Research on eco-community comprehensive evaluation model based on improved fuzzy method under the circumstance of new type urbanization development

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Abstract

In the planning of town development, the concept of eco-community is widely accepted and gradually applied to practice, which has become an important content of the new urbanization construction now. The establishment of eco-community comprehensive assessment is of great significance for the practice and development of eco-community. By the empirical analysis of the eco-community, establish a set of eco-community assessment index system that is in accordance with China's situation and combine qualitative and quantitative by adopting improved Fuzzy method, follow the detailed index reference standard of relevant research results both at domestic and foreign, carry out a quantum chemical calculation of various indexes and its weight.

Keywords: improved fuzzy, new-type urbanization, eco-community, comprehensive assessment

1 Introduction

In the 21st century, people have higher living condition requirement. The development of eco-community has become an inevitable trend. Eco-community is guided by the idea of sustainable development, aiming to seek the harmony and unity among nature, architecture, environment and human beings, thus the community of the least consumption of resources and energy and the production of least waste. Community is the cell of society and the harmony of the community is the basis of social harmony. The construction of eco-community is the substance of harmonious society construction [1].

With the great promotion of new-type urbanization strategy process, it will bring the rapid consumption of environmental resources and series problems of environmental pollution. In the case of severe environmental pressure, governments at all levels, all sectors of society and the masses pay extensive attention to construction of ecological community. Now, various countries have the universal recognition that ecological planning is the main method to relieve the environmental crisis. The ecological community planning construction of the town becomes especially urgent.

The United States carries out self-checking analysis of ecological community functional construction from the aspects of the ecology of liveable community, healthy communities and eco village concept analysis according to various natural environment and social problems in the United States. Seattle has also developed a set of development indicators for the construction of sustainable community in order to measure the level of sustainable development, monitor and forecast the future development of the city's main links etc. The construction of ecological community in Canada attaches great importance to recognition of the citizen, which requires the participation of community residents to achieve establishment, operation and growth of the community [2]. Britain and EU have also established the community index system of ecological communities, namely "Moving towards the community sustainable development – EU public index" [3] and "community life quality index" [4].

Recent years, there are many scholars pay attention to the research of the ecological community and they mainly focus on the study of connotation, function, and construction content of ecological community [5-8]. The corresponding evaluation index system is also put forward. But the construction of the index system is not comprehensive. There are more qualitative research and less quantitative research. The complete system of comprehensive evaluation on the ecological community has not yet been formed. The evaluation practice of ecological communities calls for a complete evaluation index system of norms urgently. This paper explores the evaluation index system of ecological community from the six aspects of quality of the construction, life infrastructure, community environmental quality, greening and landscape, transportation and culture education and property management and constructs a set of comprehensive evaluation model of eco-community with higher feasibility [9].

2 The connotation of ecological community

The ecological community, also known as the green community or sustainable community, emphasizes the ecological relationship integration of crowd settlement and the natural environment, the organic integration of architecture, infrastructure, natural ecological environment, house-

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holds and community social service. The construction of ecological community must display the function of the government department, planning designers, real estate developers, community residents, the property management sector and other stakeholders.

At present, there is no clear and uniform definition to the ecological community in worldwide and even different countries and regions have different titles for it. In China, we call it "ecological community" or "green community" while in European countries, it is called "sustainable community", "healthy community", "liveable community", "ecological village" in common. Although the names are different, the majority of community construction target is still relatively consistent, namely to seek the sustainable development road of community. Thus, in many cases, the boundaries between these names are rather ambiguous and sometimes can be replaced. However, it can be called the concrete expression of "sustainable development" whether in what kind of forms. We can understand the basic connotation of ecological community through the analysis of these common characteristics.

3 The basic principle of fuzzy mathematical analysis and evaluation method

Fuzzy mathematical analysis evaluation method (Fuzzy) is a mathematical theory and method for research and treatment of ambiguity phenomenon, which was first proposed by American cybernetics researchers Zadeh and Bellman from University of Southern California. The method ultimately determines the ranking of the evaluation object by using fuzzy set transform principle to describe five-factor score, blurred lines of factor and construct fuzzy matrix by multilevel compound operation based on factor of evaluation confirmation, opinion rating and weight of factor.

3.1 DETERMINE THE FACTORS CONCERNING DOMAIN OF THE EVALUATION OBJECT

$Y=\{Y_1,Y_2,\cdots,Y_n\}$, i.e, n evaluation indexes.

