



Study on the Coupling Coordination between Shandong Tourism and Eco-Environment

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Abstract: The understanding of coupling relationship between tourism and eco-environment is important due to the complex interaction in environmental effects induced by tourism. This paper aims at introducing an indicator system and developing an integrated approach to evaluate the coupling coordination between tourism and eco-environment using panel data from 2001 to 2013 for Shandong Province, China. The findings revealed that coordination degree between the tourism and eco-environment of Shandong Province generally presents an upward tendency. Shandong Province should understand the most significant variables for the coupling coordination between tourism and eco-environment, and take effective measures to balance the relationship of tourism and eco-environment.

Keywords: tourism; eco-environment; coupling and coordinating

1. Introduction

With the deepening of China's reform and opening-up policy, China has become the largest developing country in the world. According to the total revenue estimates published by *The Yearbook of China Tourism Statistics* over the years, the average level of the professionalism in Chinese tourism has reached 0.0982 in the past ten years, which signifies that tourism has become an important force in the national economy [1]. On August 21, 2014, the State Council officially issued the *Several Opinions of the State Council on Accelerating the Reform and Development of Tourism* (GF [2014] No.29), hereinafter referred to as the Opinions. According to the Opinions, tourism is a vital part of modern service industry. Hence, speeding up the reform and development of tourism carries deep significance for promoting economic stability and growth and improving eco-environment.

Since tourism is a typical industry relying on environment, the quality of eco-environment not only influences that of tourists' tourism experience, but also restricts the development process of tourism economy. The two attributes of tourism that it relies on environment and consumes resources determine the dialectic relationship between tourism economy and eco-environment. How to coordinate the relationship between them so as to achieve their sustainable development has long been a hot research topic of tourism scholars [2-4]. As the main support factor, the state of eco-environment will directly affect the sustainable development of tourism and thus can have an important influence on tourism.

2. Literature Review

For the past few years, with the gradual application of sustainable development and synergetics to tourism

research, tourism scholars at home and abroad have done much research on the relationship between tourism and eco-environment. Researchers gradually realize that tourism and eco-environment symbiotically interact with each other and enjoy coupling development. Related research abroad is earlier than that at home. It mainly focuses on aspects like the value assessment of tourism environment, tourism environmental capacity and carrying capacity, the sustainable development of tourism and ecotourism [5-7]. Farrell & Runyan hold that good eco-environment can increase the attractiveness of tourism destinations to tourists and promote ecotourism and the sustainable development of tourism [4]. In turn, the sustainable development of tourism can promote the environmental integrity and attractiveness. Wall & Wright earlier discuss the influences of tourism development on eco-environment and give a profound mechanism analysis of how tourism activities affect environmental elements[7]. Through some questionnaires and the analysis of ecological footprint and eco-efficiency, many scholars have done research about the negative effects of tourism on the environment of different countries and analyzed the research results. These countries include Thailand, Italy, Australia, India, etc[8-11]. Related foreign researchers mainly focus on the specific influences of tourism economic development on environment, and the research methods employed by them are diversified.

Domestic tourism scholars utilize the coupling principle of physics, which is mainly applied to aspects including the coupling of tourism and regional economy, the coupling of tourism and transportation, the coupling of tourism and urbanization, the coupling of regional economy-tourism-ecological environment,

etc. Scholars have in sequence analyzed the coordinated development degree between the tourism and environment of other provinces or sub-provincial cities[12-13]. The results of CUI Feng's research indicate that generally with a rising tendency, the coordinated development degree between the tourism economy and eco-environment of Shanghai still belongs to the coordinated type between medium and good, which doesn't comport with its position as an international metropolis.

Many domestic scholars tend to concentrate on the influences of tourism economy on the overall environment and research on the coordinated mechanism of action between tourism economic development and eco-environment. Much research on the coordinated development of tourism economy and eco-environment has been conducted by scholars in different subject domains. However, with simple research means and limited depth and breadth, research on the coordinated development of tourism and eco-environment is still in an immature stage.

This research is mainly based on the perspective of coupling coordination. Taking the panel data (2001-2013) of Shandong Province as an example, the research focuses on investigating the pattern evolution of the coupling coordination between tourism and eco-environment. In the building process of coupling model, this paper employs SPSS to make the principal component analysis, which identifies the indicator system of tourism and eco-environment more scientifically and reasonably. Then with the entropy value method, this paper obtains the weights of the indicator system. At last, based on the coupling model, this paper determines the correlation between the mean value of the comprehensive assessment indicators in tourism system and that in eco-environment system. At the end of this paper, the author also proposes some strategies for the future coordinated development of the tourism and eco-environment in Shandong Province, hoping to provide the theoretical basis and reference for the relevant departments in Shandong Province to formulate strategies for tourism development and eco-environment.

