Analysis on Coordinated Development Model of Regional Tourism Economy and Ecological Environment

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Abstract

In this paper, the decoupling evaluation model and the coupling coordination model of regional tourism economic growth and ecological environment pressure are constructed. Tourism level, economic benefit and evolution trend of ecological environment pressure of a tourism scenic spot in coastal areas of Guangdong and five coastal provinces of China are analyzed from 2005 to 2014. The results show that the decoupling index shows a "M" type change as a whole, and the ecology pressure index shows a trend of increasing first and then decreasing during 2005 to 2014, and presents a fluctuated change. Among which in 2004-2008 and 2009-2011 the index is in a state of gradual increase, while 2011-2014 is a state of decline. The revenue of tourism is proportional to the change of ecology pressure index in the early stage, and the reverse trend is in the later stage. The tourism level of the five provinces in China is gradually increasing, the overall economic benefit index presents a fluctuated change, the tourism benefit of the southern provinces in China is much higher than that of the northern provinces; the coupling degree of tourism and ecological environment is between 0.2 and 0.6, the coupling degree of Guangdong province is the largest, the coupling degree between tourism and ecological environment begins to develop in benign coupling; currently the tourism in other provinces and the elements of ecological environment is in state of antagonism running-in, the direct or indirect impact of tourism on the ecological environment gradually highlights.

Keywords: Tourism economy, Ecology pressure index, Decoupling evaluation, Coupling coordination index, Comprehensive benefits

1. INTRODUCTION

In recent years, the tourism industry has become an important pillar of regional economic development, the huge floating tourism population greatly promoted the rapid development of local tourism economy, but also accelerated the deterioration of the regional ecological environment (Saleh, 2007). How to ensure the coordination and sustainable development of tourism industry and ecological environment has become a hot topic of current research(Hill and Pickering, 2006).

Tourism economy and ecological environment constitute a regional complex structure system, on the one hand the continuous upgrading of the tourism industry, supporting services continue to optimize, the rapid expansion of spatial pattern can fully attract foreign tourists (Lacitignola et al., 2007), increase the local economy revenue; on the other hand, the development of tourism resources will inevitably lead to the destruction of local ecosystems (Patterson et al., 2008), threaten the biodiversity. Coordination and sustainable development is the external manifestation of the coupling relationship of regional complex system. Tourism economic system and ecological environment system exchange energy, information and material with external environment, intervene in the development of the coupling relationship through asynchronous feedback pattern, the ultimate realization of the tourism economy on the permanent use of ecological resources (see figure 1).
There are many studies on the impact of regional tourism economic development on the ecological environment (Zhang et al., 2010). The dialectical relationship between the two has become a frontier issue of tourism ecology research, but the current research focuses more on quantitative analysis between the ecological environment and single factor of tourism economy (Lee and Chang, 2008). Many scholars have proposed different evaluation models for the relationship between regional tourism activities and ecological environment, these literatures provide ideas for the follow-up research, such as input-output model, socio-ecological model (Oh, 2005), tourism-driven economy growth model (Gössling, 2002), comprehensive dynamic model (Dodds, 2007), sustainable development model and social accounting matrix model etc. All this models have contributed greatly to the corresponding research, obtained great progress in theoretical methods and empirical analysis.

Based on the existing literatures, this paper constructs the decoupling evaluation model and the coupling coordination model of regional tourism economic growth and ecological environment pressure (Wagner, 1997), analyzes tourism level, economic benefit and evolution trend of ecological environment pressure of a tourism scenic spot in coastal areas of Guangdong and five coastal provinces of China from 2005 to 2014, which provides the reference for the sustainable development of the custom tourism industry (Hatcher and Hatcher, 2004).

