Research on Synchronous Coordination Development of Tourism-Economy-Environment System in Qinghai Section of Silk Road

Huaju Xue
School of Tourism Management, Qinghai Normal University, Xining, China

Abstract. Using coupling theory in physics, the paper analyzed the relationship of coordinated development of tourism-economy-environment system (abbr. TEES) in Qinghai. Results showed the comprehensive evaluation of Qinghai TEES has been improved greatly from 2000 to 2014. However, coupling degree has still been in the running-in stage and coordination degree only arrives at the primary coordination level, the development of economy and tourism has exceeded the threshold of ecological environment after 2008, and the ecological environment has become the bottleneck restricting the further improvement of coupling coordination. In the future, Qinghai must change its mode of development and focus on industrial upgrading and transformation so as to promote the harmonious and sustainable development of TEES in the Silk Road.

1. Introduction
Regional economic level and beautiful environment are important foundations for tourism development. Developed tourism can promote local income levels, provide more employment opportunities and also protect environment. Hence, tourism has become the leading (pillar) industry in many provinces and cities. However, tourism is not "pollution-free" industry, the development of tourism beyond the environment carrying capacity will destroy the tourist landscape and affect the local ecological environment. The development of tourism and economy can not be separated from the good ecological environment. Therefore, the coordination of tourism-economic-ecological environment system (abbr. TEES) has attracted extensive attention. Butler (1991) pointed that environmental quality of tourist destination is the most important factor [1]. Tourism pressure on the environment is straightforward [2], and the environment was also influenced by greenhouse gas (GHGS) released by transportation, accommodation and other activities [3, 4]. Liu [5], Yang [6], Zhang [7] and other researchers found the environment is the bottleneck of the coupling of TEES, and TEES coupling is in the Antagonistic state.

Qinghai is a part of "the roof of the world"—Qinghai-Tibet Plateau, it’s also a typical fragile area of ecological environment with unique and rich tourist resources. Therefore, it’s of great theoretical and practical significance to study the coupling relationship of TEES in Qinghai province.
2. Research Methods

2.1. Coupling coordination model and calculation method

2.1.1. Sub-system comprehensive development level evaluation model

\[ U(t) = \sum_{i=1}^{m} a_i x_i, \quad U(j) = \sum_{i=1}^{n} b_i y_i, \quad U(h) = \sum_{i=1}^{n} c_i z_i \]  \hspace{1cm} (1)

\( U(t), U(j), U(h) \) characterize the comprehensive development level of tourism, economic and environmental systems, \( a_i, b_i, c_i \) represent the three system weights, and the weights are calculated by entropy weighting method\(^8\).

2.1.2. Coupling coordination evaluation

\[ C = \left( \frac{U(t) \times U(j) \times U(h)}{\left[ \frac{U(t) + U(j) + U(h)}{3} \right]^3} \right)^{\frac{1}{2}} \] \hspace{1cm} (2)

\( C \) is the coupling degree, \( 0 \leq C \leq 1 \), \( C \) closer to 1, indicates the system tends to orderly development, and vice versa. Four stages are divided according to the value of \( C \), that is, \( (0, 0.3) \), low level coordination stage; \( (0.3, 0.5] \), antagonistic stage; \( (0.5, 0.8) \), run-in phase; \( (0.8, 1] \), high level coordination stage.

The model of coupled coordination degree is introduced to objectively reflect the level of coordinated development between systems\(^9\).

\[ D = \sqrt{C \times T}, \quad T = \alpha U(t) + \beta U(j) + \gamma U(h) \] \hspace{1cm} (3)

\( D \) is the coupling coordination degree; \( T \) is the comprehensive evaluation index; \( \alpha, \beta, \gamma \) is the undetermined coefficient, we take \( \alpha, \beta, \gamma \) values as 0.2, 0.4, 0.4. The values of \( \alpha, \beta \) and \( \gamma \) were 0.2, 0.4 and 0.4 respectively. \( D \) value division standard referred to Liao’s research results, ten levels as follows (Table 1.).

| D level   | D level          |
|-----------|------------------|
| 0—0.09    |   extreme disorder |
| 0.10—0.19 |   severe disorder |
| 0.20—0.29 |   moderate disorder |
| 0.30—0.39 |   mild disorder   |
| 0.40—0.49 |   on the verge of disorder |
| 0.50—0.59 |   barely coordinated |
| 0.60—0.69 |   primary coordinated |
| 0.70—0.79 |   intermediate coordinated |
| 0.80—0.89 |   well-coordinated |
| 0.90—1.00 |   fine coordinated |

2.2. TEES evaluation index construction

The index selection follows the principles of scientific, operational, completeness, principal component and independence. The frequency index method, theoretical analysis method and expert consultation method are adopted to set up and select the indexes. Then determine the evaluation index system of TEES (Table 2.).
Table 2. TEES coupling coordination index system

| System name            | Evaluation index                                      |
|------------------------|-------------------------------------------------------|
| Tourism subsystem      | Total tourism revenue                                 |
|                        | The proportion of tourism income to GDP               |
|                        | International tourist trips                           |
|                        | Number of domestic tourists                           |
|                        | Domestic tourism income                               |
|                        | International tourism income                          |
|                        | Number of star hotels                                 |
|                        | Number of travel agencies                             |
| Economic subsystem     | GDP                                                   |
|                        | GDP per capita                                        |
|                        | Import and export volume                              |
|                        | The proportion of the secondary industry              |
|                        | The proportion of the tertiary industry               |
|                        | Full labor productivity                               |
|                        | The proportion of fiscal revenue to GDP               |
|                        | Total retail sales of social consumer goods per capita |
| Ecological environment subsystem | Built green coverage                              |
|                        | Green area per capita                                 |
|                        | Harmless treatment of garbage                         |
|                        | Industrial sulfur dioxide emissions                   |
|                        | Industrial waste water discharge                      |
|                        | Industrial emissions                                  |
|                        | Industrial soot emissions                             |
|                        | "Three wastes" comprehensive utilization of product output value |

2.3. Research areas and data sources
The paper takes Qinghai Province as the research object, Qinghai is the source of the Yangtze River, the Yellow River River and Lancang River, it is an important ecological security barrier in the world. Since the 18th National Congress of China, Qinghai has highlighted the concept of ecological protection to promote the coordinated development of economy and society. Therefore, the TEES coupling research in Qinghai Plateau has become the inevitable focus of sustainable development research.

