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Synthetical evaluation model on sustainable development of agricultural tourism system

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ABSTRACT

Applying touristic ecological footprint theory and method, this paper establishes an evaluation model on the sustainable development condition of Agricultural tourism system and makes a quantitative evaluation of the touristic ecological footprint and ecological carrying capacity in Red Crag Village of Yao Nationality Autonomous County in Gongcheng, Guangxi. The result shows that the ecological footprint of the research area is within ecological carrying capacity, tourism occupancy rate is low and ecological agriculture tourism is in a state of sustainable development. It illustrates that coordinating ecological agriculture tourism development with ecological protection and promoting resource conservation and environment friendly eco-tourism pattern is an effective way to reduce touristic ecological footprint and improve the sustainable developing level of eco-agricultural tourism.

KEYWORDS

Ecological footprint; Eco-agricultural tourism; Sustainable development; Red crag village.

INTRODUCTION

With the importance that is attached to issues of agriculture, farmer and rural area, the adjustment of industrial structure and the optimization of the industrial structure of agricultural and village, conventional agriculture develops to be modern acceleratingly[1].

So far, Ecological agriculture tourism, a new tourism, offers tourists extensive participation and discovery in the forms of agricultural sightseeing, demonstration of agricultural science and technology, leisure holiday, picking and processing of agricultural products under the guidance of ecological theory on the basis of constructing eco-agriculture. Eco-agricultural tourism is developing vigorously across the country and has become an effective way of solving the issues of agriculture, farmer and rural area[2]. Eco-agricultural tourism, as an important component of sustainable development in rural areas, the flowing in of a large number of tourists animates the economic development of rural areas, which also put a heavy pressure on the ecological environment of those areas. The development of eco-agricultural tourism depends highly on environment. Thus, the deterioration of environment will hamper the development of eco-tourism., which will restrict the sustainable development of eco-agricultural tourism. It is quite important to make a system evaluation on the sustainable development and eco-agricultural tourism in this context.

Ecological footprint analyses (EFA) was a method of measuring sustainable development level which was put forward by a Canadian ecological economist called William Rees in the 1990's[1]. This method was widely applied to the evaluation of researching sustainable development of all levels and scales from world to nation, district to city, community to family, business to individual activities in all dimensions of space and scales of population[2-7]. Some scholars introduced Ecological footprint analyses which is also called touristic ecological footprint into the research area of touristic sustainable development in order to measure the tourism sustainable development synthetically[8-12]. Author attempts to introduce theory and method of touristic ecological footprint into the system evaluation of eco-agricultural tourism in the scale of village. An analysis of pressure and impact of the natural ecosystems caused by tourism was conducted through a quantitative calculation of the ecological footprint in the Red Crage co-agricultural Village of Yao Nationality County, Gongcheng, Guilin, which offers a scientific ground for the sustainable development of eco-agricultural tourism.

BASIC THEORY AND MODEL OF TOURISTIC ECOLOGICAL FOOTPRINT

Touristic ecological footprint can be defined as ecologically productivity area which is needed for the tourism activity of a certain number of tourists that is supported by some area. The regional population supported by a tourism area consists of regional permanent resident and tourists, both of which consume the products and service provided by the local natural resource. The ecologically productivity area of regional permanent resident needed for living and developing is called regional milieu's ecological footprint; tourists is called the superimposed effect of touristic ecological footprint and regional milieu's ecological footprint, which has an effect on the region sustainable development. In the account system of touristic ecological footprint, the difference of ecologically productivity area can be divided into six basic types, such as fossil fuels land, arable land, grassland, forestland, built-up area and water area according to the characteristic of touristic ecological consumption. And the calculation of touristic ecological footprint consists of tourist communication, tourist accommodation, tourist catering, tourist shopping and entertainment according to the characteristic of touristic ecological consumption[8].

Footprint of touristic ecology

Touristic transportation ecological footprint

The measurement of touristic transportation ecological footprint is consist of round trip from the permanent residence to tourist destination, the energy consumption of tourist destination and the occupation of touristic transportation facilities. The calculation of built-up areas occupied by touristic transportation facilities consists of airport, railway station, motor station, vessel dock, railway, highway,

cableway station of resorts, bridge, girder and tunnel. It is notable that the built-up areas occupied by touristic transportation facilities are the sum of all transportation facilities areas deducting the areas that are not occupied by the tourists. The calculation model of touristic transportation ecological footprint is:

$$\text{TEF transport}=\sum\left(S_i * R_i\right)+\sum\left(N_j * D_j * C_j / r\right)$$

In this model, Si is the area of No.i transportation facility; Ri is tourist utilization rate of No.i transportation facilities; Nj is the numbers of No.j vehicle; Dj is the average distance of No. j vehicle that is purchased by tourists; Cj is the per capita unit distance of energy consumption of No.j vehicle; r is the average calorific value of unit fossil fuel land area in the world.

