Study on Evaluation of Nanchong Ecological Civilization Construction Based on AHP-Entropy Method

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Abstract. In the second five environmental planning of Nanchong, the construction of ecological city is divided into the three start stage, advance promotion stage and full compliance stage, after 2007--2010 four-year period starting creation, Nanchong ecological civilization construction has achieved initial success, now in upgrade period. In this paper, AHP and entropy method is studied for the construction of ecological civilization and scientific evaluation of Nanchong City, Nanchong City enhance the status of the construction of ecological civilization in advance of quantification, inadequate grasp Nanchong construction of ecological civilization, in full compliance of the further deepening of Nanchong construction of ecological civilization provide public opinion, and reached the ecological economy, beautiful environment, ecology ecological social harmony Nanchong provide policy has important significance for the reference year 2020.

Introduction

Nanchong, Sichuan Basin, located in the northeast portion of the middle reaches of the Jialing River, between latitude 30 ° 35 '~ 31 ° 51', longitude 105 ° 27 '~ 106 ° 58' between; north-south span 165km, west span of 143km. Living in the west of Chengdu, east to Hubei, North cited Shaanxi, Chongqing Winsor special location. Nanchong has jurisdiction over three districts, five counties and one city, namely: ShunQingOu, Gaoping, Jialing, Nanbu County, Yingshan, Pengan, Sichuan, West County and Langzhong, as in 2014, all The total area of the territory 12 494km2, at the end of the total population of 759.02 million. Nanchong terrain with hills, 67% of the total area, the elevation is generally 256 to 889 m. Nanchong climate is humid subtropical monsoon climate, with an average annual rainfall of 1012mm, sunshine about 1100h, the maximum wind speed 13 m / s, average wind speed 1.6 m / sec. Nanchong underground, rich in non-metallic mineral resources, geological reserve of rock salt 1.8 trillion tons, is the largest natural salt mine in western Sichuan; has proven oil reserves of 7779 million tons, natural gas reserves of 9 billion cubic meters. Nanchong rich in water resources, Jialing River flows through the city, there are more than 100 tributaries, water area of 3.8% of the total area.

The Method Used in this Study

AHP Method. AHP method is a subjective method. It is essentially the basis for complex decision problems, influencing factors and the intrinsic relationship in-depth analysis on the use of quantitative information is less mathematical thinking process of decision-making, so as to multi-objective, multi-criteria or no structural characteristics the complex decision-making problem provides a simple method of weight right decision analysis.

The first step, to establish a hierarchy diagram. The overall objective of the study, targets and impact indicators by their mutual relations descending hierarchical construct hierarchical structure. The overall objective of this study for the construction of ecological civilization evaluate Nanchong City, the highest level of this hierarchy diagram for that is always the target layer, followed by Target That criterion layer pollution control, environmental protection and social development of the three economic indicators at the bottom layer comprises 15 indicators of chemical oxygen

demand (COD) emissions intensity, sulfur dioxide (SO2) emissions intensity of urban sewage centralized treatment rate.

The second step is to build pairwise comparison matrix. The three sub-goals rule layer pairwise comparison to determine their relative importance to the overall target layer. In this step, mainly through consulting experts and scholars in related fields, according to Saty 1-9 scale method, fill out evaluation forms index, the tables finally scaling the weighted average value of seeking to build pairwise comparison matrix $A = \left(a_{ij}\right)_{g \times g}$. The matrix g = 3, $a_{ji} = \frac{1}{a_{ij}}$, $a_{ij} \neq 0$, when i = j when, $a_{ij} = 1$.

The third step is to calculate the guideline layer weight vectors and do consistency test. Guidelines for the use of Matlab software to calculate the pairwise comparison matrix A layer of maximum λ_{max}, then based on consistency index $CI = \frac{\lambda_{max} - g}{g - 1}$, random consistency index RI [1] and the consistency ratio $CR = \frac{CI}{RI}$, consistency judgment matrix A. If CR<0.1, the matrix through consistency test, it is the maximum value corresponding to the characteristic feature vectors normalized to give guidelines on the right layer of the three sub-goals overall target layer weight vector α.