3.2 DETERMINE THE COMMENT DEGREE DOMAIN

$D=\{D_1,D_2,\cdots,D_P\}$, also the grade set, each set has a corresponding fuzzy subset. Generally, if the evaluation grade p chooses the integer of [3,7]. If p is too large, it is difficult to describe or judge grade attribution. If p is too small, it does not meet the quality requirements of the fuzzy comprehensive evaluation. If there are many odd numbers, because it can have an intermediate level, it is convenient to judge evaluation grade attribution. The specific level can be described in appropriate language according to evaluation of the content, such as the competitiveness of the products (strong, moderate, weak), evaluation of social development level of a certain area (high, higher, medium, low, lower) and the evaluation of the economic effect (good, better, medium, bad, worse).

3.3 THE SINGLE FACTOR EVALUATION

Fuzzy relation matrix:

$$\widetilde{\mathrm{Z}}=\begin{pmatrix}\widetilde{Z}|\mathrm{Y}_1\\ \widetilde{Z}|\mathrm{Y}_2\\ \vdots\\ \widetilde{Z}|\mathrm{Y}_\mathrm{n}\end{pmatrix}=\begin{bmatrix}z_{11} & z_{12} & \cdots & z_{1p}\\ z_{21} & z_{22} & \cdots & z_{2p}\\ \vdots & \vdots & \ddots & \vdots\\ z_{y1} & z_{y2} & \cdots & z_{np}\end{bmatrix}_{n\times p},$$

is established. The element z_{ij} in i row j line of matrix $\tilde{Z}$ shows the degree of membership of the evaluated things from factor Y_i to D_j grade. The expression of evaluated things in factor Y_i shows that $(\tilde{Z}|Y_i)=(x_{i1},x_{i2},\ldots,x_{ip})$ evaluation methods are described by index actual value. Therefore, there is more information of the fuzzy comprehensive evaluation requirements.

3.4 DETERMINE THE FUZZY WEIGHTING VECTOR OF EVALUATION FACTORS Q

The fuzzy weighting vector of evaluation factors $Q=\{Q_1,Q_2,\cdots,Q_n\}$ needs to be determined. Generally speaking, n evaluation factors do not have the same importance level for evaluating the influence of each evaluated thing. Therefore, the fuzzy weight vector needs to be determined before the synthesis. In the fuzzy comprehensive evaluation, element q_i of the weight vector Q is essentially the membership of degree of fuzzy subset {factors of evaluated things}, determined by general fuzzy method and normalized before synthesis.

3.5 CALCULATE THE FUZZY COMPREHENSIVE EVALUATION RESULT VECTOR $\tilde{R}$

Use the proper composition operator to combine Q and the evaluated object to get the fuzzy comprehensive evaluation result vector. The different rows in $\tilde{Z}$ show the degree of membership of a fuzzy subset for each grade evaluated object from different perspective of single factor. Use the fuzzy weight vector for the comprehensive degree of membership can be obtained by evaluating things fuzzy subset for each grade from the general point of view, which is the result of fuzzy comprehensive evaluation vector. The fuzzy comprehensive evaluation models are as follows:

$$Q\tilde{Z}=(q_1,q_2,\ldots,q_n)\begin{bmatrix}z_{11} & z_{12} & \cdots & z_{1p}\\ z_{21} & z_{22} & \cdots & z_{2p}\\ \vdots & \vdots & \ddots & \vdots\\ z_{y1} & z_{y2} & \cdots & z_{np}\end{bmatrix}=(r_1,r_2,\ldots,r_n)\triangleq\tilde{R},$$

where r_j shows the degree of membership of the evaluated objects to D_j grade fuzzy subset.

3.6 THE RESULTS OF COMPREHENSIVE EVALUATION OF FUZZY VECTOR ANALYSIS

Fuzzy comprehensive evaluation of every evaluation results is represented as a fuzzy vector, which is different from the comprehensive index of each evaluated target in other places, including more information. The comprehensive evaluation of one-dimensional different values can be easily compared and sorted, but different multidimensional fuzzy vector comparison sort is not so convenient.

4 The empirical analysis

The comprehensive evaluation of ecological community is based on the satisfaction survey. This paper selects three typical representatives as the evaluation object, Y_1 is a provincial representative of the community, Y_2 for the city under the jurisdiction of a county representative of the community, Y_3 is a town on behalf of the county under the jurisdiction of the community, which has 3 research objects $Y = \{Y_i\}$ (i=1, 2, 3). The order of evaluation can be divided into four grades, namely $D = \{D_1, D_2, D_3, D_4\}$ = {very satisfied, satisfied, in general, not satisfied}.