Tourist accommodation ecological footprint

The measurement of tourist accommodation ecological footprint is consist of the bed of high, medium and low level, the area of various kinds of restaurant, holiday village, guest house and hotel and the energy consumption of service, such as supply of heat, refrigeration, air condition, illumination, clean, TV and internet. In the consideration of all levels and types of the requirement of built-up area accommodation facilities and the difference of the energy consumption of the corresponding service, the tourist accommodation facilities can be divided to one and two star hotel, three and four star hotel, five star hotel and public hotel, personal hotel and cruise. The built-up area and energy consumption of different kinds of touristic accommodation facilities can be obtained by the investigation of various accommodation facilities. The calculation model of touristic accommodation ecological footprint is:

$$\text{TEF accommo}=\sum (Ni * Si) + \sum (365 * Nj * Kj * Ci / r)$$

In this model, Ni is the numbers of beds that owed by the No.i accommodation facilities; Si is the built-up area of every bed in the No.i accommodation facilities; Nj is annual renting rate of rooms of No.j accommodation facilities; Kj is the energy consumption of every bed of No.j accommodation facilities; r is the average calorific value of unit fossil fuel land area in the world.

Ecological footprint of touristic catering

The measurement of ecological footprint of touristic catering is consist of the built-up area of meals, local flavor dished, feast, buffet, a la carte and drinks, the area of biological production of tourists' food(consist of arable land, forest land, grass land and water area) the fossil fuel acreage that provide energy consumption of catering service, the built-up area of catering facilities and the area of various society restaurant (not consist of accommodation) except for the catering service within the above touristic accommodation facilities. We presume that the consumption amount in the travel destination is the same as that of the local people in order to overcome the difficulty of obtaining food consumption amount and the materials of energy consumption amount because the official do not have the relevant data, the owner do not want to provide the consumption amount in the practical investigation and the holding energy consumption amount is also hard to confirmed). Per capita daily food consumption amount and energy consumption amount of local people can be obtained from local statistical yearbook of last year. The calculation model of touristic catering ecological footprint is:

$$\text{TEF food}=\sum S + \sum (N * D * Ci / pi) + \sum (N * D * Ej / rj)$$

In this model, S is built-up area of catering facilities: N is number of tourists: D is average traveling days; Ci is the daily consumption amount of food No.i; pi is the annual average productivity of biological productivity area that is relative to No.i food; Ej is the daily consumption amount of energy per capita; rj is the average calorific value of unit fossil fuel productivity area of No.j energy in the world.

Tourist shopping ecological footprint

Tourist shopping is an extension of tourist activity. Tourists often buy some tourist souvenirs, arts and crafts, native products and necessities of life. The consumption of tourist shopping occupied the built-up area, ecologically productivity areas, fossil fuel area. The built-up area is consist of tourist market that selling tourist products, tourist supermarket, tourist production manufacturing enterprises, the commodity street and the fixed shopping center of tourist products. Different tourist destinations provide various main tourist products and the different kinds of tourist products are corresponding to the different kinds of ecologically productivity area. Thus, relevant ecologically productivity area can be calculated by presuming that all shopping expense was spent on one or several kinds of main tourist product in order to overcome the difficulty of obtaining the data of the numbers of entity that tourists consume and increase the error of complicated calculation. Then the consumption of tourist product entity can be obtained according to the average price of that kind of tourism product, by which the relevant ecologically productivity area can be calculated. The energy consumption of producing and selling the tourist products can be neglected because the amount is relatively small. The calculation model of tourist shopping ecological footprint is:

$$\text{TEF shopping} = \sum \text{Si} + \sum [(\text{Ri} / \text{pi} / \text{gi})]$$

In this model, Si is the built-up area of production and sales facility of No. I touristic product; Ri is the consumer spending of No.i touristic product that is purchased by tourists; pi is the local average price of No.i touristic product; gi is the annual productivity of local ecologically productivity area that is correspondent to No i unit touristic product.

Touristic entertainment ecological footprint

The measurement of touristic ecological footprint consists of the built-up area of reactional facilities and energy consumption. The indoor reactional facilities, such as dancing hall, swimming pool, chess room, tennis court, gym and bowling room, are usually affiliated to accommodation and dinning facilities. Thus, these built-up acreages are not taken into account. The large scale of outdoor entertainment such as theme park, golf course and so on is regarded as the built-up acreage according to the actual acreage. The energy consumption in entertainment is relatively little and it can be neglected. The calculation model of entertainment ecological footprint is:

$$\text{TEF entertainment} = \sum \text{Si}$$

In this model, S_i is the built-up areas of outdoor entertainment facilities.

