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The Dynamic Analysis on Tourism Ecological Footprints in Liaoning Province[1]

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Abstract: This article uses the concepts and calculation models of "Ecological Footprint" and "Tourism Ecological Pressure" to conduct quantitative analysis on the tourism ecological footprints, tourism ecological deficits, and the dynamic changes of tourism ecological pressures in Liaoning Province from year 2000 to year 2005. Results indicate: rapid economic development, especially the tourist size increase, introduces huge pressure on tourism ecological environment. Both tourism ecological deficits and tourism ecological pressure present an annually increasing trend, and the future perfection of ecology construction in Liaoning Province is therefore the approach to reduce tourism ecological deficits and ensure the sustainable development of tourism industry.

Key words: tourism ecological footprint; tourism ecological deficit; tourism ecological pressure; Liaoning Province

1 INTRODUCTION

Tourism industry is supposed to be a win-win industry to promote environmental protection and economy development; the tourism industry development in recent years, however, shows that the issue of ecological environment in tourism industry development has been increasingly highlighted. It needs to perform both qualitative and quantitative measures on ecological tourism in order to achieve the sustainable development of tourism industry. The ecological footprint theory, as one of the methods to study sustainable development and measure ecological construction, has gained rapid development ever since 1992 when it was firstly introduced and as well been widely applied in tourism sector. There are currently more studies on both the theory and practice of tourism ecological footprints; however there are relative fewer of those for Liaoning Province specifically.

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2 THE CALCULATION MODEL AND METHOD OF TOURISM ECOLOGICAL FOOTPRINTS

Ecological Footprint (EF) and ecological carrying capacity, one method to calculate the difference between natural resource ecological consumption needs (ecological footprint) from human beings and ecological supply (ecological carrying capacity) from the nature, was initially introduced by Canadian ecological economists Professor William Rees (Rees, 1992) and was gradually perfected with his doctoral student Wackemagel in 1996 (Rees, 1996). EF calculation formula is:

$$EF=N\cdot e_f=N\cdot r_j\cdot\sum(aa_i)=N\cdot r_j\cdot\sum(c_i/p_i) \quad (1)$$

Among which: EF stands for total ecological footprint; N for population; e_f for ecological footprint per capita, r_j for the balance factor of different biological productive lands; aa_i for the component of ecological footprint per capita converted by type i consumption item; c_i for consumption amount per capita of type i consumption item; and p_i for the average productivity of type i consumption item. Biological productive land areas are classified into six major types of fossil fuel land, arable land, woodland, grassland, construction land, and waters.

Ecological carrying capacity calculation formula is:

$$EC=N\cdot e_c=N\cdot\sum(a_j\cdot r_j\cdot y_j)\ \ (j=1,2,3\ldots6;i=1,2,3\ldots n) \quad (2)$$

Among which: *EC* stands for total ecological carrying capacity; e_c for ecological carrying capacity per capita (hm^2/person); a_j for biological production area per capita; r_j for balance fator; y_j for yield factor; and j for biological production area type.

Tourism ecological footprint refers to the quantity (hm^2) (YANG & LI, 2005) of productive land area needed by tourism industry out of the one needed by GDP in the whole area. Tourism ecological carrying capacity refers to the quantity (hm^2) (ZHANG & ZHANG, 2004) of productive land area can be provided for tourism industry out of the one can be provided for GDP. Tourism consumptions include: transportation, accommodation, food, shopping, sightseeing, and entertainment, etc, constituting total tourism revenue. The proportion of total tourism revenue in regional national income can be described as tourism industry contribution rate (r) to GDP, tourism ecological footprint (or tourism ecological carrying capacity) can be represented by the product[5] of ecological footprint (or ecological carrying capacity) and contribution rate in the region (ZHAO & LIU, 2008).