Entropy Method. Entropy Law is an objective weighting method. It is based on the degree of variation indicators calculated using information entropy weight of each index, resulting in a more objective index weight. If the information entropy index of the smaller, the greater the amount of information provided by this indicator, in the comprehensive evaluation of the role the greater the weight, the higher; and vice versa.

According to the established hierarchy of AHP graph, the first step is to determine the evaluation index system, construction of the original matrix. Assuming there are m objects to be evaluated, n evaluation indexes, by evaluation of the original data constituting the original matrix $R = \left\{r_{ij}\right\}_{m \times n}, 0 \leq r_{ij} \leq 1$ where the p_ij represents the i-th object to be evaluated Evaluation of the j-th index raw data, i = 1,2,3 ...... m, j = 1,2,3 ...... n. This study evaluated the object is a guide to filling the city under the nine counties (districts, cities), so m = 9; evaluation have 15, then n = 15.

$$r_{ij} = \begin{cases} \dfrac{p_{ij} - min\left(p_j\right)}{max\left(p_j\right) - min\left(p_j\right)}, & \text{When } p_{ij} \text{ is Positive indicators,} \quad \text{the bigger the better} \\[4mm] \dfrac{max\left(p_j\right) - p_{ij}}{max\left(p_j\right) - min\left(p_j\right)}, & \text{When } p_{ij} \text{ is negetive indicators,} \quad \text{the smaller the better} \end{cases}$$

The third step is to calculate the index of the j-th Entropy ej:

$$s_{ij} = r_{ij} \bigg/ \sum_{i=1}^{m} r_{ij}$$

$$e_j = -k \sum_{i=1}^{m} s_{ij} \cdot \ln s_{ij}$$

wherein, $k = \dfrac{1}{\ln m}$, $0 \leq e_j \leq 1$

The fourth step is to calculate the n-th evaluation of entropy w_j:

$$w_j = \left(1 - e_j\right) \bigg/ \sum_{j=1}^{n} \left(1 - e_j\right)$$

The fifth step, that is calculated separately for each evaluation target counties (districts, cities) comprehensive evaluation index esi _i:

$$esi_i = \sum_{j=1}^{n} w_j \gamma_{ij}$$

Esi refers to the i-th counties (districts, municipalities), comprehensive index of ecological civilization.

Nanchong City Ecological Civilization Construction Evaluation

Establish Evaluation Index System. Combined with the national "ecological county, city ecology, ecological province construction index" (2008), "Sichuan-class eco-counties (cities, districts) building indicators" and regional characteristics Nanchong City Index System Evaluation of ecological civilization construction, in Figure 1.
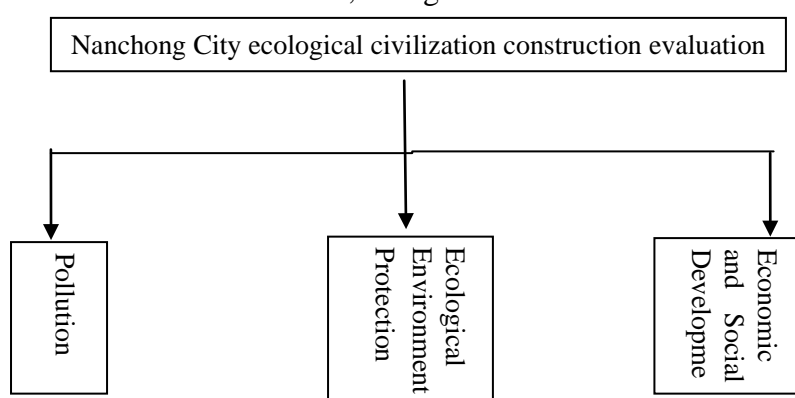

Fig. 1 Construction of the evaluation index system of ecological civilization nanchong city

The evaluation system includes pollution control, environmental protection and social development of the three economic criteria layer:

(1) Pollution: (COD) emissions intensity, sulfur dioxide (SO2) emissions intensity, urban sewage treatment rate by chemical oxygen demand, urban domestic garbage treatment rate of industrial solid waste disposal utilization metrics to measure.

(2) environmental protection: by unit GDP energy consumption, air quality compliance rate environment, drinking water quality compliance rate of forest coverage, urban green space, the intensity of chemical fertilizer (pure) indicators measure;

(3) Economic and Social development: by indicators of farmers per capita net income of urban residents per capita disposable income, the natural population growth, urbanization rate measure.

