two star hotel</td>
<td>Built</td>
<td>129</td>
<td>5000</td>
<td>0.01</td>
<td>80</td>
<td>140</td>
<td>4.79452E-05</td>
</tr>
<tr>
<td></td>
<td>Fossil energy land</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>876</td>
<td>0.0003</td>
</tr>
<tr>
<td>One star hotel</td>
<td>Built</td>
<td>256</td>
<td>11225</td>
<td>0.01</td>
<td>75</td>
<td>314.30</td>
<td>5.11416E-05</td>
</tr>
<tr>
<td></td>
<td>Fossil energy land</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1843.70</td>
<td>0.0003</td>
</tr>
<tr>
<td>Other Accommodation facilities</td>
<td>Built</td>
<td>76</td>
<td>2519</td>
<td>0.006</td>
<td>60</td>
<td>42.32</td>
<td>3.83562E-05</td>
</tr>
<tr>
<td></td>
<td>Fossil energy land</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>248.25</td>
<td>0.000225</td>
</tr>
</tbody>
</table>
**Sentertainment** is the built-up area of tourism and entertainment facilities; **Eentertainment** is the bio-ecological land area converted from the energy consumption generated in tourism and recreation activities. The ecological footprint of tourism and entertainment only considers the ecological footprint formed by the built-up area of all kinds of entertainment facilities, and the energy consumption is mostly clean energy such as electricity, so the energy consumption footprint is not considered. Regardless of the gyms, chess and card rooms and KTV in star hotels, among the current entertainment facilities in Nanyue, the completed area of Tianzishan Square and Wanshou Square is 0.044 km\(^2\), the completed area of Genting Gym and Yinma Gym is 0.14 km\(^2\), and the completed area of song and dance club is 0.0068 km\(^2\). Network sports club built area of 0.004147 km\(^2\) per capita ecological footprint is 2.9759E-08 hm\(^2\).

\[
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\]

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\[
\text{Nanyue Tourism Shopping Ecological Footprint}
\]

The specific calculation model of ecological footprint of tourism shopping is as follows:

\[
TEF_{purchas} = \left[ \sum S_i + \sum \left( R_i \frac{P}{g_i} \right) \right] \times F_c
\]

\[
(7)
\]

\(S_i\) is the built-up area of type \(i\) tourist shopping mall; \(R_i\) is consumption expenditure for tourists to buy the \(I\) tourist goods, \(P\) is the local average selling price of the \(i\) tourist commodity, \(g_i\) is the annual average productivity of the local biologically productive land corresponding to the unit of tourism commodity \(i\).

At present, most of the tourist shopping shops in Nanyue are featured by the demand for incense and sacrificial supplies. Most of the owners are native residents of Nanyue, shops are compact and close to the core scenic area. Therefore, the built-up area of the shop is actually the residential land of the place.

<table>
<thead>
<tr>
<th>Project</th>
<th>Built-up land area (hm(^2))</th>
<th>Equilibrium factor</th>
<th>Ecological footprint after equilibrium (hm(^2))</th>
<th>Ecological footprint per capita (hm(^2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>The scenic trails</td>
<td>4.56</td>
<td>2.8</td>
<td>12.76</td>
<td>1.0967E-06</td>
</tr>
<tr>
<td>Scenic highway</td>
<td>1.35</td>
<td>2.8</td>
<td>3.78</td>
<td>3.2469E-07</td>
</tr>
<tr>
<td>Viewing space</td>
<td>0.68</td>
<td>2.8</td>
<td>1.904</td>
<td>1.6355E-07</td>
</tr>
</tbody>
</table>
The specific variables only consider the biological productive land footprint reflected by the goods sold in the Nanyue scenic area, and those non-local produced handicrafts and souvenirs are not considered within the scope. Nanyue popular shopping souvenirs belong to local products are Buddhist beads, cloud tea, Guanyin bamboo shoots, goose fungus, Nanyue longevity wine, longevity cake, Gaoshan longevity rice, yellow essence, kiwi fruit and so on. According to statistics, the total number of tourists received by Nanyue in 2019 was 110 0239 person-times, and the total tourism revenue was 100.42 billion yuan, among which tourism commodities accounted for 17.4%, and the per capita tourism shopping consumption was 1588.12 yuan. Because the statistics related to the number, variety and category of tourist commodities purchased by tourists, consumption expenditure and purchase price at that time have not been completed completely, the data used in the research can only be estimated and assumed. Here, it is assumed that all the products purchased by tourists are local specialties, and the purchase price at that time is 1600 yuan/Kg, the average value of various types and merchants. It can be seen that the total ecological footprint after balanced tourism and shopping is 0.005643055 hm², and the ecological footprint per capita is 5.12894E-09 hm².