The calculation formula of Tourism Ecological Footprint (TEF) is:

$$TEF=EF\cdot r \quad (3)$$

$$tef=TEF/\text{total tourist number(person)} \quad (4)$$

Among which: *TEF* stands for tourism ecological footprint (hm^2); *EF* for ecological footprint of the region; *r* for tourism industry contribution rate to GDP; and *Tef* for tourism ecological footprint per capita (hm^2/person).

The calculation formula of Tourism Ecological Capacity (TEC) is:

$$TEC=EC\cdot r \quad (5)$$

$$tec=TEC/\text{ total tourist number(person)} \quad (6)$$

Among which: *TEC* stands for tourism ecological carrying capacity (hm^2); *EC* for ecological carrying capacity (hm^2/person) of the region; and *tec* for tourism ecological carrying capacity per capita

(hm^2/person). The difference between tourism ecological carrying capacity and tourism ecological footprint is tourism ecological deficit (or tourism ecological surplus) (WANG & LIN, 2005).

Tourism Ecological Pressure (TEP) refers to the ratio of tourism ecological footprint per capita against tourism ecological carrying capacity per capita in a country or region, indicating the pressure level undertaken by the region, its calculation formula is:

$$TEP=tef/tec \quad (7)$$

Among which: *TEP* stands for Tourism Ecological Pressure; *tef* for tourism ecological footprint per capita (hm^2/person); and *tec* for tourism ecological carrying capacity per capita (hm^2/person).

Tourism Ecological Pressure shows the tourism ecological safety threshold in a region, it can measure ecological environment damage level caused by tourism industry development in the region and can be used as a important indicator of tourism ecological protection.

3 THE DYNAMIC CHANGES IN TOURISM ECOLOGICAL FOOTPRINTS IN LIAONING PROVINCE

3.1 An Overview of the Region under Study

Liaoning Province is located in the south of Northeast China (38°43′N－43°26′N, 118°53′E－125°46′E) with total land area of 145.900 km^2[4], accountable for 1.5% in China. It is also the most northern coastal province in China with fairly rich tourism resources of both natural scenery of beaches, mountains, lakes, springs, valleys, plains, sand, forests, and grasslands and humanistic landscape of numerous historical sites, ancient and modern architectures, and unique folk Custom. Rich but unique tourism resources establish sound material foundation for the tourism industry development and grow into the important safeguard to achieve leaping development for the tourism industry in Liaoning Province. Through 30 years of reform and opening up development, the scale of the tourism industry in Liaoning Province continuously increase and has turned into a new growing point of national economy and social development in Liaoning Province. Over-rapid tourism industry development introduces a series of ecological environmental issues that need to be repaired with ecological theory.

3.2 Data Source

The basic data mainly comes from Liaoning Ecological Footprint calculated by Dong Zeqin and Sun Tieheng (DONG & SUN, 2004) and Liaoning Ecological Footprint calculated by Lin Nan and Li Fayun (LIN & LI, 2009) in 2004 and other data from Liaoning Province Statistical Yearbook5 and Liaoning Province Economic Development Bulletin.

3.3 Calculation Results and Result Analysis

By applying previous methods, it can calculate Liaoning Province tourism ecological footprint from 2000 to 2005 with the results showed in Table 1 below.

[4] *Liaoning Provincial Tourism Administration, Basic Knowledge of Tour Guide.* (2008) Shenyang Publishing Housing.

[5] *Liaoning Provincial Bureau of Statistics, Liaoning Province Statistical Yearbook.* (2006). Liaoning People's Publishing House.

