Hook Benefit Evaluation on the Increase of Urban Construction Land and the Decrease of Rural Construction Land in the Suburbs of Chongqing City, China

WANG Ke*, XIE De-ti, HUANG Chun-fang, WANG San

College of Resource and Environment, Southwest University, Chongqing 400715, China

Abstract According to the socio-economic statistical data and the land use data of Jingguan Town in the year 2008, hook benefit evaluation index system suitable for the actual situation of research region is determined, based on the systematic analyses of the basic data of current status and the related information of hook in research region. Fuzzy Comprehensive Evaluation Method is adopted to evaluate the increase of construction land of Jingguan Town before and after the hook. Result shows that the economic, social and ecological benefits of research region have significantly improved after the hook. And the fuzzy comprehensive evaluation index system and evaluation methods established in this research can provide references for the hook benefit evaluation in the suburbs of Chongqing City, China.

Key words Construction land, Benefit, Hook, Jingguan Town, China

Hook benefit evaluation includes a number of benefit target factors. In order to correctly evaluate the benefits, various indices should be considered. Traditional evaluation method usually classifies the grades of evaluation factors and gives them scores. Thus, two factors having little differences at different levels might be classified into two grades, or two factors having great differences in the same level might be classified into one grade. To overcome the above drawbacks, this research uses Fuzzy Comprehensive Evaluation Method by considering the advice of experts and the actual demands of hook project. Based on the factors related to the hook benefit, Fuzzy Comprehensive Evaluation Model is established to evaluate the benefits of hook project, so as to obtain relatively objective conclusion of hook benefit evaluation.

1 The general situation of research region

Chongqing Taiwan Farmers Pioneer Park is taken as the research region, which is located in the Jingguan Town, Beipei District, Chongqing City, China. This research region is high in southeast and low in northwest with the landform of shallow hill, and belongs to typical subtropical monsoon climate. The annual average temperature is 17.4 degrees centigrade, the annual average forest-free period is 319 days, and the annual average precipitation is 1 070 millimeter. There is neither cold and frost-bitten injury, nor disastrous weather. Since the climate of the research region is merely the same with that in Taiwan, the research region is an ideal climate zone to plant characteristic crops of Taiwan. Moreover, the research region is located in the Jiangdong Flower and Tourism Agricultural Industry Belt of Chongqing, and has convenient transportation. It is 21 kilometers from Beipei City, 32 kilometers from Chongqing Jiangbei International Airport, and about 10 kilometers from the exit of Raocheng speedway.

2 Data source and research method of index system construction

2.1 Data source Research data mainly include the socio-economic statistical data of Jingguan Town in 2008 and the land use data of Jingguan Town in 2008. Among them, land use data are mainly the 1:2 000 land use status data provided by the planning institutes of Hemu Village and other 3 villages of Jingguan Town in the year 2008. Socio-economic statistical data are mainly from the *Annual Report on Rural Economic Statistics* and the 2008 – 2020 *Village Planning of Jizhen Village*, *Douti Village*, *and Hemu Village of Jingguan Town* provided by government of Jingguan Town.

2.2 Technique route Based on the systematic analyses of the basic data of current status and the related information of hook in research region, hook benefit evaluation index system is determined suitable for the actual situation of research region, as well as the index weight of Analytic Hierarchy Process. Then, according to the situations of research region before and after hook, experts are invited to evaluate the grades and use Fuzzy Statistical Method to determine the membership degree of the index. Fuzzy Comprehensive Evaluation Method is adopted to evaluate the economic, social and ecological benefits of research region before and after the hook, and their grades are also evaluated. Finally, comparative analysis of the evaluation result is conducted. Fig. 1 illus-

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* Corresponding author. E-mail: xdt@swu.edu.cn

trates the specific technical route.

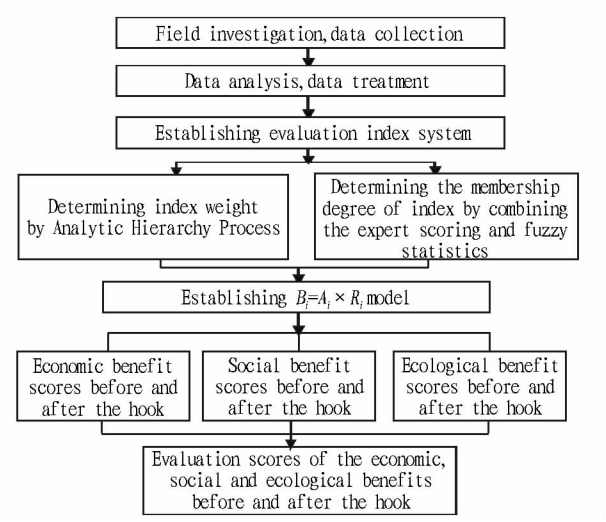

Fig.1 The technical route of the hook benefit evaluation

2.3 Evaluation index system Table 1 reports that there are 3 economic benefit scores, 3 social benefit scores, and 2 ecological benefit scores[1-2].