2. DECOUPLING EVALUATION OF TOURISM ECONOMY AND ECOLOGY PRESSURE

2.1 The model of decoupling evaluation

Decoupling theory refers to the regional economic growth and the environment is in a non-synchronous relationship, during the period of time, the regional economic growth rate exceeded environment deterioration rate which caused by the economic activities (Wei et al., 2013). Based on the principles of independence, systematical and dynamism, this paper constructs a comprehensive evaluation system of tourism economy and ecological environment. Refer to decoupling index method and decoupling elastic coefficient method, this paper constructs an evaluation system suitable for regional tourism economic growth and ecological environment pressure. The specific parameters and indicators are as follows (Balaguer and Cantavellajordá, 2002):

Landscape fragmentation degree $L_b$

$$L_b = \left( \frac{N_p}{A_c} - 1 \right) / A_c$$

(1)

$N_p$ denotes the quantity of landscape patches; $A_c$ is the ratio of the region total area to the smallest patch area. The larger the value of landscape fragmentation, the damage of the regional ecological environment function and environment balance is more serious.

Tourism disturbance degree $I_d$
\[ I_{di} = \frac{L_i}{S_i} \]  

(2)

\( I_{di} \) denotes the disturbance degree of the \( i \)th landscape; \( L_i \) is the length of gallery of the \( i \)th landscape in the tourist area; \( S_i \) is the total area of the regional landscape. Biological survival and environmental pressure is proportional to the size of \( I_{di} \).

Biological diversity index \( H \)

\[ H = -\sum_{j=1}^{n} P_j \ln(P_j) \]  

(3)

\( n \) is the biological species in the region; \( P_j \) is the proportion of the \( i \)th species to the total organism

EPI (Ecology Pressure Index)

\[ EPI = \sum_{i=1}^{n} M_i / n \]  

(4)

\( M_i \) is the standard normalized ecology pressure index; the standardized treatment is as follows:

\[ M_i = \left( x_i - x_{\text{min}} \right) / \left( x_{\text{max}} - x_{\text{min}} \right) \]  

(5)

EPI reflects the state of the regional ecological environment pressure. Set \( TI \) as tourism revenue, then decoupling index \( \varepsilon_{tk} \) can be expressed as:

\[ \varepsilon_{tk} = \frac{\Delta EPI_{tk}}{\Delta TI_{tk}} = \left( \frac{EPI_{t_1} - EPI_{t_2}}{EPI_{t_1}} \right) \left( \frac{TI_{t_1} - TI_{t_2}}{TI_{t_1}} \right) \]  

(6)

\( EPI_{t_1}, EPI_{t_2} \) and \( TI_{t_1}, TI_{t_2} \) represent the ecological pressure index and tourism revenue at the early and late stage of \( t \) period respectively. \( \Delta EPI_{t} \) and \( \Delta TI_{t} \) represent the ecology pressure index and the rate of change of tourism revenue respectively. When \( \Delta EPI = \Delta TI \), the growth rate of tourism economy is equal to the growth rate of environmental pressure, and the system is in the critical state. Assuming tourism revenue is growing every year, that is \( \Delta TI \) constant is greater than zero, then the decoupling index has \( \varepsilon_{tk} \leq 0 \), \( 0 < \varepsilon_{tk} < 1 \), \( \varepsilon_{tk} = 1 \) and \( \varepsilon_{tk} > 1 \) total 4 states. When \( \varepsilon_{tk} \leq 0 \), the tourism economy grows rapidly, meanwhile the ecological pressure declines, the system is in the most ideal state; when \( 0 < \varepsilon_{tk} < 1 \), that is \( \Delta EPI < \Delta TI \), the system is of strong sustainability, while \( \varepsilon_{tk} > 1 \), the ecological environment is seriously deteriorated, and the economy growth rate is less than the ecological environment pressure growth rate, the system is of poor sustainability, the local tourism industry must suspend production for rectification.