Table 1: Liaoning Province Tourism Ecological Footprint from 2000 to 2005

	2000	2001	2002	2003	2004	2005
Tourism Ecological Footprint ($\times10^4hm^2$)	672.1	792.8	1105.4	1069.7	1265.2	1475.9
Tourism Ecological carrying capacity ($\times10^4hm^2$)	149．7	170．1	219．8	197．8	217．8	237．5
Tourism Ecological deficits ($\times10^4hm^2$)	522.4	622.7	885.6	871.9	1047.4	1238.4
Tourism Ecological Footprint per capita (hm^2/person)	0.1554	0.1567	0.1728	0.1697	0.1557	0.1477
Tourism Ecological carrying capacity per capita (hm^2/person)	0.0346	0.0336	0.0344	0.0314	0.0268	0.0238
Tourism Ecological Pressure	4.4913	4.6637	5.0824	5.4045	5.8097	6.2059

The results in Table 1 show that all of tourism ecological footprint, tourism ecological carrying capacity, tourism ecological deficits, and tourism ecological pressure from 2000 to 2005 in Liaoning Province, in general, present a increasing trend; however, the increasing margin of tourism ecological carrying capacity is less than that of tourism ecological footprint and tourism ecological deficits grows up year by year as well, generating a big tourism ecological pressure.

The dynamic changes of tourism ecological footprint, tourism ecological carrying capacity, and tourism ecological deficits are showed as Figure 1. Tourism ecological footprint increased from $672.13\times10^4hm^2$ in 2000 to $1475.94\times10^4hm^2$ in 2005 with average annual increase of $133.97\times10^4hm^2$. The major increasing reasons are associated with largely scaled tourism industry development, widely launched tourism evens, and greatly strengthened tourism publicity and promotion in Liaoning Province. Tourism ecological carrying capacity increased from $149.7\times10^4hm^2$ in 2000 to $237.5\times10^4hm^2$ in 2005, a moderate increase. Tourism ecological deficits increased from $522.4\times10^4hm^2$ in 2000 to $1238.4\times10^4hm^2$ in 2005 with average annual increase of $118\times10^4hm^2$. The figures suggest there already has been appearing severe environmental resource consumption in tourism industry; tourism industry development owes natural ecological environment more; and they as well demonstrate low tourism ecological resource use efficiency in Liaoning Province.

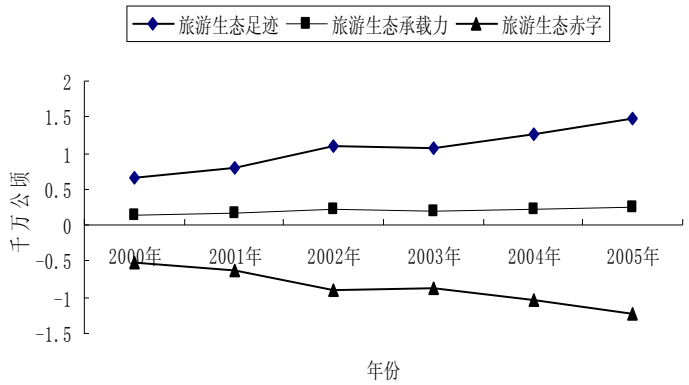

Figure 1: The changes of tourism ecological footprints, tourism ecological capacity, and tourism ecological deficits in Liaoning from 2000 to 2005

The dynamic changes of tourism ecological footprint per capita and tourism ecological carrying

capacity per capita are showed in Figure 2. In Liaoning Province from 2000 to 2005, total tourist number increased from 43,24 millions to 99.902 millions, tourism ecological footprint per capita decreased from 0.1554hm^2/person to 0.1477hm^2/person with an average tourism ecological footprint per capita of 0.1595 hm^2/person, significantly higher than that of 0.093 hm^2/person in China in 1999. Tourism ecological carrying capacity per capita decreased from 0.0346hm^2/person in 2000 to 0.0238hm^2/person in 2005 with an average tourism ecological carrying capacity per capita of 0.0308 hm^2/person, lower than that of 0.048 hm^2/person in China in 1999. It can cearly be seen that tourism ecological supply and demand contradiction in Liaoning Province is increasingly prominent.