Table 1 Evaluation index system of the benefit of hook project

Target layer	First-grade index	Second-grade index
Comprehensive benefit	Economic benefit	Added value of per capita GDP in research region
		Increasing rate of per capita annual net income of farmers
		Increasing rate of land unit yield
	Social benefit	Increasing rate of agricultural labor productivity
		Increasing rate of per capita traffic area
		Increasing rate of per capita cultivated area
	Ecological benefit	Added value of forest coverage rate
		Added value of land reclamation rate

2.4 Research method

2.4.1 The basic model of fuzzy evaluation.

(1) Assuming that the evaluation object is P, its factor set is $U=\{u_1, u_2, \cdots, u_m\}$ and evaluation grade set is $V=\{v_1, v_2, \cdots, v_m\}$. Fuzzy evaluation on the factors in set U is carried out according the grade index in evaluation set. Thus, the judgment matrix is:

$$R=\begin{bmatrix} r_{11}, r_{12}, \cdots, r_{1m} \\ r_{21}, r_{22}, \cdots, r_{2m} \\ r_{n1}, r_{n2}, \cdots, r_{nm} \end{bmatrix} \quad (1)$$

where r_{ij} is the membership degree of U_i to V_j, and (U,V,R) is a Fuzzy Comprehensive Evaluation Model.

(2) The importance index of each factor (weight number) is determined, which is denoted by $A=\{a_1, a_2, \cdots, a_n\}$.

(3) Fuzzy Comprehensive Evaluation Model of each benefit is established according to the membership degree matrix of each index.

$$B_i=A_i \times R_i \quad (2)$$

(4) Introduce equidifferent method to set the evaluation classification standard. Establish the evaluation standard score function $F=(f_1, f_2, f_3, f_4, f_5)^T$.

(5) Calculate the evaluation score of each benefit in the research region before and after the hook.

$$Z_i=B_i \times F \quad (3)$$

2.4.2 Analytic Hierarchy Process. Analytic Hierarchy Process is applied in the index weight of hook benefit evaluation. If there are two factors in the decision-making layer, the determination of weight is directly assigned by the experts. Analytic Hierarchy Process is used to establish the model, which basically follows several steps[3]:

(1) Constructing all the judgment matrixes in different layers. Experts table of the judgment matrix of Analytic Hierarchy Process is designed. A total of 15 experts in related fields, who are familiar with the research region, are invited to evaluate the importance value of the matrix.

(2) Grade sorting and consistency test.

The maximum eigenvalue λ_{max} and eigenvector W of judgment matrix are obtained. After the normalization, we can obtain the ranking weight of the relative importance of a corresponding factor at the same grade to a certain factor in the upper grade.

When $CR<0.10$, the consistency of judgment matrix constructed by the experts is acceptable. Based on this, weights of all factors in the same grade can be calculated. Then, the sum of all the factor weights calculated by the judgment matrix is divided by the number of experts, which is factor weight in the corresponding grade. Thus, the weight in each grade is obtained.

3 Result and analysis

3.1 Determination of evaluation index weight Model is established by Analytic Hierarchy Process. And Table 2 reports the weights of hook benefits evaluation indices in research region.

3.2 Determination of the membership degree of evaluation index Excellent, good, fair, poor, bad are the five grades of evaluation index in the evaluation index system. A total of 15 exports are invited to evaluate the second-grade indices by fuzzy comprehensive evaluation index V, in order to determine the membership degree of evaluation index and to establish the fuzzy evaluation matrix[4-5].

Membership degree matrix of evaluation index before hook is:

$$R_1=\begin{Bmatrix} 0.200\,0 & 0.200\,0 & 0.400\,0 & 0.200\,0 & 0.000\,0 \\ 0.266\,7 & 0.400\,0 & 0.200\,0 & 0.133\,3 & 0.000\,0 \\ 0.200\,0 & 0.533\,3 & 0.266\,7 & 0.000\,0 & 0.000\,0 \end{Bmatrix}$$

$$R_2=\begin{Bmatrix} 0.200\,0 & 0.066\,7 & 0.533\,3 & 0.200\,0 & 0.000\,0 \\ 0.333\,3 & 0.400\,0 & 0.266\,7 & 0.000\,0 & 0.000\,0 \\ 0.333\,3 & 0.133\,3 & 0.466\,7 & 0.066\,7 & 0.000\,0 \end{Bmatrix}$$

$$R_3=\begin{Bmatrix} 0.133\,3 & 0.400\,0 & 0.466\,7 & 0.000\,0 & 0.000\,0 \\ 0.200\,0 & 0.400\,0 & 0.333\,3 & 0.066\,7 & 0.000\,0 \end{Bmatrix}$$