Carrying capacity of touristic ecology

The first step is to figure out the ecological carrying capacity which refers to the sum of ecological productivity area that is provided by natural ecosystem. The ecological productivity acreage of the area multiplied by equaling factor and output adjustment coefficient sum to the ecological carrying capacity and the supply of ecological footprint and then divided by the total population. The result is the per capita ecological carrying capacity or the per capita ecological supply. The Formula is:

$$EC = \left(\sum_{i=1}^{n} SiAiEQiYi\right) / N \ (i = 1,2.3...6)$$

In this model, EC refer to per capita ecological carrying capacity. Ai refers to the ecological productivity acreage of different kinds of land. EQi is equivalence factor. Yi is the land output adjustment coefficient of different kinds of ecological productivity area which can be presented by specific value of unit acreage biological productivity and world average biological productivity. Yi> 1

means that unit acreage biological productivity is greater than world average biological productivity and vice versa.

N refers to the total population. Touristic ecological carrying capacity refers to the amount of productivity area support for tourism in the total ecological carrying capacity. The method of calculation is:

TEC= EC * r

In this formula, r= the total income of tourism / GNP

Occupation rate of touristic occupation rate

The degree of sustainable development of regional tourism is mainly confirmed by ecological occupation rate. Ecological occupation rate= per capita touristic ecological footprint/ per capita touristic ecological carrying capacity.

AN OVERVIEW OF RESEARCH AREA

Red Crag Village in Yao Nationality County of Gongcheng, Guilin, Guangxi is located in the south of Gongcheng and within the jurisdiction of Lotus Town, which is fifteen kilometers to county. Total area is eight km2 and peasant household is 95, a population of 390[4]. In the early 1990's, the economic development of local area is lagging. The major income come from planting rice and commercial crop and the annual income of everyone was less than 400 Yuan. However, afterwards, People adjust the structure of planting industry actively taking full use of local advantage and developed the waste mountain to plant persimmon. The per capita income of Red Crag Village was more than 4000 Yuan[4]. Local government took Red Crag Village as a model village of affluent ecological homestead in 2003 and decided to plan and construct according to high start point, standard, quality and requirement and made an integrated plan of ecological environment, road, water conservancy, planting, cultivation, greening and environment health. With the development and improvement of eco-agriculture and country tourism of ecological travel village in Red Crag Village, the country developed to tourist attraction which is integrated with ecological agriculture, sightseeing, holiday, and exhibition of agricultural products. It was awarded as regional rich model ecological village, one of top ten rich model ecological village of Guangxi agricultural system and it was also honored as the demonstration spot of national agricultural tourism in November, 2005. Red Crag Village was becoming base of Guangxi specialty industrial development, model of new village construction, model of ecological environment protection, leader of science and technology promotion, field of increasing production and pioneer of spiritual civilization. It was honored as top ten national charming village of CCTV[6,7].

CALCULATION OF TOURISTIC ECOLOGICAL FOOTPRINT IN RED CRAG VILLAGE

Research data and source of material

The data, such as the sum and composition of communication, accommodation, catering, entertainment, sightseeing and shopping, the sum and composition of energy consumption, the amount and type of per capita annual consumption food of local resident and the productivity level of various biological productivity areas, mainly come from statistical yearbook and tourism development planning. The content of investigation is the acreage and utilization rate of touristic communication, accommodation, catering, entertainment, sightseeing and shopping, deposition of tourists, deposition of consumption, average traveling distance within the tourist area, the purchasing of vehicles and the average dates of traveling. The object of the investigation consists of tourists and local touristic public institution. The research obtained data by interview. And time of the investigation was in August, 2011 and August, 2011. In addition, data, such as land type and annual ecological productivity of world food, average calorific value and convert coefficient of world unit fossil fuel productivity area, energy

consumption and equivalence factor of unit average distance of different vehicle, all come from relevant research literature.

Calculation result of touristic ecological footprint

TABLE 1 shows a summary of the ecological footprint of touristic communication, accommodation, catering, shopping and entertainment adopting the above calculation method according to statistical data and data from the investigation. The per capita touristic ecological footprint in Red crag is 0.634 03 $*10^{-4}hm^2$ in 2013. Catering footprint accounts for 65.4% that is the largest. And transportation footprint is secondary and accounts for 22.87%. Thus, catering and transportation is the critical factor that effect touristic ecological footprint. So far, average staying time in Red Crag is only one day. Some tourists even ate a country style cuisine and left. Transportation ecological footprint is the energy consumption that consumed when tourists ride vehicle and it is composed of fossil fuels. Energy consumption of Red Crag Village mainly comes from interregional transportation of national tourists.