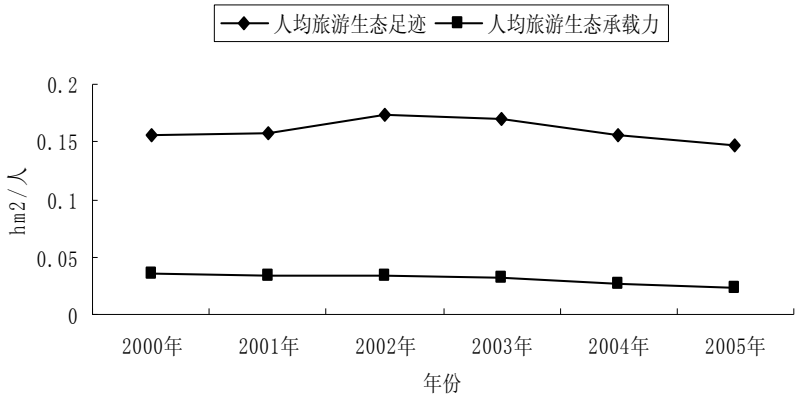

Figure 2: The changes of tourism ecological footprints per capita and tourism ecological capacity per capita in Liaoning from 2000 to 2005

The dynamic changes of tourism ecological pressure are showed in Figure 3. The tourism ecological pressure indicators in Liaoning Province increased from 4.4913 in 2000 to 6.2059 in 2005 and also show an increasing trend, suggesting that the ecological environment demand strength from tourism economy activities in Liaoning Province is more than the supply capacity of tourism ecological carrying capacity, a wake-up call for the tourism development in Liaoning Province; and also reflecting the over largely seized tourism industry development in Liaoning Province and increasingly expanded contradiction among economy, society, and environment.

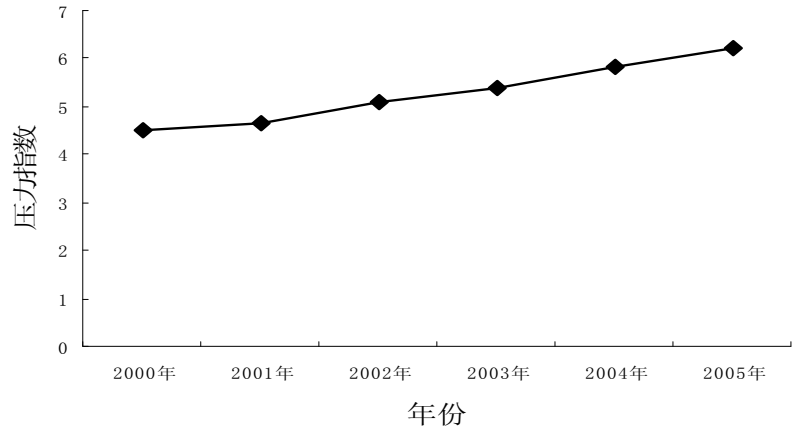

Figure 3: The change of tourism ecological pressure indicators in Liaoning from 2000 to 2005

4 CONCLUSIONS AND DISCUSSION

This article conducts quantitative analysis on the dynamic changes on tourism ecological footprint, tourism ecological deficit, and tourism ecological pressure in Liaoning Province from 2000 to 2005 by using concepts and calculation methods of "Tourism ecological footprint" and "Tourism ecological pressure". Research outcome shows: over-rapid tourism industry development in Liaoning Province introduces huge pressure on tourism ecological environment; annually increased tourism ecological deficit and tourism ecological pressure generate ecological hidden dangers for sustainable tourism industry development in Liaoning Province. To ease tourism ecological pressure it needs to improve tourism ecological footprint supply level and capacity in one hand; and take effective measures to protect tourism ecological environment and reasonably control tourism ecological footprint demand in the other. Meanwhile, ecological construction perfection is an important approach to reduce tourism ecological pressure and tourism ecological deficit and ensure sustainable tourism industry development in Liaoning Province.

The ecological footprint model is a convenient method to measure the ecological impact of tourism, comprehensive feature of tourism industry determines that it still needs more in-depth and detailed study on tourism ecological footprint.

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