2.2 Analysis of instance

The tourism economic development and environmental data in a tourism scenic spot of Guangdong coastal area from 2005 to 2014 were adopted (Petrosillo et al., 2006). The trend of the \( \text{Lb}, \text{Id} \) and the biodiversity index \( H \) in this area during the ten years is shown in Figure 2. The change of tourism revenue and eco-environmental pressure curve is shown in Figure 3.
From Figure 2, it can be seen that the index of biodiversity is relatively large, and the degree of landscape fragmentation and the degree of tourism disturbance are small from 2005 to 2007 which is the early period of research area. This is because in the years 2005-2007, the region's tourism industry is still in the early stages of construction and development, infrastructure facilities and tourism-related construction have not formed scale, so the ecological environment is more complete, with the government heavily invested in the local tourism industry after 2007, the biodiversity index decreased rapidly, while the landscape fragmentation degree and tourism disturbance degree index increased obviously, namely the ecological environment pressure increased day by day, eventually the regional biodiversity reached the lowest value in 2011, at this point the landscape fragmentation and tourism disturbance index is still at a high level.

From Figure 3 it showed, after 2007, the region's tourism revenue is steadily rising, with an average annual growth of 21.7%, fully shows that the rapid economic growth in the region at the expense of the ecological environment, reflected from the side that the adverse impact caused by one-sided pursuit of high returns on the ecological environment at the early stage of development. From the beginning of 2011, the index of biodiversity began to rise, and the degree of landscape fragmentation and the degree of tourism disturbance decreased in different degrees, based on strict ecological protection, limiting the number of tourists and strengthening environmental management. Indicating that the growth of tourism economic benefit in this period has been separated from the extensive management mode in the initial period, the pressure of ecological environment has decreased gradually, and the tourism economy-ecological environment system of the whole area tends to a good development mode.

Figure 2 The evaluation index value curves between tourism economy and ecological environment

Figure 3 The curves of eco-environmental pressure index and tourism revenue during 2005-2014
As shown in Figure 3, the ecology pressure index showed a trend of increasing first and then decreasing from 2005 to 2014, and presented a fluctuated change. Among which in 2004-2008 and 2009-2011 index is in a state of gradual increase, while 2011-2014 is a state of decline. The tourism revenue is proportional to the change of ecology pressure index at the early stage, and the reverse trend is in the later stage. Since the ecology pressure index comprehensively reflects the biodiversity, landscape fragmentation degree and tourism disturbance degree in the region, it can be seen from Figure 3 that after 2011, due to the government's efforts to promote the development of eco-tourism, low-carbon tourism and green tourism, eco-environmental pressure gradually decreased, tourism total revenue continued to grow, forming a healthy development.

![Figure 4](image)

**Figure 4** The rate of eco-environmental pressure index and tourism revenue during 2005-2014

Figure 4 shows the change rate curve of the ecological environment pressure and tourism revenue. As shown in the figure, the decoupling index shows a "M" type change, and the decoupling index is less than 1 during the period of 2005-2014, that is, the economic growth rate is higher than deterioration rate of the ecological environment, and the regional sustainability is good in whole. Specific to different stages, the growth rate of tourism revenue is greater than the growth rate of ecological environment pressure, and the value of $\varepsilon_{tk}$ is small. At this time, due to the small number of tourists and the ecological pressure is relatively small. From 2006 to 2010, the value of $\varepsilon_{tk}$ has been in a high state. due to the slowdown in tourism revenue growth during this period, while the damage of tourism industry to ecological environment continued to increase, resulting in a significant increase in ecological environment pressure, the regional ecological environment continues to deterioration, the sustainability of the system gradually decreased. As the ecology pressure index reached maximum staged value in 2009. The value of $\varepsilon_{tk}$ began to decline year by year, and the value of $\varepsilon_{tk}$ was negative in the year 2011 to 2012 and the year 2013 to 2014, that is, the growth rate of tourism revenue rose sharply, while the ecological environmental pressure showed a downward trend, the system showed a virtuous circle of development.

