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Evaluation and Analysis of Environmental Carrying Capacity of Recreation Area in Qinglong Lake Wetland Park

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Abstract: With the rapid development of cities, the contradiction between citizens' demand for recreation and the limited area of green space in parks has become increasingly prominent. Research on recreation environmental carrying capacity is conducive to solving this problem. This paper uses analytic hierarchy process to determine the index weight, fuzzy mathematics to determine the degree of membership, and finally determines the comprehensive evaluation model of environmental carrying capacity of Qinglong Lake Wetland Park. The research results provide guidance for solving the contradiction between citizens' recreation needs and the limited area of green space in parks.

1. Introduction

With the rapid development of cities, the contradiction between citizens' demand for recreation and the limited area of green space in parks has become increasingly prominent. The research on recreation environmental carrying capacity is conducive to solving this problem. The recreation environmental carrying capacity refers to the maximum amount of human recreation activities that a recreation place can bear in a certain period of time on the premise that the structure and function of the recreation system are not damaged and tourists' recreation experience is not negatively affected. In general, it is composed of natural resource recreation carrying capacity, ecological recreation environment carrying capacity, recreation environment space carrying capacity, recreation environment facility carrying capacity and social environment carrying capacity. The determination of recreational environmental carrying capacity is helpful for scientific development, planning and management of recreational areas, so that they can provide effective and long-term recreational services and take the road of sustainable development.

In 2022, The State Council approved the construction of a park city demonstration zone in Chengdu to practice the new development concept. Qinglong Lake Wetland Park is the largest wetland park in the downtown area of Chengdu. Its overall design takes the Ming Dynasty Shu culture as the main content, green ecology as the keynote, lakes and forests as the main scene, and

comprehensively considers tourism, leisure and entertainment, sports and fitness, business meetings, etc., aiming to realize the transformation of historical landscape gardens from beautifying life to guiding healthy life. The transformation from urban green space planning to urban outdoor recreation space design. It is of great significance to study the environmental carrying capacity of Qinglong Lake Wetland Park to meet the growing needs of Chengdu citizens for a better life.

2. Research on environmental carrying capacity of urban parks

Lime (1979) proposed for the first time that environmental capacity is a complex system integrating physical, social, cultural, psychological and management capacity[1]. Alexis Saveriades (2000) constructed a mathematical model of the socio-psychological environmental carrying capacity of recreation areas[2]. Steven et al. (2003) took the example of Arches National Park and tested the socio-environmental capacity of the research area with a computer model, and then proposed some targeted management measures[3]. Zhu (2014) calculated the ecological carrying capacity, spatial carrying capacity, facility carrying capacity and social carrying capacity of Chongqing Zhaomushan Park and obtained the limit value of environmental carrying capacity of the whole park scenic spot[4]. Miao (2011) indicated the factors that affect the carrying capacity of recreation environment can be divided into objective and subjective factors. The objective factors mainly include recreational resources, recreational infrastructure and ecological structure of recreational areas. These factors are the basic factors that affect the carrying capacity of recreational environment. Due to their small change range and large impact effect, they are the limiting factors. Subjective factors mainly include recreation environment planning, recreation environment product type, recreation environment management level, recreation environment reception level, tourists' needs and characteristics, etc. These factors are mostly affected by human thought and behavior habits, with a large change range and influence effect. In contrast, regulating the subjective factors affecting the recreational environmental carrying capacity can significantly and effectively regulate the recreational environmental carrying capacity[5].

3. Construction of environmental carrying capacity evaluation system of Qinglong Lake Wetland Park

3.1. Conceptual model

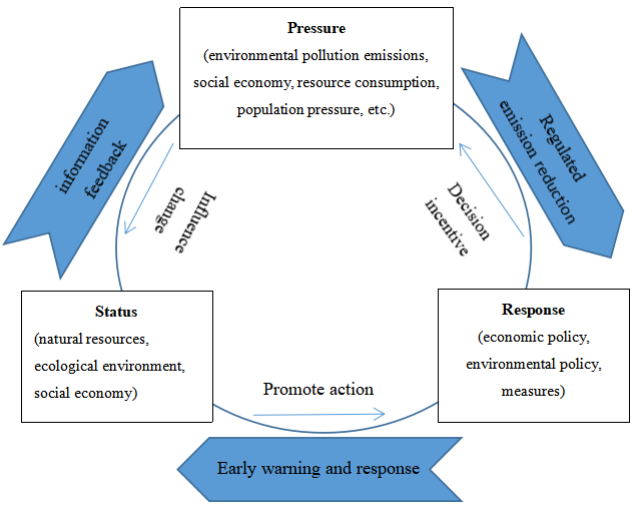

Figure 1: Action mechanism of PSR model.

