Grey Clustering Evaluation of Water Resources Carrying Capacity Based on Triangle Whitening Weight Function

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Abstract. Water resources are an important component of the resource environment. The sustainable carrying capacity of water resources is an essential indicator for the comprehensive evaluation of regional sustainable development. This paper will select 17 water resources carrying capacity impact factors to establish a sustainable water resources assessment system. The grey clustering evaluation based on the triangle whitening weight function is used to obtain the objective evaluation results of water resources carrying capacity.

Keywords: water resources; bearing capacity; evaluation index; triangular whitening weight function.

1. Introduction

Water resources are the material basis for human survival and the factors that affect regional economic strength. As global water demand increasing, achieving sustainable water development is vital [1].Since the reform and opening up delete it 30 years ago, Chinese economic and social outlook has undergone profound and extensive changes, but the rapid growth of the economy and people's living standards have also paid a massive resource and environmental cost. The sustainable carrying capacity of water resources refers to the socio-economic scale that water resources in the region can support in a specific socio-economic and regional environment for the foreseeable future [2]. Through a comprehensive evaluation of the sustainable carrying capacity of water resources, which could provide decision-making basis for the scientific planning of regional water resources and the sustainable use of water resources.

2. Construction of evaluation index system

The purpose of establishing an evaluation index system is to form an orderly and comprehensive evaluation indicator system by selecting appropriate metrics,which based on the coupling relationship between indicators to quantitatively reflect and measure the characteristics of water resources systems in different regions and their impact on the socio-economic system. The carrying status of the ecosystem, identifying and diagnosing, maintaining or maintaining the restrictive links of the normal operation of the carrying object and its degree of restriction [3]. This paper has drawn on the study of constructing resource-saving agricultural comprehensive evaluation index system and constructs the target layer and guidelines. The evaluation index system for sustainable water resources carrying capacity of Chongqing City, including layers and indicators.References Xia Xumei[4], Xie Fei[5], Wang Jianhua[6], Wang

Rui[7], Chen Wei[8] and other literature to determine the subsystem weight. The indicator system has shown in Table 1 below.

Table 1. Comprehensive evaluation index system for water resources carrying capacity

Subsystem	index	Indicator meaning	Subsystem weight
Water resources system(s_1)	X_1	Total water resources	0.3789
	X_2	Average annual rainfall	
	X_3	Water resources development and utilisation	
	X_4	Per capita water resources	
	X_5	Water resources per unit of land area	
	X_6	Per capita water consumption	
	X_7	Per capita water consumption	
Socioeconomic system(s_2)	X_8	Natural population growth rate	0.3567
	X_9	The level of urbanisation	
	X_{10}	Cultivated land irrigation rate	
	X_{11}	Per capita GDP	
Ecological environment system(s_3)	X_{12}	Forest cover rate	0.2644
	X_{13}	Sewage discharge	
	X_{14}	Sewage discharge compliance rate	
	X_{15}	COD emissions	
	X_{16}	Ecological environment water use rate	
	X_{17}	Soil erosion control rate	

## 3. Scoring criteria for evaluation of each subsystem

For the scoring of each subsystem, the scoring standard designed by the "item rating tool" is used, and the score of 100 points is evenly distributed to the indicators of each stage. When the value of the indicator is within the normal range, the score of the indicator is in the second half of the total score.When the value of the indicator is out of the normal range, the score of the indicator will in the first half of the total score. As the water resources system shows, 100 points are evenly distributed among 7 indicators, and the total score of each indicator is 14.286. For the indicator range within the normal range (7.143, 14.286], for the indicator range over the normal range is [0, 7.143]. Finally, the sum of the seven indicator scores is the subsystem's Total Score.

4. Grey assessment of sustainable water resources carrying capacity based on the triangular whitening weight function

After the weights and scoring results of each subsystem were determined, the triangular whitening weight function is used to evaluate the carrying capacity of water resources. The specific steps of the assessment are as follows:

(1) Firstly, the evaluation categories of water resources carrying capacity are divided into four categories, don't need,just delete it, A, B, C, and D. Let λk be the centre point of k-grey, with

$\lambda 1$, $\lambda 2$, $\lambda 3$, $\lambda 4$ as the representatives of each ash class, assuming that the critical values of four ash classes are x1=25, x2=55, x3=75, x4=85, x5=95.

(2) Extending the range of ash, generally extending in the left and right directions, extending to x0=0 and x6=100, that is, adding 0 ash and x on the basis of x1, x2, x3, x4, x5 s+1 gray class, resulting in a new center point sequence x0, x1, x2, x3, x4, x5, x6.