3. Materials and Methods

3.1. Mechanism of Action of Coupling Coordination

Coupling refers to the phenomenon that two or more systems or movement forms interact and thus influence each other. To achieve the coupling of the systems also needs a dynamic coordination process, which can lead the development of the systems from disorder to order. The coupling coordination degree means that on the basis of coupling and interdependence, the systems realize positive and harmonious development. It also mirrors the degree of excellence to which the systems coordinate with each other based on coupling.

The development of tourism and eco-environmental issues are two closely related systems, which interact but also restrict each other. The sustainable development of both tourism economy and eco-environment can be achieved only by realizing the coordinated operation of the two systems mentioned above on the basis of coupling.

Tourism has both positive and negative influences on eco-environment. On the one hand, the fast but unplanned development of the former can bring to tourism destinations harms like the pollution of air, water and noise, the destruction and disturbance of animals and plants and the destruction of landscape environment.

On the other hand, as a resource-saving and environment-friendly industry, with appropriate development and management, tourism can be beneficial to the sustainable use of natural-cultural resources and eco-environment.

The economic benefits brought by tourism can also show the community residents and government the potential of tourism and the unique environment on which tourism relies. The residents will actively protect both the natural and cultural environment of the tourism areas to attract more tourists.

At the same time, government will show stronger support for environmental protection in terms of policy, management, funding, etc. Meanwhile, to increase the attractiveness of tourism destinations to tourists, government needs to adopt measures like the construction of ecological tourism and pollution abatement, planting trees and grass, cultivating flowers, and comprehensively treating phenomena like water and soil loss and the pollution of air and water.

In this way, government not only protects and beautifies environment, but also improves the environment awareness of the residents. All of this can promote the positive cycle of eco-environment and create a favorable natural environment, which naturally achieves the harmony between tourism and eco-environment.

Tourism and eco-environment develop harmoniously in the same temporal sequence at the same spatial sequence.

Tourism can support or restrict the eco-environment improvements including the following three aspects: tourism benefit, tourism marketing and the scale of tourism industry. At the same time, eco-environment can promote or threaten the development of tourism including environmental pollution and government.

Refer to Figure 1 for the system of the coupling relationship between tourism and eco-environment.

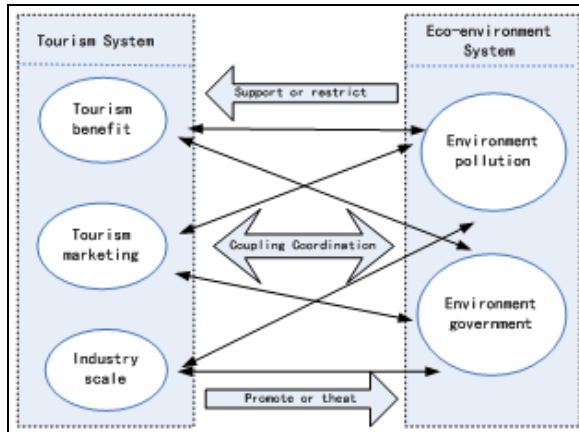


Figure 1: Mechanism of Action of Coupling between Tourism and Eco-environment

3.2. Methods and Data Sources

In order to deeply analyze that coupling relationship, it's necessary to standardize the raw data (Shandong Statistics Bureau, 2001-2013; China National Tourism Administration, 2001-2013) by using formula (1) and (2).

$$u_{ij} = \frac{x_{ij} - \min x_{ij}}{\max x_{ij} - \min x_{ij}} \quad \text{Positive indicator} \quad (1)$$

$$u_{ij} = \frac{\max x_{ij} - x_{ij}}{\max x_{ij} - \min x_{ij}} \quad \text{Negative indicator} \quad (2)$$

In formula (1) and (2), u_{ij} is the j^{th} indicator of the i^{th} system, the value of which is as follows: X_{ij} ($i=1,2,3,\dots,m; j=1,2,3,\dots,n$). Plus, $\max(x_{ij})$ and $\min(x_{ij})$ represent the maximum and minimum values of the indicator X_{ij} , respectively.

Since tourism system and eco-environment system are two different but interactional subsystems, one can use the base methods to calculate the contribution degree of the subsystems' indicators to the system. Generally the geometric mean and linear weighted methods are employed. The formula is as follows:

$$U_i = 1, 2 = \sum_j^n \lambda_j u_{ij} \quad \sum_j^n \lambda_j = 1 \quad (3)$$

In formula (3), U_1 and U_2 refer to the comprehensive assessment functions of tourism system and eco-environment system, respectively; λ_j represents the weight in the i^{th} system. All the indicator weight is obtained through the entropy weighting method.

Entropy weighting method is a kind of objective weighting method, according to the source in the objective environment of the original information, it can analyse the relationship between the indexes and the of amount of information to determine the index of the weight, to a certain extent, it can avoid the deviation caused by the subjective factors.