A fully comprehensive evaluation index system of ecological communities is established after investigation and analysis research is shown in Table 1.

TABLE 1 The comprehensive evaluation index system of ecological community

First grade index	Second grade index	Third grade index	Weight	First grade index	Second grade index	Third grade index	Weight
Degree of satisfaction	B_1 Construction quality (0.18)	B_{11} House type design	0.21	Degree of satisfaction	B3 Community environment quality (0.20)	B_{34} Effect of noise	0.13
		B_{12} Structural soundness	0.05			B_{35} Flammable and combustible	0.11
		B_{13} Variations of sunlight	0.27			B_{36} Public security	0.06
		B_{14} Natural draft	0.23		B4 Greening and landscape (0.22)	B_{41} Planting	0.3
		B_{15} Noise reducing and sound insulation	0.21			B_{42} Outdoor cleaning	0.15
		B_{16} Maintainability	0.03			B_{43}Floor cleaning	0.15
	B2 Life infrastructure (0.20)	B_{21} Medical care	0.14			B_{44} Building sketch	0.22
		B_{22} Commodity network	0.16			B_{45} Entertainment Plaza	0.18
		B_{23} Power supply system	0.05		B5 Transportation and culture education (0.15)	B_{51}distribution of schools	0.35
		B_{24} Telecom Service	0.17			B_{52} Work distance	0.1
		B_{25}Water supply and drainage system	0.16			B_{53}Cultural entertainment	0.12
		B_{26} Parking in residential areas	0.13			B_{54} Parking space distribution	0.25
		B_{27} Catering facilities	0.12			B_{55} surrounding traffic	0.18
		B_{28} Vegateble market	0.07		B6 Property management (0.05)	B_{61} Sanitary	0.3
	B3 Community environmental quality (0.20)	B_{31}Geographical position	0.33			B_{62} Defend system	0.47
		B_{32} Air quality	0.31			B_{63} Facility maintenance	0.11
		B_{33} Immersing in culture	0.06			B_{64}Community awareness	0.12

According to the multi-level fuzzy evaluation steps, index set, $B = \bigcup_{1}^{6} B_j$ namely B_1, B_2, B_3, B_4, B_5, B_6 respectively represent the community building quality, living infrastructure, environmental quality, community greening and landscape, transportation and culture education, property management 6 factors. For these 6 factors, each factor respectively include three level indicators, namely $B_{jk} = \{B_{j1}, B_{j2}, ..., B_{jk}\}$, j = 1, 2, …, 6, k = 1, 2, ..., t. In this case, t chooses 4~8 respectively. Questionnaire, interview survey and observation survey are used to collect residents' opinions in three communities. 200 copies of questionnaire are given out in the three communities with the recovery efficiency of 83.2%.

Adopt the fuzzy statistical methods to determine degree of different evaluation grades in the three communities, namely the degree of membership Z_{ip}, see Table 2.

TABLE 2 Z_{ip} statistics of the third grade index

The third grade index	Y_1				Y_2				Y_3			
	D_1	D_2	D_3	D_4	D_1	D_2	D_3	D_4	D_1	D_2	D_3	D_4
B_{11}	0.163	0.510	0.286	0.414	0.104	0.563	0.229	0.104	0.000	0.500	0.500	0.000
B_{12}	0.000	0.469	0.449	0.082	0.354	0.458	0.125	0.063	0.000	0.767	0.233	0.000
B_{13}	0.041	0.469	0.408	0.082	0.276	0.426	0.234	0.064	0.000	0.035	0.379	0.586
B_{14}	0.061	0.204	0.592	0.143	0.271	0.500	0.208	0.003	0.467	0.067	0.466	0.000
B_{15}	0.663	0.245	0.122	0.000	0.170	0.447	0.319	0.064	0.000	0.133	0.700	0.167
B_{16}	0.103	0.615	0.282	0.000	0.188	0.500	0.250	0.062	0.000	0.241	0.759	0.000
B_{21}	0.082	0.714	0.163	0.041	0.250	0.479	0.229	0.042	0.000	0.000	0.667	0.333
B_{22}	0.490	0.347	0.163	0.000	0.174	0.565	0.196	0.065	0.033	0.038	0.750	0.179
B_{23}	0.122	0.694	0.163	0.041	0.146	0.313	0.416	0.125	0.000	0.133	0.567	0.300
B_{24}	0.469	0.449	0.082	0.000	0.043	0.396	0.417	0.144	0.033	0.067	0.700	0.200
B_{25}	0.128	0.615	0.231	0.026	0.167	0.478	0.313	0.042	0.000	0.500	0.500	0.000