(3) Connect the point (λ k, 1) with the center points (xk-1, 0), (xk+2, 0) of the two small gray classes k-1 and k+2,Obtain the triangular whitening weight function of the i-index on k-grey $f_j^k(\cdot)$(j=1,2,3,4,5;k=1,2,3,4),As shown in Figure 1 below.
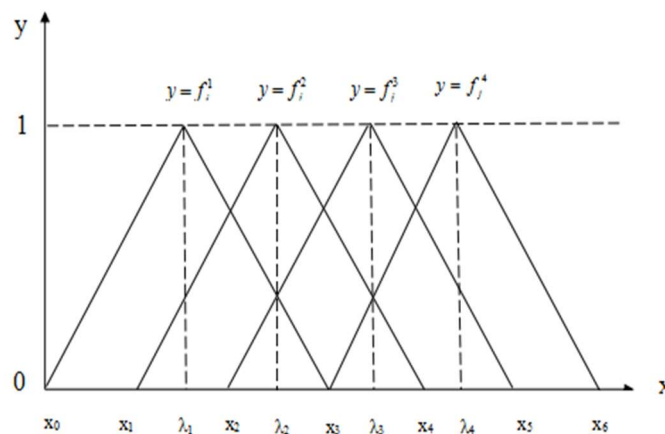
Figure 1. Grey clustering evaluation model based on a triangular whitening weight function

In this study, λ k selects the midpoint of each ash, $\lambda 1$=40, $\lambda 2$=65, $\lambda 3$=80, $\lambda 4$=90. According to the following formula, the membership degree belonging to the grey class k is calculated.

$$f_1^1(x) = \begin{cases} 0 & x \notin [0,75] \\ \dfrac{x}{40} & x \in [0,40] \\ \dfrac{75-x}{35} & x \in [40,75] \end{cases} \qquad f_1^2(x) = \begin{cases} 0 & x \notin [25,85] \\ \dfrac{x-25}{40} & x \in [25,65] \\ \dfrac{85-x}{20} & x \in [65,85] \end{cases}$$

$$f_1^3(x) = \begin{cases} 0 & x \notin [55,95] \\ \dfrac{x-55}{25} & x \in [55,80] \\ \dfrac{95-x}{15} & x \in [80,95] \end{cases} \qquad f_1^4(x) = \begin{cases} 0 & x \notin [75,100] \\ \dfrac{x-75}{15} & x \in [75,90] \\ \dfrac{100-x}{10} & x \in [90,100] \end{cases}$$

To determine the evaluation result of the final water resources carrying capacity, rewrite this sentence is necessary to calculate the overall clustering coefficient of the evaluation object i for the grey class k. The specific calculation formula is as follows:

$$P_i^k = \sum_{j=1}^{m} f_j^k(x_{ij}) \eta_j$$

The maximum value is selected in the comprehensive clustering coefficient to determine which grey type the object belongs to, and the evaluation result corresponding to the water resources carrying capacity is determined according to the grey type.

5. Evaluation results represented by each ash

After determining the ash to which the water resources carrying capacity belongs, the evaluation results corresponding to each ash are shown in the following table.

Table 2. Evaluation results of each ash

Gray code	Result description
A	Good water resources carrying capacity, providing a good foundation for the sustainable use of water resources
B	The water resources are of medium capacity and can unnecessary use this word maintain the sustainable use of water resources.
C	The water resources carrying capacity is general, although there are certain problems, it can basically maintain sustainable use.
D	Water resources carrying capacity is weak, unable to maintain sustainable use of water resources

6. Conclusion and revelation

To make a reasonable evaluation of water resources carrying capacity, this paper first constructed an evaluation index system based on relevant literature, including sub-indicators in subsystems and subsystems. Each subsystem was then scored using the Project Rating Tool. Then, based on the convenient point-based triangular misunderstanding this sentence, rewrite it, the final evaluation results of water resources carrying capacity are obtained, and a reasonable evaluation system of water resources carrying capacity are formed.

References

[1]   Hu Shengxiang, Pan Zhengwei, Zhou Yixing. Analysis of the Coordinated Development Level of Water Resources and Social Economy[J]. People's Pearl River, 2018(2).

[2]   Ge Jie, Zhang Xin. Research on Industrial Structure Optimization of Yulin City Based on Water Resources Carrying Capacity[J]. Water Saving Irrigation, 2018(4).

[3]   DANG Lijuan, XU Yong. Research Progress and Enlightenment of Water Resources Carrying Capacity[J]. Soil and Water Conservation Research, 2015, 22(3): 341-348.

[4]   XIA Xumei, JIA Bo. Research on Comprehensive Evaluation of Destructive Innovation Capability of High-tech Industry Based on Entropy Weight Method[J]. Science & Technology Progress and Policy, 2014(14): 114-118.

[5]   Xie Fei, Gu Jiguang, Lin Zhangwen. Reservoir Ecosystem Health Assessment Based on Principal Component Analysis and Entropy Weight——A Case Study of Wanning Reservoir in Hainan Province[J]. Chinese Journal of Applied Ecology, 2014, 25(6): 1773-1779.

[6]   Wang Jianhua, Qi Zhengli, Sang Xuefeng, et al. Research on water resources carrying capacity index system and evaluation criteria[J]. Journal of Hydraulic Engineering, 2017, 48(9): 1023-1029.

[7]   WANG Rui, ZHOU Lihua, CHEN Yong, et al. Evaluation of Water Resources Carrying Capacity of Hangjin Banner Based on Fuzzy Comprehensive Evaluation[J]. Soil and Water Conservation Research, 2017, 24(2): 320-324.

[8]   Chen Wei, Ai Wei. Research on Water Resources Carrying Capacity of Wuhan Based on Multiple Linear Regression Model[J]. Journal of Henan Polytechnic University(Natural Science), 2017, 36(1): 75-79.