The specific calculation steps are as follows:

The weight of indicator u_{ij} is $P_{ij} = u_{ij} / \sum_{i=1}^m u_{ij}$

The entropy of indicator j^{th} is $e_j = -k \sum_{i=1}^m P_{ij} \ln P_{ij}$

K is the adjustment factor $k = (1 / \ln m)$

The difference coefficient of j^{th} is $h_j = 1 - e_j$

The weight $w_j = h_j / \sum_{j=1}^n u_{ij}$

In formula (4), C stands for the coupling coordination degree of tourism and eco-environment. U_1 and U_2 are the assessment indicators of tourism system and eco-environment system.

$$C = \sqrt{U_1 * U_2 / (U_1 + U_2)(U_1 + U_2)} \quad (4)$$

It's essential to build a model based on the above analysis, which can more objectively reflect the coupling coordination degree between tourism and eco-environment. The formula is as follows:

$$D = \sqrt{C * T} \quad T = \alpha U_1 + \beta U_2 \quad (5)$$

In formula (5), D donates the coupling coordination degree ($D \in [0,1]$) (Table 1) and T the comprehensive assessment indicator of tourism and eco-environment. α and β are undetermined coefficients. With reference to the results of existing study the author assigns respectively α and β with the value 0.5.

Table 1: Assessment Criteria for the Degree of Coupling Coordination

Sequence	Coupling Coordination Degree	Coupling Coordination Level
1	0-0.09	Extreme Imbalance
2	0.10-0.19	Serious Imbalance
3	0.20-0.29	Moderate Imbalance
4	0.30-0.39	Mild Imbalance
5	0.40-0.49	Minimum Imbalance
6	0.50-0.59	Minimum Coordination
7	0.60-0.69	Elementary Coordination
8	0.70-0.79	Moderate Coordination
9	0.80-0.89	Good Coordination
10	0.90-1.00	Excellent Coordination

Source: Li (2012) and Liao (1999).

3.3. Indicator System

The systems of tourism economic development and eco-environment are two complex nonlinear systems with close relationships. For this reason, the selection of systematic indicators need fellow strict rules so as to precisely determine the horizontal and vertical

relationships between the systems and intensively study their coupling coordination degree. To set and select assessment indicators, frequency statistical method, theory analytical method, and expert consultation method are used.

Based on the formulas for coupling coordination and the data from related yearbooks (Shandong Statistics Bureau, 2001-2013; China National Tourism Administration, 2011-2013)(Table 2).

Table 2: Assessment Indicator System and Indicator Weight

Criteria Hierarchy	Indicator Hierarchy/Unit	Weight
Tourism	Foreign Exchange Earnings from Tourism /10,000 USD	0.0706
	Domestic Tourism Income/ 10^8 CNY	0.0790
	Tourism Contribution to GDP/%	0.0460
	Inbound Tourists Arrival/10,000 persons	0.0634
	Domestic Tourists Arrival/10,000 persons	0.0743
	Number of Star Rated Hotels/pieces	0.0446
	Number of Travel Agencies/pieces	0.0412
	Number of A-grade Scenic Spots/pieces	0.0573
	Number of Tourism practitioners /10,000 persons	0.1153
	Industrial Wastewater Discharge Amount/ 10,000 t	0.0372
Eco-environment	Industrial SO ₂ Emission Amount/ 10,000 t	0.0317
	Urban wastewater Discharge Amount / 10,000 t	0.0421
	Industrial Solid Waste Generation Amount /10,000 t	0.0417
	Annual Wastewater Treatment Rate/%	0.0425
	Household Waste Harmless Treatment Rate/%	0.0230
	Comprehensive Reuse Rate of Industrial Waste/%	0.1527
	Urban Green Coverage Rate/%	0.0377

4. Empirical Analysis of the Coupling Coordination

According to the methods mentioned above, the author works out the comprehensive evaluation function, coupling degree and coupling coordination degree of the tourism and eco-environment systems in Shandong Province. Refer to Table 3 and Figure 2 for the results.