Figure 1 is the “PSR” model. The “Pressure - State - Response” (PSR) model was first proposed by Canadian statisticians Rapport and Friend. Later, the United Nations Environment Program jointly developed the system framework for the study of ecological environment, carrying capacity assessment, ecological security assessment and other fields. Pressure indicators represent the unsustainable effects of human recreational social and economic activities on the ecological environment. State indicators indicate the state of environmental quality, ecosystem and natural resources in the process of sustainable development; Response indicators represent the countermeasures and measures taken by human beings to reduce, prevent, mitigate, restore and prevent the negative impact of human recreational activities on the environment to promote sustainable development. The action mechanism of PSR model is shown in Figure 1.

3.2. Construction of evaluation index system

3.2.1. Establishment of hierarchical structure model

This paper uses analytic hierarchy process to determine the index weight, fuzzy mathematics to determine the degree of membership, and finally determines the comprehensive evaluation model of environmental carrying capacity of Qinglong Lake Wetland Park. The environmental carrying capacity evaluation index of Qinglong Lake Wetland Park is divided into three layers, and the target layer represents the environmental carrying capacity of the recreation area of Qinglong Lake Wetland Park. The criterion layer includes three indexes: pressure, state and response. As shown in Table 1. The pressure indicators indicate the unsustainable impact of human activities on the environment in Qinglong Lake Wetland Park. State indicators indicate the environmental status of Qinglong Lake Wetland Park; The response indicators represent the measures taken to prevent the negative impact of human activities in Qinglong Lake Wetland Park on the environment. The index layer is the further explanation and explanation of the criterion layer.

Table 1: Evaluation system of environmental carrying capacity of Qinglong Lake Wetland Park.

Target layer	Criterion layer	Index level
Environmental carrying capacity of Qinglong Lake Wetland Park	Pressure	The average area of park space used per person
		Environmental pollution situation
		Passenger flow volume
	State	Water quality
		Vegetation landscape health degree
		Tourist density
	Response	Cleanliness
		Tourist complaint rate
		Park management regulations

3.2.2. The judgment matrix of each level is constructed

By pairwise comparison of each index, the judgment matrix A is constructed and the formula (1) is obtained.

$$A = (a_{ij})_{n \times n} \tag{1}$$

The a_{ij} comparison result is obtained by comparing the *i* factor and *j* factor in formula (3-1), and the judgment matrix is constructed, as shown in formula (2) :

$$A=\begin{bmatrix} a_{11} & a_{12} & \ldots & a_{1n} \\ a_{21} & a_{22} & \ldots & a_{2n} \\ \ldots & \ldots & \ldots & \ldots \\ a_{n1} & a_{n2} & \ldots & a_{nn} \end{bmatrix} \quad (2)$$

Add the terms of matrix A to get $W_i^{'}$, and normalize the sum vector to get the weight vector:

$$W_i=\frac{w_i^{'}}{\sum_{i=1}^{n} w^{'}}(i=1,2,3...n) \quad (3)$$

3.2.3. Consistency check

In order to test the results of the matrix, a consistency test is required, as shown in formula (4):

$$\lambda_{\max}=\sum_{i=1}^{n}\frac{(Aw)_i}{n\times w_i} \quad (4)$$

Where $\lambda_{\max}$ represents the largest eigenvalue and A represents the n-order matrix.

$$CR=\frac{CI}{RI} \quad (5)$$

When $CR=\frac{CI}{RI}<0.1$, the judgment matrix passes the consistency test.

3.3. The construction method of fuzzy comprehensive evaluation model

(1) Determine the set of evaluation indicators and the set of comments

The factor set of the criterion layer is expressed as U.

$$U=\{U_1,U_2,...,U_n\} \quad (6)$$

Suppose the index factor set is:

$$U_m=\{U_{m1},U_{m2},...,U_{mk}\} \quad (7)$$

(2) Establish an evaluation set

The composition of the evaluation results was obtained by using the expert scoring method. Represented by V:

$$V=\{v_1,v_2,...,v_n\} \quad (8)$$

(3) Build weight set

$$C=\{c_1,c_2,...,c_m\} \quad (9)$$

$$C_i=\{c_{i1},c_{i2},...,c_{im}\} \quad (10)$$

(4) Establish a first-level evaluation matrix

r_{ij} represents the membership degree of V_j, and the evaluation result of U_i is expressed as:

$$R_i=\{r_{i1},r_{i2},...,r_{in}\} \tag{11}$$

After professional evaluation, the fuzzy evaluation matrix R is determined.

$$R=\begin{bmatrix}R_1\\R_2\\...\\R_n\end{bmatrix}=\begin{bmatrix}r_{11} & r_{12} & ... & r_{11}\\r_{21} & r_{22} & ... & r_{2n}\\... & ... & ... & ...\\r_{m1} & r_{m2} & ... & r_{mn}\end{bmatrix} \tag{12}$$

Let B= ($b1$,$b2$,... bn), b_j represents the comprehensive degree of the evaluated object, and the formula (13) is obtained.