Measurement and Analysis of Ecological Footprint Account of Nanyue Tourism Practitioners

According to the consumption of ecological resources generated by tourism service providers in the core area of scenic spots, the ecological footprint calculation model of tourism human resources is constructed as follows:

\[
TEF_{employee} = F_r \times \left[ \sum (N \times S) + \sum (365 \times K \times N \times \frac{C_r}{T}) \right] \\
+ F_s \times \left[ \sum (N \times D \times \frac{C_r}{P}) + \sum (N \times D \times \frac{E_j}{r_j}) \right]
\]

(8)

\(F_r\) is the equilibrium factor of built-up land; \(N\) is the number of employees; \(S\) is accommodation area for employees; \(K\) is staff accommodation rate; \(C_r\) is bed energy consumption; \(r\) is the average calorific value of the world's land area per unit of fossil fuel production; \(D\) is the annual average working days of employees; \(C_{r_i}\) is the consumption of the \(i\) food per employee per day; \(P_i\) is the annual average productivity of biologically productive land corresponding to food type \(i\); \(E_j\) is the \(j\) energy consumption per employee per day; \(r_j\) is the average calorific value of land area per unit of fossil fuel production for the \(j\) energy source.

At present, Nanyue's administrative establishment within the number of 4618 people, more than a year of long-term contract employment for 1232 people, temporary employment for 57122 people, the total number of employment for 62972 people. The average person works about 235 days a year. According to the actual situation of Nanyue, the accommodation environment of employees is managed uniformly according to the bed standard of ordinary hotels, and this standard is used as the bed energy consumption. Nanyue temporary workers accounted for a large number of administrative institutions, long-term contracts hired staff and some temporary staff do not occupy the number of beds, so the comprehensive accommodation rate of 88%. The catering footprint consumption of employees is treated with the same standard as the calculation method of tourists. The results showed that the ecological footprint of the accommodation site was 1798.742 hm², the ecological footprint of fossil energy was 1190.43144 hm², and the total footprint of the accommodation was 2989.147 hm². The catering ecological footprint of employees is 238.6658145 hm², and the per capita catering ecological footprint is about 2.05 hm². The total ecological footprint of tourism practitioners is 3227.813 hm².

Summary and Composition Analysis of Nanyue Tourism Ecological Footprint Account

In order to further understand the specific contribution rate of each account of tourism ecological footprint and summarize the guiding factors and antagonistic mechanism behind the data, the total amount of ecological footprint, per capita ecological footprint and contribution rate of each account are described, as shown in Table 6.

From the above, it is not difficult to see that in recent years, the number of Nanyue tourism soaring, tourism income is increasing, ecological footprint consumption mainly concentrated in tourism traffic, catering, accommodation and practitioners of several aspects, tourism, entertainment, shopping has a great share of space.

Results and Discussions

Calculation and Analysis of Nanyue Tourism Ecological Carrying Capacity

Based on the ecological carrying capacity model, the specific calculation model of tourism ecological carrying capacity is as follows:

\[
TEC = N(tec) = N \sum_{j=1}^{k} a_j \times r_j \times y_j
\]

(9)

\[
REC = (1-12\%) \times TEC
\]

(10)

Where \(j\) is the type of ecologically productive land; \(TEC\) is the total tourism ecological carrying capacity
of the region; \( N \) is the total number of tourist visits; \( T_{ec} \) is per capita tourism ecological carrying capacity; \( a_j \) is the per capita ecological productive land area; \( r_j \) is the equilibrium factor, \( y_j \) is yield factor; \( REC \) is the effective ecological carrying capacity after deducting 12% of the protected area of biodiversity. According to the recommendations of the World Commission on Environment and Development, it is more scientific to deduct 12% of the protected area of biological diversity to derive the ecological carrying capacity.

