RESEARCH ARTICLE

Resource development and tourism environment carrying capacity of wetland park ecotourism industry

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The purpose of this study is to support the protective construction of wetland parks by obtaining the economic benefits through fully utilizing the tourism resources in wetland parks. The value of tourism resources and the carrying capacity of tourism environment in Xixi National Wetland Park, Hangzhou City, Zhejiang Province, China were analyzed by using analytic hierarchy process and related calculation, respectively. The results showed that the value of tourism resources of Xixi National Wetland Park was 82.30 (hundred-mark system), which was excellent, but lacking in added values such as popularity. The daily carrying capacity of tourism environment of the wetland park was 4,250, and the annual carrying capacity was 1.0625 million people, of which the traffic facilities in the park were the major flaws. According to the analysis results, several suggestions were put forward to enhance the value of tourism resources and the carrying capacity of tourism environment, which included setting protection zones for ecologically fragile areas while developing tourism values of the wetland park, monitoring pollution to the wetland environment, strengthening added values with species diversity in the wetland park, and increasing investment in transportation tools in the wetland part. This study provides a useful reference for the eco-tourism development and protection in wetland parks.

Keywords: wetland park; tourism resources; environmental carrying capacity; ecotourism.

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Introduction

Wetland, as a part of the natural ecological environment, is the combination of water and land and is specially known as "the kidney of the earth" [1]. In the past, people did not have a thorough understanding of wetland function and roughly classified it as a resource that cannot produce economic value and carried out irreversible and destructive development on it. Now people have realized the important role of wetlands in the ecological environmental diversity and find the value of ecotourism. Therefore, most people and the governments pay more attention on the sustainable development of wetland eco-tourism and initiate the processes to protect wetland consciously. Wetland Park, in short, is a park with wetland landform [2]. Wetland is a kind of natural environment and a part of the whole ecological balance [3]. Comparing to the conventional park, the main landscape of the wetland park is a wetland with a certain scale. In addition to the sightseeing function of the conventional park, the wetland park also has the function of ecological protection of wetland. Although wetland as an ecosystem has some independence and integrity, it is relatively fragile and is difficult to restore once being damaged. Therefore, in the construction of wetland park to

protect wetlands, a complete planning is needed to prevent excessive development. The construction of wetland park is a way to protect wetland ecosystem. However, as a kind of park, it also has the function of providing leisure tourism for the masses. When developing and operating the ecotourism industry of wetland park, it should not only consider the development of wetland resources, but also consider whether the development of wetland resources exceeds its bearing bottom line. Tourism environmental capacity can effectively reflect whether the local tourism activities make a reasonable use of the existing ecological resources (the wetland tourism resources in the wetland park) [4], so as to guide the development of the local ecotourism industry in a positive direction. Liu, *et al*. took the design of Aixi Lake Wetland Park as an example to summarize a set of appropriate wetland park design scheme, which provided a basis for the ecological restoration and protection of wetland resources in Nanchang, Jiangxi Province, China [5]. Li, *et al*. investigated the species diversity and composition of bird community in Honghaizi Wetland Park in Ejin Horo, analyzed the relationship between the main dominant bird species and habitat characteristics, and concluded that the deterioration of water quality might lead to the occurrence of bird diseases and death of birds [6]. Cohen-shacham, *et al*. conducted a stakeholder analysis based on semi-structured interviews with the Hula wetland in the Sea of Galilee and found that there was a lack of coordination between management organizations, which might lead to the sacrifice of habitat services (i.e., biodiversity protection) for the competition of cultural services, especially tourism [7]. In this study, the value of tourism resources and the carrying capacity of tourism environment were analyzed based on the data collected from Xixi National Wetland Park, Hangzhou City, Zhejiang Province, China.

Materials and methods

The study area

The Xixi National Wetland Park is located at No. 518, Tianmushan Road, West Lake District, Hangzhou, Zhejiang, China, which is in the northwest of West Lake and Yuhang Districts with less than 5 km away from West Lake. The land greening rate of the park is over 85%. Soils in the area mainly include red loam, rocky soil, and rice soil. Rivers are abundantly distributed in the park with about 70% of the area covered by rivers, ponds, lakes, and swamps. The wetland park has a subtropical monsoon climate with an average annual temperature of 15.1℃, an average annual relative humidity of 78%, and an average annual precipitation of 1,399 mm, respectively [8]. The wetland park has mild climate, abundant rainfall, long hours of sunshine, and four distinct seasons.