$$B=C\times R=\begin{bmatrix}c_1 & c_2 & ... & c_3\end{bmatrix}\times\begin{bmatrix}r_{11} & r_{12} & ... & r_{11}\\r_{21} & r_{22} & ... & r_{2n}\\... & ... & ... & ...\\r_{m1} & r_{m2} & ... & r_{mn}\end{bmatrix} \tag{13}$$

(5) Establishment of secondary evaluation

The second-level fuzzy comprehensive evaluation is an evaluation aimed at the criterion level. See the formula (14) for details.

$$B_m=C_m\times R \tag{14}$$

The two-level fuzzy comprehensive evaluation matrix R is as follows:

$$R=\begin{bmatrix}B_1\\B_2\\...\\B_n\end{bmatrix}=\begin{bmatrix}b_{11} & b_{12} & ... & b_{11}\\b_{21} & b_{22} & ... & b_{2n}\\... & ... & ... & ...\\b_{m1} & b_{m2} & ... & b_{mn}\end{bmatrix} \tag{15}$$

The second-level fuzzy comprehensive evaluation set B is:

$$B=C\times R=\begin{bmatrix}B_1\\B_2\\...\\B_n\end{bmatrix} \tag{16}$$

(6) Get the result

According to the results obtained from formula (17), the maximum membership principle is adopted to obtain the evaluation results.

$$b^*=\max\{b_1,b_2,...b_m\} \tag{17}$$

4. Conclusions

Firstly, we should strengthen the management of eco-tourism environment in Qinglong Lake Wetland Park. First, we should give full play to the leading role of the government. The development of eco-tourism in Qinglong Lake Wetland Park has a strong dependence on the regional environment. If the management is not in place, it will cause irreversible impact on the

ecological environment and directly affect the residents' recreational life quality. Therefore, the government should start from the macro level, formulate park management rules and regulations, pay attention to the late maintenance of the park, and ensure that the park has been in a "high-quality" state to achieve sustainable development.

Secondly, we should strengthen the monitoring and strengthen the management of Qinglong Lake Wetland Park, and make full use of modern technology means and equipment to strengthen the monitoring of environment and recreation carrying capacity of Qinglong Lake Wetland Park. According to the park area, facilities and the flow of people, we should reasonably increase management and protection personnel, while according to the spatial and temporal distribution of visitors, we should timely increase or decrease management and cleaning personnel to improve the utilization of human resources and park management capacity[6].

Thirdly, according to the characteristics of the recreational groups of Qinglong Lake Wetland Park, combined with the planning and construction objectives of the park, on the basis of fully considering the environmental carrying capacity of the wetland park, related amusement facilities and equipment can be added to enrich the recreational experience of the wetland park. At the same time, it is necessary to protect the ecological environment, improve the forest coverage rate, vigorously implement greening projects, increase the green area, and improve the forest coverage rate[7].

Fourthly, it is necessary to popularize the knowledge of environmental protection laws, publicize the park management system, improve the quality of visitors, advocate civilized parks, and improve the awareness of tourists to love green, protect green, health and civilized parks. Reasonable guidance should be given to the behavior of visitors to reduce the frequency of damage, reduce the difficulty of management, and improve the environmental carrying capacity of urban parks. At the same time, volunteer service teams can be formed to encourage the public to participate in park management on a regular basis[8].

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References

[1] Lime, S. G. H. (1979) Carrying Capacity: Maintaining Outdoor Recreation Quality in Land and Leisure [J], Leisure Research, 105-118.

[2] Alexis, S. (2000) Establishing the Social Tourism Carrying Capacity for the Tourist Reports of the Coast of the Republic of Cyprus [J].Tourism Management, 21.

[3] Steven, R L. et al. (2003) Proactive monitoring and adaptive management of social carrying capacity in Arches National Park: an application of computer simulation modeling [J]. Journal of Environmental Management, 68(3): 305-313.

[4] Zhu, J., Chen, X., Zhou, J. (2014) Analysis of environmental carrying capacity of urban mountain parks—A case study of Zhaomushan Park in Chongqing [J]. Chinese Journal of Applied and Environmental Biology, 20 (4): 727-73.

[5] Miao, K. (2011) Analysis on the carrying capacity of green space recreation environment in urban parks -- A case study of Zhengzhou City [D]. Zhengzhou: Henan Agricultural University.

[6] Huang, J., Fu, W., Li, F. (2019) Evaluation of environment and recreation carrying capacity of Meizhou Island tourism resort [J]. Journal of Ningde Normal University (Natural Science), 31(01): 100-106.

[7] Zhong, P. (2020) Construction of recreation opportunity spectrum in Wuhan East Lake National Wetland Park [D]. Changsha: Hunan Normal University.

[8] Fan, Y. (2019) Study on environmental carrying capacity and sustainable development of urban parks in Xining City [J]. Science and Technology of Qinghai Agriculture and Forestry, (01):12-17.