The comprehensive analysis of tourism ecological bearing (TEC) is the second key data to calculate the tourism ecological footprint index. The TEC calculation in this study mainly selects the part of Nanyue used for tourism development planning area and potential resource utilization development zone, including cultivated land, woodland, grassland, water area and built land. According to the particularity of the tourism industry, the carrying capacity is calculated from the land area that can be used for construction in the six accounts of food, housing, transportation, tourism, shopping and entertainment. According to relevant government data such as Nanyue District Tourism Bureau and Land Administration, the total bearing area data of all kinds of land are calculated, and the formula calculation results are shown in Table 7 according to the corresponding equilibrium factor and yield factor. The results showed that the overall tourism ecological carrying capacity of Nanyue was 25611.71362 hm\(^2\). After deducting 12% of the biodiversity area, the remaining effective tourism ecological carrying capacity was 22538.30799 hm\(^2\), and the effective per capita tourism ecological carrying capacity was 0.02048492 hm\(^2\).

Nanyue Tourism Ecological Footprint Index Calculation and Sustainable Development Level Evaluation

Tourism Ecological Footprint Index (TEFI) is used in this study to measure the degree of sustainable development of a Tourism destination. It is mainly expressed by the difference between the Tourism carrying capacity and the total Tourism Ecological Footprint. The calculation model is as follows:

\[
TEFI = \frac{TEC - TEF}{TEC}
\]  

(11)

TEFI is the tourism ecological footprint index, TEF is the tourism ecological footprint, and TEC is the tourism ecological carrying capacity.

Table 6. Comprehensive analysis of various accounts of Nanyue tourism ecological footprint.

<table>
<thead>
<tr>
<th>Specific account</th>
<th>Total ecological footprint (hm(^2))</th>
<th>Ecological footprint per capita (hm(^2))</th>
<th>Contribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tourist traffic</td>
<td>112417.6716</td>
<td>0.060724082</td>
<td>68.819470%</td>
</tr>
<tr>
<td>Tourist accommodation</td>
<td>3564.861025</td>
<td>0.001640868</td>
<td>2.182325%</td>
</tr>
<tr>
<td>Tourism catering</td>
<td>44122.40063</td>
<td>0.003790031</td>
<td>27.010702%</td>
</tr>
<tr>
<td>Tourist entertainment</td>
<td>0.3464417</td>
<td>2.98e-08</td>
<td>0.000212%</td>
</tr>
<tr>
<td>Tourist</td>
<td>18.452</td>
<td>1.58e-06</td>
<td>0.001296%</td>
</tr>
<tr>
<td>Tourism shopping</td>
<td>0.005643055</td>
<td>5.13e-09</td>
<td>0.000003%</td>
</tr>
<tr>
<td>A tourist practitioner</td>
<td>3227.813</td>
<td>0.051257908</td>
<td>1.975992%</td>
</tr>
<tr>
<td>Summary</td>
<td>163351.5503</td>
<td>0.117414509</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

Table 7. Tourism ecological carrying capacity in 2019.