Evaluation of the tourism resources

The tourism resource value of the wetland park was evaluated by the analytic hierarchy process (AHP) method [9] as shown in Figure 1, which included two aspects. The first one was the evaluation items of the former, which included ornamental value, historical and humanistic value, rare and peculiar degree, scale degree, and integrity degree. The second one was the evaluation items of the latter, which included popularity, appropriate tour period (the most appropriate period for sightseeing) and added value. The weight distribution and scoring of evaluation items were performed through questionnaire by invited five experts. And then, the tourism resource value of the wetland park was recorded. All five experts had more than five years of experience in tourism management of wetland parks. The basic steps of the analytical hierarchy process were constructing layers, calculating the weights of different levels using a judgment matrix, and scoring the evaluation items of the target level by experts (hundred-mark system). The specific steps were as follows:

(1) Construct layers. As shown in Figure 1, the highest layer was “tourism resource value of the wetland park” while the middle layers were “resource value” and “additional value of resource influence”. The target layers under “resource value” were “ ornamental value ”,

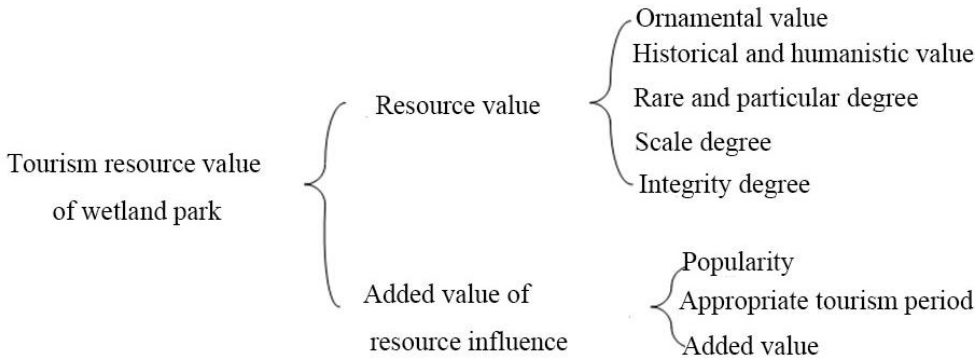

Figure 1. The hierarchical division of the tourism resource value evaluation of the wetland park based on analytic hierarchy process.

"historical and humanistic value", "rare and particular degree", "degree of scale", and "degree of integrity". The target layers under "additional values of resource influence" were "popularity", "appropriate tour period", and "added value".

(2) Construct a judgment matrix and calculate weights. Taking the three target layers under "additional values of resource influence" as an example, a 3×3 judgment matrix was constructed. Element a_{ij} in the matrix represented the importance of element *i* to element *j*. The value was between 1 and 9 with the larger the value was, the more important it was. The maximum characteristic root of the matrix and its characteristic vector were calculated. The characteristic vector was normalized. If the normalized characteristic vector passed the consistency test, it was assigned as a weight. However, if it failed, then elements in the judgment matrix was adjusted to recalculate the characteristic vector. The formula of the consistency test was as follows:

$$\begin{cases} CI = \dfrac{\lambda - n}{n-1} \\ CR = \dfrac{CI}{RI} \end{cases}$$

where *CI* stands for a consistency indicator. λ is the maximum characteristic root of the judgment matrix. *n* is the order of the judgment matrix. *RI* is the random consistency indicator. *CR* is the test coefficient. When the value of *CR* was smaller than 0.1, it was considered that it passed the consistency test.

(3) Scoring the evaluation items of the target level. After determining the weight of every layer, items in the target layer were scored by using a questionnaire. The content of the questionnaire is shown in Table 1. Every question in the questionnaire was answered by scores. A hundred-mark system was adopted in this study, and the higher the score was, the better the evaluation on the corresponding item was.

Evaluation of the tourism environment carrying capacity

The tourism environment carrying capacity of the wetland park was evaluated, and the evaluation results of tourism resources value were combined to guide the development of the ecotourism industry of the wetland park. The calculation model for tourism environmental carrying capacity is described below. The data of the model included the relevant types used to calculate the tourism environmental carrying capacity, among which the data such as the area and the opening hours of the wetland park were fixed over a period of time and were obtained through investigation. The park's ability to handle pollutants was understood by investigating the park management. The data related to the number of visitors and the playing time in the wetland park were obtained from the local tourism bureau. The questionnaire survey of

Table 1. The content of the questionnaire.