B_{26}	0.020	0.755	0.163	0.062	0.104	0.708	0.146	0.042	0.000	0.200	0.500	0.300
B_{27}	0.103	0.615	0.200	0.082	0.244	0.556	0.111	0.089	0.133	0.600	0.267	0.000
B_{28}	0.295	0.432	0.250	0.023	0.239	0.413	0.326	0.022	0.000	0.000	0.750	0.250
B_{31}	0.388	0.469	0.143	0.000	0.146	0.437	0.292	0.125	0.000	0.000	0.600	0.400
B_{32}	0.020	0.837	0.143	0.000	0.196	0.508	0.201	0.095	0.000	0.414	0.586	0.000
B_{33}	0.208	0.479	0.313	0.000	0.042	0.354	0.458	0.146	0.000	0.552	0.448	0.000
B_{34}	0.000	0.551	0.408	0.041	0.021	0.458	0.396	0.125	0.133	0.600	0.267	0.000
B_{35}	0.041	0.327	0.490	0.142	0.255	0.468	0.234	0.043	0.000	0.069	0.828	0.103
B_{36}	0.060	0.760	0.180	0.000	0.082	0.688	0.188	0.042	0.033	0.038	0.750	0.179
B_{41}	0.122	0.694	0.163	0.041	0.104	0.608	0.246	0.042	0.000	0.467	0.500	0.033
B_{42}	0.061	0.204	0.592	0.143	0.254	0.229	0.413	0.104	0.000	0.100	0.367	0.533
B_{43}	0.560	0.260	0.180	0.000	0.174	0.465	0.296	0.065	0.000	0.500	0.500	0.000
B_{44}	0.633	0.245	0.122	0.000	0.042	0.417	0.375	0.146	0.000	0.414	0.586	0.000
B_{45}	0.429	0.306	0.265	0.000	0.271	0.438	0.288	0.003	0.000	0.133	0.700	0.167
B_{51}	0.020	0.755	0.163	0.062	0.276	0.426	0.234	0.064	0.033	0.038	0.750	0.179
B_{52}	0.000	0.469	0.449	0.082	0.170	0.447	0.319	0.064	0.000	0.200	0.533	0.267
B_{53}	0.128	0.615	0.231	0.026	0.229	0.442	0.267	0.062	0.000	0.290	0.710	0.000
B_{54}	0.000	0.449	0.510	0.041	0.250	0.479	0.229	0.042	0.000	0.370	0.370	0.260
B_{55}	0.128	0.615	0.231	0.026	0.128	0.474	0.292	0.106	0.000	0.448	0.552	0.000
B_{61}	0.429	0.206	0.265	0.100	0.042	0.417	0.375	0.146	0.000	0.233	0.767	0.000
B_{62}	0.082	0.614	0.163	0.141	0.162	0.510	0.243	0.085	0.000	0.133	0.700	0.167
B_{63}	0.000	0.569	0.349	0.082	0.208	0.438	0.292	0.062	0.000	0.241	0.759	0.000
B_{64}	0.041	0.527	0.290	0.142	0.042	0.437	0.375	0.166	0.000	0.035	0.586	0.379

Calculate the fuzzy Y_1 community of three level indexes relative to the two level index membership degree matrix according to three level index weight coefficient in Table 1.

$$\tilde{Z}_1 = \begin{pmatrix} 0.163 & 0.510 & 0.286 & 0.414 \\ 0.000 & 0.469 & 0.449 & 0.082 \\ 0.041 & 0.469 & 0.408 & 0.082 \\ 0.061 & 0.204 & 0.592 & 0.143 \\ 0.663 & 0.245 & 0.122 & 0.000 \\ 0.103 & 0.615 & 0.282 & 0.000 \end{pmatrix},$$

$$\tilde{Z}_2 = \begin{pmatrix} 0.082 & 0.714 & 0.163 & 0.041 \\ 0.490 & 0.347 & 0.163 & 0.000 \\ 0.122 & 0.694 & 0.163 & 0.041 \\ 0.469 & 0.449 & 0.082 & 0.000 \\ 0.128 & 0.615 & 0.231 & 0.026 \\ 0.020 & 0.755 & 0.163 & 0.062 \\ 0.103 & 0.615 & 0.200 & 0.082 \\ 0.295 & 0.432 & 0.250 & 0.023 \end{pmatrix},$$