And membership degree matrix of evaluation index after hook is:

$$R'_1=\begin{Bmatrix}0.533\,3 & 0.200\,0 & 0.066\,7 & 0.200\,0 & 0.000\,0\\ 0.466\,7 & 0.200\,0 & 0.200\,0 & 0.133\,3 & 0.000\,0\\ 0.533\,3 & 0.200\,0 & 0.266\,7 & 0.000\,0 & 0.000\,0\end{Bmatrix}$$

$$R'_2=\begin{Bmatrix}0.600\,0 & 0.133\,3 & 0.066\,7 & 0.200\,0 & 0.000\,0\\ 0.466\,7 & 0.266\,7 & 0.266\,6 & 0.000\,0 & 0.000\,0\\ 0.466\,7 & 0.333\,3 & 0.133\,3 & 0.066\,7 & 0.000\,0\end{Bmatrix}$$

$$R'_3=\begin{Bmatrix}0.466\,7 & 0.333\,3 & 0.200\,0 & 0.000\,0 & 0.000\,0\\ 0.533\,3 & 0.266\,7 & 0.200\,0 & 0.000\,0 & 0.000\,0\end{Bmatrix}$$

3.3 Evaluation of hook benefit

3.3.1 Calculation of the fuzzy comprehensive rating model. Weight matrix A and index membership degree matrix R determined by Table 1 are brought into equation (2). Hence, the evaluation models of ecological, social and economic benefits before and after the hook are obtained: Economic benefit evaluation models before and after hook are $B_1=[0.224\,3, 0.334\,9, 0.302\,3, 0.138\,5, 0.000\,]$ and $B'_1=[0.509\,1, 0.200\,0, 0.152\,4, 0.138\,5, 0.000\,0]$; social benefit evaluation models before and after hook are $B_2=[0.280\,4, 0.214\,49, 0.412\,5, 0.092\,7, 0.000\,0]$ and $B'_2=[0.519\,6, 0.227\,0, 0.160\,7, 0.092\,7, 0.000\,0]$; and ecological benefit evaluation models before and after hook are $B_3=[0.159\,3, 0.400\,0, 0.414\,8, 0.025\,9, 0.000\,0]$ and $B'_3=[0.492\,6, 0.307\,4, 0.200\,0, 0.000\,0, 0.000\,0]$.

Table 2 The weight of hook benefits evaluation index

Target layer	First-grade index	Weight	Second-grade index	Weight
Comprehensive benefit	Ecological benefit	0.430 4	Added value of per capita GDP in research region	0.449 7
			Increasing rate of per capita annual net income of farmers	0.364 5
			Increasing rate of land unit yield	0.185 8
	Social benefit	0.363 0	Increasing rate of agricultural labor productivity	0.397 0
			Increasing rate of per capita traffic area	0.403 6
			Increasing rate of per capita cultivated area	0.199 4
	Ecological benefit	0.206 6	Added value of forest coverage rate	0.611 3
			Added value of land reclamation rate	0.388 7

3.3.2 Calculation of the score of hook benefit evaluation. In order to compare the benefits in research region before and after the hook and to reflect the benefits actually, equidifferent method is introduced to set the evaluation grade standard according the results of fuzzy calculation. The evaluation criteria score function is established:

$$F=(f_1,f_2,f_3,f_4,f_5)^T=(100,80,60,40,20)^T.$$

Calculation result of equation (2) and the evaluation criteria score function F are brought into equation (3). Then, the economic benefits evaluation scores before and after the hook are 72.90 and 81.59; the social benefits evaluation scores before and after the hook are 73.65 and 83.47; and the ecological benefits evaluation scores before and after the hook are 73.85 and 85.85.

4 Conclusion

Benefits evaluation scores before the hook are all lower than 80 in the research region, while those after the hook are all greater than 80, indicating that the implementation of hook has brought relatively great economic, social and ecological benefits. Thus, it can be concluded that the implementation of hook is successful as a whole.

Experimental work of hook is a complex system. Its benefit evaluation involves economy, society, ecology and other benefit goal factors. In order to fully and correctly evaluate the comprehensive benefit, indices of various aspects should be considered by combining with the actual situation of research region. At present, Fuzzy Comprehensive Evaluation Method is an effective method of fuzzy mathematics which is widely applied. Considering all the influencing factors, the merits of a given subject are scientifically evaluated. Since there are few researches on the hook benefit evaluation, standards for reference are lacked. Therefore, benefit evaluation method in this research can provide references for the hook benefit evaluation in the suburbs of Chongqing City, China.

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