The highest layer	The middle layer	Target layer	Question
Tourism resource values of the wetland park	Resource value	Ornamental value	How do you rate the ornamental value of tourism resources in the wetland park?
		Historical and cultural value	What is your assessment of the historical value of the tourism resources in the park?
		Rare and exotic degree	How do you rate the rare and exotic degree of the tourism resources in the park?
		Degree of scale	How do you rate the scale of tourism resources in the park?
		Degree of integrity	How would you rate the integrity of the tourism resources in the park?
	Additional values of resource influence	Popularity	How do you rate the popularity of the park?
		Appropriate tour period	How do you rate the suitable time for tourism of the park?
		Added value	How do you rate the added value of the park?

wetland park visitors was mainly to collect the data needed for the calculation of psychosocial carrying capacity [10]. All the data were collected in 2019. Moreover, the tourism environmental carrying capacity of the wetland park was calculated with the following formula:

$$\begin{cases} T_{EBC} = \min(R_{EBC}, E_{EBC}, S_{EBC}, P_{EBC}) \\ R_{EBC} = \dfrac{S \times T}{d \times t} \\ E_{EBC} = \min\left(\dfrac{N_i \times S + H_i}{P_i}\right) \\ S_{EBC} = \min\left(\dfrac{G_i}{D_i}\right) \\ P_{EBC} = \dfrac{S}{P_a} \end{cases}$$

where T_{EBC} represents the carrying capacity of tourism environment (the minimum value is taken according to bucket theory [11]). R_{EBC}, E_{EBC}, S_{EBC}, and P_{EBC} are resource space, ecological environment, tourism economy, and social psychological capacity, respectively. S represents the total area that can be visited in the wetland park. T is the opening duration of the park. d is the best density for tourists to travel in the park. t is the per capita travel time of tourists. N_i is the purification amount of the i-th class pollutants per unit area of wetland park. H_i is the artificial purification quantity of the i-th class pollutants. P_i is the per capita pollution of the i-th class pollutants. G_i is the quantity of the i-th class materials, D_i represents per capita demand of the i-th class materials. P_a represents the maximum density that can be achieved without aversion of tourists.

Results

Evaluation of the tourism resources

By using the form of questionnaire survey, five experts rated eight items of the tourism resource value of the wetland park (Table 1). The average scores given by the experts for the ornamental value, the historical and humanistic value, the rare and peculiar degree, the scale degree, the integrity degree, popularity, the appropriate tour period, and the added value of the wetland park were 89.27, 89.29, 98.24, 99.32, 89.20, 40.95, 66.32, and 73.66, respectively. Regardless of the

Table 2. Evaluation results of tourism resources value of the wetland park.

	Value of resources					Added value of resource influence		
Weight A	0.7					0.3		
Items	Ornamental value	Historical and humanistic value	Rare and particular degree	Scale degree	Integrity	Popularity	Appropriate tour period	added value
Weight B	0.40	0.24	0.16	0.12	0.08	0.54	0.30	0.16
Calculation formula	Final score = score of item × weight B × weight A							
Final score	25.02	15.66	11.21	8.35	6.88	6.35	5.89	3.54
Total score	82.30							

proportion of each item in the value of the tourism resources, with the only observation of each single item score, it was found that the scores of the first five items were high. The score of popularity was the lowest one among the last three items while the scores of appropriate tour period was medium and the added value was above average.

The evaluation results of tourism resources of the wetland park based on AHP method and questionnaire survey are shown in Table 2. Between the two aspects for evaluating the tourism value of the wetland park, the weight of the value of the resource itself was 0.7, and the weight of the added value of the influence brought by the resource was 0.3, i.e., for the tourism resources of the wetland park, its own value is the most important one. Among the values of resources, the weights of the ornamental value, the historical and humanistic value, the rare and particular degree, the scale degree, and the integrity degree were 0.40, 0.24, 0.16, 0.12, and 0.08, respectively. The contribution of those evaluated items to the value of resources decreased in turn. Among the added values of resource influence, the weights of popularity, the appropriate tour period, and the added value were 0.54, 0.30, and 0.16, respectively, which the contribution to the value of resources also decreased in turn. The final score was obtained by multiplying the average score of the above items given by the experts through the questionnaire survey with the corresponding weights, which gave the score of the tourism resource value of the wetland park as 82.30 points. For the ecotourism industry, the tourism resource of the wetland park demonstrated a high value.

Evaluation of the tourism environment carrying capacity

The tourism environmental bearing capacity of Xixi National Wetland Park was calculated by the tourism environmental bearing capacity model, and the results are shown in Table 3. The resource space bearing capacity reflects the number of people who can be accommodated in the tourist space of the wetland park. The daily bearing capacity of resource space of the wetland park was about 5,880 people. The Xixi National Wetland Park is usually open all year round. After eliminating the extreme weather such as rain, snow, and strong wind, 250 days are suitable for sightseeing every year. Therefore, the annual bearing capacity of the resource space was 1,470,250 people.