The data of this paper comes from Qinghai Statistical Yearbook, Qinghai Provincal Statistical Bulletin, and Qinghai Tourism Network.

3. Results and Discussion

3.1. Coupling type analysis
From the coupling development stage (Table 3.), the TEES in Qinghai province runs from the antagonism (2000~2003) to the running in (2004~2014). The level from the disorder phase (2000~2006) to the coordination phase (2007~2014). As for the relative development of the three systems, there have experienced two stages, i.e., the basic coordination (2000~2008), and the coordination stage (2009~2014), but still in the primary coordination stage.
3.2. Reason analysis for TEES Coupling

For tourism and economic development, results showed economy surpassed tourism, indicating that Qinghai tourism development was relatively slow, though the economic level of Qinghai improved rapidly, its supportive capacity for tourism was limited because of its weak foundation, it is difficult to effectively promote the rapid development of tourism. Tourism ahead of economic development in 2002, 2006, 2007 and 2014, which owed to such events, the "Western Development" strategy in 2000, Qinghai Lake International Road Cycling Race in 2002; Qinghai-Tibet Railway operation in 2006 and the success of the Silk Road inscription in 2014, and so on. It can be seen that the development of tourism in Qinghai mainly benefits from national policy support, high-level international events and transportation function.

| Time  | D   | Relative development | Coupling coordination types and characteristics | level                     |
|-------|-----|----------------------|-----------------------------------------------|---------------------------|
| 2000  | 0.30| U(h)>U(j)>U(t)       | Economic advance, tourism, economy, environmental system basic coordination | moderate disorder         |
| 2001  | 0.38| U(h)>U(j)>U(t)       | Economic advance, tourism, economy, environmental system basic coordination | mild disorder             |
| 2002  | 0.40| U(h)>U(t)>U(j)       | Tourism ahead, tourism, economy, environmental system basic coordination   | on the verge of disorder  |
| 2003  | 0.35| U(h)>U(j)>U(t)       | Economic advance, tourism, economy, environmental system basic coordination | moderate disorder         |
| 2004  | 0.43| U(h)>U(j)>U(t)       | Economic advance, tourism, economy, environmental system basic coordination | on the verge of disorder  |
| 2005  | 0.42| U(h)>U(j)>U(t)       | Economic advance, tourism, economy, environmental system basic coordination | on the verge of disorder  |
| 2006  | 0.47| U(h)>U(t)>U(j)       | Tourism ahead, tourism, economy, environmental system basic coordination   | on the verge of disorder  |
| 2007  | 0.52| U(h)>U(t)>U(j)       | Economic advance, tourism, economy, environmental system basic coordination | barely coordinated        |
| 2008  | 0.52| U(h)>U(j)>U(t)       | Economic advance, tourism, economy, environmental system basic coordination | barely coordinated        |
| 2009  | 0.51| U(j)>U(t)>U(h)       | Economic advance, tourism, economy, environmental system basic coordination | barely coordinated        |
| 2010  | 0.56| U(j)>U(t)>U(h)       | Economic advance, tourism and economic development beyond the environmental carrying threshold | barely coordinated        |
| 2011  | 0.61| U(j)>U(t)>U(h)       | Economic advance, tourism and economic development beyond the environmental carrying threshold | primary coordinated       |
| 2012  | 0.63| U(j)>U(t)>U(h)       | Economic advance, tourism and economic development beyond the environmental carrying threshold | primary coordinated       |
| 2013  | 0.65| U(j)>U(t)>U(h)       | Economic advance, tourism and economic development beyond the environmental carrying threshold | primary coordinated       |
| 2014  | 0.69| U(t)>U(j)>U(h)       | Tourism ahead, tourism and economic development beyond the environmental carrying threshold | primary coordinated       |
4. Conclusion

We used the coupled coordination degree model and calculation method, established TEES coupling coordination index, analyze the coupling degree of TEES in Qinghai Province from 2000 to 2014. This research obtained the following conclusions:

(1) Qinghai's tourism and economic system was on the rise as a whole. Among them, Qinghai's economic system provided a powerful guarantee for tourism development and environmental protection. Qinghai province's economic and tourism development has exceeded the ecological environment threshold since 2008. In the future, Qinghai must change its development model and focus on industrial upgrading and transformation.

(2) Qinghai has achieved a coordinated development of tourism, economy and environment. But the coupling degree was still in the running in stage, and the coordination degree only reached the primary coordination. The eco-environment has become a bottleneck restricting further enhancement of coupling. So it is necessary to change the traditional mode of development of Qinghai, tourism and economic development should be to protect the eco-environment as the premise, increase tourism support efforts and traffic facilities, add investment in environmental protection, promote the harmonious and sustainable development of TEES.

The study provides references for the coordinated development and sustainable development of the Qinghai-Tibet plateau.

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