3. THE EVALUATION OF COUPLING DEGREE BETWEEN TOURISM ECONOMY AND ECOLOGICAL PRESSURE IN COASTAL REGION OF CHINA

3.1 The coupling coordination model

Set $x_1, x_2, \ldots, x_n$ as n parameters of regional tourism development evaluation system; $y_1, y_2, \ldots, y_m$ are the m parameters that reflect the local socio-economy; $z_1, z_2, \ldots, z_p$ are the p parameters that reflect the regional ecological pressure Parameter. Let $f(x), g(y)$ and $h(z)$ be the function of regional tourism level, economic benefit and ecological pressure function respectively, then the comprehensive development level can be expressed as:
\[
f(x) = \sum_{i=1}^{n} a_ix_i \\
g(y) = \sum_{i=1}^{n} b_iy_i \\
h(z) = \sum_{i=1}^{n} c_iz_i
\]  
(7)

Then \( P \) is the comprehensive benefit evaluation index of \( f(x), g(y) \) and \( h(z) \), the equation is:

\[
P = \mu f(x) + \lambda g(y) + \eta h(z)
\]  
(8)

In the equation, \( \mu, \lambda \) and \( \eta \) are coefficient, and \( \mu + \lambda + \eta = 1 \).

Construct the coupling coordinate function of regional economy and ecological environment pressure, \( C \).

\[
C = \sqrt[2]{u_1 \cdot u_2}
\]  
(9)

In the equation, \( u_1 \) and \( u_2 \) denote the tourism economic and eco-environmental evaluation index respectively. When the development level of \( u_1 \) and \( u_2 \) is in the initial stage, big error will exist in the calculation result, so the equation 9 is amended,

\[
D = \sqrt[2]{C \cdot T}
\]

\[
T = \alpha u_1 + \beta u_2
\]  
(10)

\( D \) is the amended coupling function, \( T \) is the comprehensive evaluation index of tourism economy and ecological environment, \( \alpha \) and \( \beta \) are the undetermined coefficients, \( \alpha = \beta = 0.5 \).

3.2 Analysis of the research results

According to equation 7 and 8, \( f(X), g(Y), \) and \( h(Z) \) of five typical coastal provinces (Shandong, Hebei, Jiangsu, Zhejiang and Guangdong) are calculated as well as the comprehensive benefit evaluation index, As shown in Fig.5 and Fig.6.

**Figure 5** The index of tourism-oriented development and economic benefit in coastal region of China
The index of eco-environmental pressure and comprehensive benefit in coastal region of China

The figure showed, the tourism level of the five provinces showed a trend of increasing, it can be seen that the government attaches great importance to the development of tourism, among which the highest level of tourism in Guangdong, followed by Zhejiang. Hebei is the worst; The tourism economic benefit index, the overall economic benefit index showed a fluctuated change, the tourism benefits of the southern provinces of China is much higher than the northern provinces; from the ecology pressure index, Hebei Province has the best ecological environment while tourism and economic development is lagging behind. The maximum value of \( h(z) \) is only 0.41, although the tourism level and economic benefit of Guangdong Province are high, but the ecology environment pressure has not been increased, except the initial period (2005-2006) for vigorously development of the tourism industry which lead to greater pressure on the ecological environment, at the latter stage with transformation of economic development and under the guidance of eco-environmental protection policies, environmental quality improved markedly. The ecological environment pressure index of Zhejiang, Jiangsu and Jiangsu has been maintained at a high level and the ecological environment has been under great pressure; From the comprehensive benefit evaluation, the P value of Shandong, Hebei, Jiangsu, Zhejiang and Guangdong increased by 33.1%, 85.6%, 63.2%, 39.6% and 34.8% respectively, showing a sustained growth momentum, the comprehensive benefit of Guangdong Province is the highest and the comprehensive benefit of Hebei Province is the worst, but from the growth percentage point of view, Hebei’s tourism industry developed the fastest in the past ten years. The five provinces have achieved a good development mode that tourism drives economic development and the development of the economy back to feeds tourism.

Figure 6 The index of eco-environmental pressure and comprehensive benefit in coastal region of China

Figure 7 The coupling degree index between tourism-oriented development and ecological environment quality
Our tourism level and ecological environment of Hebei province of Guangdong Province is the largest economic pressure in coastal areas of five provinces is much higher y is good in whole. From 2005 to 2006 ve pressure are constructed. Tourism level highlights antagonism running coupling. The tourism level in other provinces and the elements of ecological environment is in state of antagonism running.