The wetland park had class 2 air quality. Therefore, the atmospheric carrying capacity of the wetland park was regarded as infinite and was not shown in Table 3. The water resources bearing capacity depended on the capacity of water environment and the pollution amount of tourists to the water environment. The daily bearing capacity of water resources was about 8,890 people and the annual bearing capacity was about 2,219,500 people. The solid waste in

Table 3. Tourism environmental bearing capacity of the wetland park.

Type of bearing capacity		Daily capacity (people)	Annual capacity (10,000 people)
Resource space bearing capacity		5,880	147.025
Ecotourism environmental bearing capacity	Water resources bearing capacity	8,890	221.950
	Bearing capacity of solid waste	14,270	356.875
Tourism economic bearing capacity		4,250	106.250
Social psychological bearing capacity		13,270	331.750

Xixi National Wetland Park was mainly treated by artificial way. The daily bearing capacity of solid waste in the park was about 14,270 people and the annual bearing capacity was about 35,687,500 people.

The tourism economic bearing capacity was considered in this study only as the traffic facilities in the park. In addition to walking, tourists use cruise boats for sightseeing. There were 80 cruise boats in the park with the passenger limitation of 20 people per boat. The operation time of the cruise boats was 8 hours per day with 50 minutes for each ride. The cruise boats must keep a distance of at least 200 m in the process of travel. Therefore, the tourism economic daily bearing capacity was about 4,250 people and the annual bearing capacity was about 1,062,500 people.

In general, the social psychological carrying capacity should include the psychological bearing capacities of both residents and tourists. However, the former one was not considered in this study because there was no residential community near the wetland park. The psychological bearing capacity of tourists was calculated by the way of questionnaire survey. The daily social psychological bearing capacity of the wetland park was 13,270 people and the annual bearing capacity was 3,317,500 people.

Discussion

As a kind of ecological landscape, wetland plays an important role in maintaining the stability of the ecosystem. Moreover, the ecological diversity of wetland also makes it a good ornamental value. Wetland Park is a tourist site constructed based on wetland. It has the function of wetland protection and is also a kind of ecotourism industry. Tourists will inevitably cause the damages to the local ecological environment in the process of tourism. This study analyzed the tourism resources and environmental bearing capacity of Xixi National Wetland Park, Hangzhou, Zhejiang Province, China in order to provide the solid information for the sustainable development of the ecotourism industry of wetland park.

The results showed that the value of tourism resources was more important than the added value of its influence. Although the total score of tourism resources value was 82.30, which was excellent, the popularity and added value of Xixi National Wetland Park were low from the perspective of the branch score, i.e., the development of the added value of the wetland tourism resources was not enough.

In addition, the results demonstrated that the tourism environmental bearing capacity of the wetland park was 4,250 people/day according to the bucket theory, and the annual bearing capacity of the wetland park was 1,062,500 people if the park operated normally for 250 days every year. It was also found that the wetland park had excellent solid waste treatment and obvious purification treatment on water pollution. Moreover, the wetland park provided good service for tourists, so that tourists could get reasonable activity. The only restriction on the tourism bearing capacity of the wetland park found in this study was the tourism economic

bearing capacity, i.e., traffic facilities in the park. Based on the above results and analysis, several suggestions are put forward as:

(1) The development of the value of wetland itself in the wetland park should continue, including protecting wetland ecological diversity, establishing monitoring base, regularly detecting wetland environment and local animals and plants to timely find ecological vulnerable areas and establish protected areas.

(2) The environmental pollution of wetland should be monitored, and the industrial park near the wetland park should be rectified or relocated. In terms of water body protection, in addition to the regular water body monitoring, ecological treatment measures should also be actively taken, and the use of chemicals and other extensive methods should be prohibited to control pollution.

(3) In terms of enhancing the added value of tourism resources, abundant species and excellent environment in the wetland park can be taken as the promotion points to enhance the popularity. Moreover, the residual resources from the wetland environment in the park can be taken as the peripheral products for selling to improve the added value of resources.

(4) In order to improve the tourism environment bearing capacity, first of all, the input of means of transportation in the park should be increased, such as increasing the number of cruise boats, extending the service time provided by cruise boats, increasing the frequency of the use of cruise boats, *etc*. Secondly, the park can gradually open the wetland conservation area and protection and utilization area to increase the sightseeing areas. In terms of the ecological environment bearing capacity, in addition to increasing the artificial treatment of solid wastes, measures of artificially treating water pollution should also be taken.

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