$$\tilde{Z}_3 = \begin{pmatrix} 0.388 & 0.469 & 0.143 & 0.000 \\ 0.020 & 0.837 & 0.143 & 0.000 \\ 0.208 & 0.479 & 0.313 & 0.000 \\ 0.000 & 0.551 & 0.408 & 0.041 \\ 0.041 & 0.327 & 0.490 & 0.142 \\ 0.060 & 0.760 & 0.180 & 0.000 \end{pmatrix},$$

$$\tilde{Z}_4 = \begin{pmatrix} 0.122 & 0.694 & 0.163 & 0.041 \\ 0.061 & 0.204 & 0.592 & 0.143 \\ 0.560 & 0.260 & 0.180 & 0.000 \\ 0.633 & 0.245 & 0.122 & 0.000 \\ 0.429 & 0.306 & 0.265 & 0.000 \end{pmatrix},$$

$$\tilde{Z}_5 = \begin{pmatrix} 0.020 & 0.755 & 0.163 & 0.062 \\ 0.000 & 0.469 & 0.449 & 0.082 \\ 0.128 & 0.615 & 0.231 & 0.026 \\ 0.000 & 0.449 & 0.510 & 0.041 \\ 0.128 & 0.615 & 0.231 & 0.026 \end{pmatrix},$$

$$\tilde{Z}_6 = \begin{pmatrix} 0.429 & 0.206 & 0.265 & 0.100 \\ 0.082 & 0.614 & 0.163 & 0.141 \\ 0.000 & 0.569 & 0.349 & 0.082 \\ 0.041 & 0.527 & 0.290 & 0.142 \end{pmatrix},$$

$$\tilde{Z} = \begin{pmatrix} 0.2017 & 0.3740 & 0.3629 & 0.1461 \\ 0.2318 & 0.5671 & 0.1919 & 0.0315 \\ 0.1548 & 0.5962 & 0.2280 & 0.0210 \\ 0.3462 & 0.3868 & 0.2392 & 0.0338 \\ 0.0384 & 0.6079 & 0.2988 & 0.0480 \\ 0.1722 & 0.4762 & 0.2293 & 0.1223 \end{pmatrix}.$$

According to second grade index weight vector in Table 2 Q = (0.18, 0.20, 0.20, 0.22, 0.15, 0.05), calculate Y_1 community satisfaction membership degree vector $\tilde{R}$:

$$\tilde{R} = Q\tilde{Z} = (0.18, 0.20, 0.20, 0.22, 0.15, 0.05) = \begin{pmatrix} 0.2017 & 0.3740 & 0.3629 & 0.1461 \\ 0.2318 & 0.5671 & 0.1919 & 0.0315 \\ 0.1548 & 0.5962 & 0.2280 & 0.0210 \\ 0.3462 & 0.3868 & 0.2392 & 0.0338 \\ 0.0384 & 0.6079 & 0.2988 & 0.0480 \\ 0.1722 & 0.4762 & 0.2293 & 0.1223 \end{pmatrix} = .$$

$$(0.2042, 0.5001, 0.2582, 0.0575)$$

It can be seen that the satisfactory degree of the comprehensive evaluation of community among the represen-

tative residence is 0.2042 and the relative satisfactory degree is 0.5001, the general satisfactory degree is 0.2582 and the dissatisfactory degree is0.0575. So we can conclude that most of the community residents are satisfied with the community.

We can also get the results of satisfaction evaluation in Y_2 and Y_3 community according to the same method.

Y_2: $\tilde{R}$ = (0.0316, 0.4693, 0.3627, 0.0754),

Y_3: $\tilde{R}$ = (0.0298, 0.2956, 0.5241, 0.1769).

It can be seen that the provincial capital of representtative of the community have more geographical location advantages than the county representative of the community through the comparison of Y_1, Y_2, Y_3 with more reasonnable and more standardized ecological planning. So the satisfaction degree will be higher. Similarly, the county representative of the community has more geographical location advantages than town representative of the community with more reasonable and more standardized ecological planning. So the satisfaction degree will be higher. This also reflects the causes why the population in town flow into the county and buy houses, which is in consistent with the trend of rural population gathering in the town in the process of urbanization and township population agglomeration to the city or county.

5 Conclusion

Fuzzy AHP method introduces the membership of this concept of trend and degree quantitative analysis becomes possible. But the method to determine the weight of each membership is more subjective and can be easily influence by conjecture. This paper is improved through investigation questionnaire and exactly solves the problem of the conjecture, making the evaluation results more consistent with practical, and achieving initial objective of this evaluation.

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