The analysis of the relationship between regional tourism and environmental pressure indicates:

1. The ecology pressure index shows a trend of increasing first and then decreasing during 2005 to 2014, and presents a fluctuated change. Among which in 2004-2008 and 2009-2011 the index is in a state of gradual increase, while 2011-2014 is a state of decline. The revenue of tourism is proportional to the change of ecology pressure index in the early stage, and the reverse trend is in the later stage.

2. The decoupling index shows a "M" type change, and the decoupling index is less than 1 during the period of 2005-2014, that is, the economic growth rate is higher than deterioration rate of the ecological environment, and the regional sustainability is good in whole. From 2005 to 2006, the growth rate of tourism revenue is greater than the growth rate of ecological environment pressure, and the value of $\epsilon_{ek}$ is small. From 2006 to 2010, the value of $\epsilon_{ek}$ has been in a high state, due to the slowdown in tourism revenue growth during this period, while the damage of tourism industry to ecological environment continued to increase, resulting in the regional ecological environment continues to deterioration, the sustainability of the system gradually decreased. After 2009, the growth rate of tourism revenue increased sharply, and the ecological environment pressure showed a downward trend, the system showed a virtuous cycle of development.

The evaluation of the coupling degree between tourism economy and ecological pressure in coastal areas of China indicates:

1. The tourism benefit of the five provinces in China has been increasing gradually. The economic benefit index of the five provinces presents a fluctuated change. The tourism benefit of the southern provinces is much higher than that of the northern provinces; In 2014, the P value of Shandong, Hebei, Jiangsu, Zhejiang and Guangdong increased by 33.1% %, 85.6%, 63.2%, 39.6% and 34.8% respectively compared with that in 2005, showing a sustained growth momentum, the five provinces have achieved a good development model that tourism drives economic development and the development of the economy back to feeds tourism.

2. The coupling degree of tourism and eco-environment in the five provinces is between 0.2-0.6. The coupling degree of Guangdong Province is the largest, tourism and ecological environment begin to develop benign coupling. The tourism level in other provinces and the elements of ecological environment is in state of antagonism running-in, the direct or indirect impact of tourism on the ecological environment gradually highlights, system structure has yet to be optimized, the tourism industry in urgent need of transformation and upgrading.

4. CONCLUSION

In this paper, the decoupling evaluation model and the coupling coordination model of regional tourism economic growth and ecological environment pressure are constructed. Tourism level, economic benefit and evolution trend of ecological environment pressure of a tourism scenic spot in coastal areas of Guangdong and five coastal provinces of China are analyzed from 2005 to 2014, the conclusions are as follows:

The five provinces. It is observed from the figure that the coupling degree of tourism and eco-environment in the five provinces is between 0.2-0.6. The coupling degree of Guangdong Province is the largest, and the coupling degree is above 0.5 in most years. This shows that the level of tourism in Guangdong Province and the quality of ecological environment have entered the stage of running-in. The government no longer focuses only on economic benefits, but put a considerable proportion of funds into the protection of eco-environment, tourism and ecologcal environment begin to develop benign coupling. The coupling degree of Hebei Province is the smallest, only in year 2008-2009 and year 2013-2014 the coupling value is above 0.3, indicating that the level of tourism in the whole province is low, and the impact of tourism on ecological environment quality is not significant at the early stage of research. After 2012, the tourism level and ecological environment of Hebei Province are in antagonism period, the direct or indirect impact of tourism on the ecological environment gradually highlights. On the whole, except that Guangdong province has a relatively high level of tourism, the tourism level in other provinces and the elements of ecological environment is in state of antagonism running-in, mainly due to the low level of industry in each province, system structure has yet to be optimized, the tourism industry in urgent need of transformation and upgrading, to achieve sustainable development of the tourism industry.
REFERENCES