So far, touristic productivity area of Red Crag Village is construction land, water area, woodland, farming land and grass land. Construction land consists of shopping, entertainment, transportation and accommodation. The per capita ecological carrying capacity of Red Crag Village can be calculated according to the statistical materials and other relevant materials as showed in TABLE 2.

TABLE 1 : Touristic ecological footprint of Red Crag Village

Project	2011			2013		
	Footprint size/hm2	Per capita footprint *10-4/per capita	percentage %	Footprint size/hm2	Per capita footprint *10-4/per capita	percentage %
Catering	3.81159	0.54451	62.83	5.80496	0.41464	65.40
Accommodation	0.50575	0.07225	8.34	0.91151	0.06511	10.27
Transportation	1.68000	0.24000	27.69	2.03000	0.14500	22.87
Entertainment	0.05800	0.00829	0.96	0.10500	0.00750	1.18
Shopping	0.01100	0.00157	0.18	0.02500	0.00179	0.28
Total	6.06634	0.86662	100.00	8.87647	0.63403	100.00

TABLE 2 : Per capita touristic ecological carrying capacity of Red Crag Village

Types of land utilization	Yield factor	Equivalence factor	2011		2013	
			Acreage/hm^2	Per capita carrying capacity*10^{-4}/per capita	Acreage/hm^2	Per capita carrying capacity*10^{-4}/per capita
Farming land	1.66	2.80	643.283	91.89757	606.099	43.29279
Woodland	0.91	1.10	466.866	66.69514	482.882	34.49157
grassland	0.19	0.50	8.588	1.22686	7.068	0.50486
Water area	1.00	0.20	0.400	0.05714	0.400	0.02857
Construction land	1.49	2.80	176.893	25.27043	210.269	15.01921
total			1296.030	185.14714	1306.718	93.33700
TEC			336.968	48.13826	339.747	24.26762

An analysis of sustainable development of eco-agricultural tourism

The result of occupation rate of touristic ecology of 2011 is 1.80% and 2013 is 2.61% as showed in TABLE 3. And TABLE 3 also showed that the occupation rate of touristic ecology in Red Crag Village is small, ecological footprint is within the ecological carrying capacity, the pressure of tourism activity on tourism environment is also within the ecological carrying capacity, the development of tourism is in a good state, and The ecological agricultural system that eco-agricultural tourism development relied on is safe. The protection of ecological environment in 2007 offered an economic basis. Thus the requirement of touristic activity on touristic development improved the awareness of

protecting ecological environment of government and residents. It can not be denied that the increasing of the scale of tourists and the longer of staying time increase the requirement of resource and ecological service. And the rapid development of ecological tourism promotes the course of local ecological environment protection. The increase of touristic income needs for more resource and ecological service. Undoubtedly, it will lead to the deterioration of regional sustainable development. Therefore, the mutual coordination of government and local people on policy, expenditure and technology is needed. By doing this, it can coordinate the relation between tourism development and ecological protection, which will promote the sustainable development of them.

TABLE 3 : Ecological occupation rate of Red Crag Village

Year	Touristic footprint/hm^2	Per capita touristic footprint $*10^{-4}hm^2$/per capita	Touristic carrying capacity/hm^2	Per capita touristic carrying capacity/$*10^{-4}hm^2$/per capita	Ecological occupation rate/%
2011	6.06634	0.86662	336.968	48.13826	1.80
2013	8.87647	0.63403	339.747	24.26762	2.61

CONCLUSION AND DISCUSSION

Ecological footprint is a new method of quantitative evaluation touristic sustainable development with a visual concept, innovated theory, clear target, concise explanation and strong operability. It can make a quantitative measurement of the pressure and effect that tourism development take on natural ecological system and the gap between human tourism activity requirement and the supply of natural ecological system, which provide a new idea and reference on the practice and research of tourism sustainable development.

Recent years, Red Crag Village is developing eco-agriculture tourism vigorously and meanwhile it drew up and carried out a serious of development plan and ecological construction plan, which improve the environment of the whole village. However, we must notice that the requirement of resource and ecological service is improving with the increase amount of tourists and the longer staying time. The lagging of relevant policy, capital, administration, policy and technology will lower the level of sustainable development of eco-agriculture in Gongcheng County. Thus, they must have a clear idea of future development and make a preparation in advance. The deposition of touristic ecological footprint in Red Crag County showed that the critical factor that affect the size of ecological footprint is consist of amount of tourists, consumption level and pattern of tourists, space behavior, scale of facilities in touristic area and touristic policy and orientation. The effective ways, such as making use of modern technology to reduce the unit energy consumption of vehicle, improving unit acreage biology production of natural resource, applying existing transportation, catering, accommodation, sightseeing and shopping and proposing ecological pattern of resource saving and environment friendly can reduce the requirement of touristic ecological footprint.

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