<table>
<thead>
<tr>
<th>Type</th>
<th>With a total area (hm(^2))</th>
<th>Equilibrium factor</th>
<th>Production factor</th>
<th>Tourism ecological carrying capacity (hm(^2))</th>
<th>Per capita tourism ecological carrying capacity (hm(^2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arable land</td>
<td>1134.09</td>
<td>2.8</td>
<td>1.66</td>
<td>5271.25032</td>
<td>0.004791005</td>
</tr>
<tr>
<td>Woodland</td>
<td>14345.83</td>
<td>1.1</td>
<td>0.91</td>
<td>14360.17583</td>
<td>0.013051869</td>
</tr>
<tr>
<td>Grass</td>
<td>22.75</td>
<td>1.1</td>
<td>0.19</td>
<td>4.75475</td>
<td>4.32156e-06</td>
</tr>
<tr>
<td>Water area</td>
<td>266.65</td>
<td>0.2</td>
<td>1</td>
<td>53.33</td>
<td>4.84713e-05</td>
</tr>
<tr>
<td>Built</td>
<td>1274.14</td>
<td>2.8</td>
<td>1.66</td>
<td>5922.20272</td>
<td>0.005382651</td>
</tr>
<tr>
<td>Summary</td>
<td>25611.71362</td>
<td></td>
<td></td>
<td>22538.30799</td>
<td>0.02048492</td>
</tr>
<tr>
<td>Effective tourism ecological bearing capacity</td>
<td></td>
<td></td>
<td></td>
<td>22538.30799</td>
<td>0.02048492</td>
</tr>
</tbody>
</table>
According to the research results of relevant scholar (Wu Yi [20], 2019), the evaluation criteria of the paper is shown in Table 8.

According to the tourism ecological footprint index model, Nanyue ecological pressure index is obviously super high, the specific data is -140813.2423 hm². The result of tourism ecological footprint index is -6.247729085 hm². According to the evaluation standard of tourism ecological footprint index, the TEFI value is ≤-1, and the sustainability level of tourism development is intensity negative. The results show that the ecological footprint depletion of Nanyue is serious, and the tourism ecological deficit is 140813.2423 hm². The sustainable level of tourism development is obviously deviated from the normal track. It is necessary to start from the loss ratio of the ecological footprint account, strengthen the correction level of tourism ecology, and promote its management and development in the sustainable direction.

### Conclusions

Many scholars use the ecological footprint model to study the sustainable development of tourism [21-22] (Gossling 2002; Asmelash 2019), but there are few studies on mountain-type scenic spots from the perspective of ecological footprint assessment. Hu [23] (2007), Shi [24] (2023) and Liu [25] (2023) conducted studies on Jiangxi Mount Lu, Anhui Huang Mount and northern Xinjiang, but there are fewer dimensions. This article uses seven ecological footprint accounts to improve the accuracy of the measurement. This paper evaluates the sustainability level of tourism development in mountain scenic spots. First of all, Nanyue tourism ecological situation is not optimistic, and tourism ecological pressure value is -140813.2423 hm². The deficit is more serious. The result of tourism ecological footprint index is -6.247729085 hm², and the sustainability level of tourism development is negative, which reveals that local tourism development should focus on reducing the base of ecological footprint and exploring sustainable tourism development mode. From the perspective of the ecological footprint consumption structure of Nanyue, tourism transportation, tourism catering, tourism accommodation and tourism employees play important roles. But the rest of the tourism entertainment, sightseeing, shopping parts are at a low level. Finally, the main factors affecting the ecological capacity on scenic spots are tourism scale, transportation and infrastructure construction, catering consumption. According to the influence degree of each index in the tourism ecological footprint model, the results of tourism capacity and tourism ecological footprint index, the antagonistic factors of the ecological footprint on scenic spots can be summarized as the scale of tourists, the selection of infrastructure, transportation tools, and the consumption of food and beverage.

In order to achieve sustainable development, the first step is to reduce the base of ecological footprint, especially control the ecological footprint dissipation of tourism traffic. Secondly, the ratio allocation of other accounts should be strengthened. On the premise of decreasing the footprint dissipation base, the accommodation rate of tourists should be increased, sightseeing, entertainment and shopping should be increased, and the ratio of tourism transportation and catering should be reduced. Thirdly, we should strengthen the intelligent management and the tourism transformation facilities, so as to reduce the loss of resources. Strengthening the renovation of accommodation and management facilities reduces the ecological footprint. The accommodation and management facilities should be transferred to the periphery of the scenic area. We should ensure the ecological footprint is in the bearing range through reasonable planning of dormitory area and energy use.

However, because of the difficulty of obtaining local data and evaluating it only on the basis of cross-sectional data, it is difficult to monitor the impact of Nanyue’s ecological footprint on the sustainable development. In the future, data collection should be further strengthened so as to accurately measure the ecological footprint and sustainable development level.

### Acknowledgments

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### Conflict of Interest

The authors declare no conflict of interest.

### References