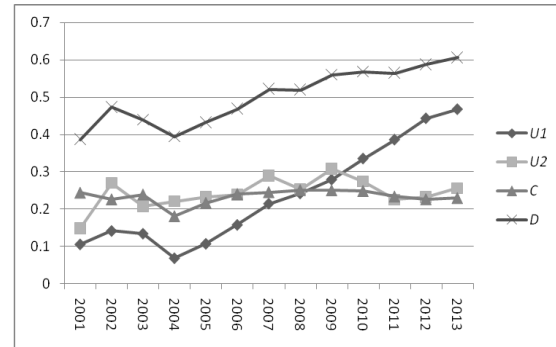


Figure 2: Coupling Indicators of Tourism and Eco-environment in Shandong Province

Table 3: Coupling Degree, Coordination Degree and Assessment of Tourism and Eco-environment

Year	U_1	U_2	C	D
2001	0.1053	0.1481	0.2429	0.3864
2002	0.1411	0.2702	0.2254	0.4732
2003	0.1339	0.2081	0.2382	0.4396
2004	0.0683	0.2209	0.1804	0.3945
2005	0.1068	0.232	0.2159	0.4323
2006	0.1573	0.2388	0.2394	0.4690
2007	0.2141	0.2888	0.2445	0.5220
2008	0.2415	0.2536	0.2499	0.5199
2009	0.2786	0.3082	0.2494	0.5598
2010	0.3349	0.2742	0.2475	0.5685
2011	0.3855	0.2252	0.2328	0.5648
2012	0.4424	0.232	0.2257	0.5876
2013	0.4667	0.256	0.2288	0.6067

4.1. Time Sequence Analysis of Comprehensive Assessment Indicators

As is mentioned above, U_1 and U_2 respectively refer to the comprehensive assessment functions of tourism system and eco-environment system. According to Table 3 and Figure 2, U_1 and U_2 generally present a rising tendency during 2001-2013, with U_1 increasing from 0.1053 to 0.4667 and U_2 from 0.1481 to 0.256.

U_1 experienced a decrease in 2003-2005, which is mainly caused by the 2003 SARS outbreak and the lagged effects of SARS on tourism economy. The number of U_1 didn't return to normal until the year 2007, which shows the vulnerability of tourism in some way. During the whole period, U_2 showed a rising trend with fluctuations, but its growth is not as obvious as that of U_1 . This difference shows that eco-environment protection requires continuous efforts of related departments. In 2012, Shandong Province issued *Decisions of Shandong Provincial Government on Building an Ecological Shandong*, which accelerated the eco-environment improvement efforts of Shandong Province. The government successively passed related documents like the guiding opinions on building eco-cities and developing green transportation in Shandong Province. Therefore, the

development index of ecological system has moved on a rising trend since 2012.

4.2. Time Sequence Analysis of Coupling Degree and Coupling Coordination Degree

As is shown in Table 3 and Figure 2, the mutual promotion between the tourism and eco-environment systems of Shandong Province increasingly strengthened during 2001-2003. Also, the coupling coordination degree between the two systems gradually became higher. The coupling coordination level changed from mild imbalance in 2001 to minimum coordination in 2013.

Based on the coordination degree changes of different phases, the coordination degree of the tourism and eco-environment in Shandong Province saw positive growth. In 2001-2006, the coupling degree developed from moderate imbalance to minimum imbalance, yet still at the imbalance level. According to the related data, in the same period, the comprehensive level of tourism system was relatively low, which manifests that tourism system has a bigger influence than eco-environment system on their coordination degree. However, in 2007-2013, the coordination type of these two systems managed to change from minimum coordination to elementary coordination, which is closely related to their comprehensive level and coupling. It is worth to mention that the coordination realized in 2013 is just barely elementary.

According to the relationship between U_1 and U_2 , we can classify different coupling coordination degrees into the following three types: hysteretic development of tourism ($U_1 > U_2$), hysteretic development of eco-environment ($U_1 < U_2$), synchronal development of tourism and eco-environment ($U_1 = U_2$). From figure 2 and Table 3 we can learn that in 2001-2009 the coupling coordination degree of tourism and eco-environment in Shandong belongs to the first type but becomes the second type in 2011-2013. It's obvious that the comprehensive development level of tourism is higher than that of eco-environment during the same period. Further, the development level of eco-environment in Shandong cannot meet the development demand of tourism, which to some extent restricts tourism development.

5. Conclusion

Analyzing the mechanism of the coordinated development action between the tourism and eco-environment systems, this paper builds a coupling indicator system of tourism and eco-environment. Selecting Shandong Province as the object of study, empirical study on the coupling coordination relationship of tourism and eco-environment in Shandong Province during 2001-2013 are conducted. Study findings are as follows:

- (1) There are remarkable coupling development features in the tourism and eco-environment systems; elements of the two systems interact and

influence each other; what's more, the internal elements of each system enable the coordinated development between tourism and urbanization by organizing and evolving.

- (2) The tourism and eco-environment of Shandong Province has improved a lot, with U_1 rising from 0.1053 in 2001 to 0.4667 in 2013 and U_2 from 0.1481 in 2001 to 0.256 in 2013.
- (3) The coupling degree of tourism and eco-environment in Shandong Province experienced the transition from the imbalance stage in 2001-2006 to the coordination stage in 2007-2013; this research analyzes the mechanism of the mutual interaction between tourism development and eco-environment improvement, and to some extent it expands the ecological validity of tourism.

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