Evaluation of Ecological Civilization Construction of Nanchong City in 2013. The data used in this section are to regard Nanchong 2014 Statistical Yearbook 2014 economic Workbook, 2014 Environmental Quality Report and the county in 2014 Statistical Yearbook, 2014 Environmental Quality Report and other information. According to the Law of Entropy first step to data collected in statistical data constituting the original matrix P, followed by (1) its dimensionless according to the formula, to obtain standardized matrix R9 × 15, then:

$$R_{9 \times 15} = \begin{bmatrix}
1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 0.927 & 0 & 0.956 & 0 & 1.000 & 0.038 & 1.000 & 1.000 & 0.065 & 1.000 \\
0.539 & 0.900 & 0.824 & 1.000 & 1.000 & 0 & 0.530 & 1.000 & 0.455 & 1.000 & 0.490 & 0.283 & 0.258 & 0.432 & 0.207 \\
0 & 0 & 1.000 & 1.000 & 1.000 & 0.667 & 0 & 0.905 & 0.285 & 1.000 & 0.375 & 0 & 0.070 & 0.265 & 0.156 \\
0.789 & 0.901 & 0.346 & 0.403 & 0 & 0.530 & 0 & 0.678 & 1.000 & 0.113 & 1.000 & 0.569 & 0.823 & 0 & 0.096 \\
0.607 & 0.575 & 0 & 0.687 & 0 & 0.600 & 0 & 0.442 & 0.308 & 0.030 & 0.145 & 0.048 & 0.316 & 0.006 \\
0.845 & 0.871 & 0.151 & 0 & 0 & 0.272 & 0 & 0.036 & 0.723 & 0.009 & 0 & 0.627 & 0 & 0.458 & 0 \\
0.619 & 0.927 & 0.346 & 0.433 & 0 & 1.000 & 1.000 & 0 & 0.557 & 0 & 0.594 & 0.060 & 0.567 & 0.239 & 0.011 \\
0.627 & 0.603 & 0.980 & 0.388 & 0 & 0.749 & 0 & 0.750 & 0.644 & 0.014 & 0.936 & 0.080 & 0.112 & 0.671 & 0 \\
0.679 & 0.590 & 0.902 & 0.716 & 0 & 0.534 & 0.448 & 0.732 & 0.565 & 0.142 & 0.494 & 0.543 & 0.695 & 1.000 & 0.083
\end{bmatrix}$$

Right calculate entropy data into the matrix equation (2) and (3), and finally by the equation (4) to calculate the weight of each index, shown in Table 1:

Table 1

Evaluation index	Weighting (w_j)
Chemical oxygen demand (COD) discharge strength (kg / million)	0.0209 (w_1)
Sulfur dioxide (SO2) emission intensity (kg / million)	0.0213 (w_2)
Urban sewage centralized treatment rate (%)	0.0313 (w_3)
Urban living garbage treatment rate (%)	0.0210 (w_4)
Utilization of industrial solid waste disposal (%)	0.1665 (w_5)
Unit GDP energy consumption (tce / million)	0.0228 (w_6)
Ambient air quality compliance rate (%)	0.1763 (w_7)
Drinking water quality compliance rate (%)	0.0305 (w_8)
Forest coverage (%)	0.0271 (w_9)
Urban green area (ha)	0.1421 (w_{10})
Intensity of chemical fertilizer (pure) (kg / ha)	0.0490 (w_{11})
Farmers per capita net income (yuan)	0.0549 (w_{12})
Urban residents per capita disposable income (yuan)	0.0653 (w_{13})
The natural population growth rate (%)	0.0449 (w_{14})
The urbanization rate (%)	0.1361 (w_{15})

The standardized data matrix index weights R9 × 15 and Table 1 weight into the formula (5), calculated Nanchong City, nine counties (cities, districts) of ecological civilization comprehensive index, shown in Table 2:

Table 2　Nanchong in 2013 counties (cities, districts) comprehensive index of ecological civilization

Counties (districts, cities) name	esi
ShunQing disctrict	0.71
Gaoping district	0.63
Jialing district	0.47
Nanbu County	0.28
Yingshan County	0.12
Pengan County	0.12
Yilong County	0.35
Xichong County	0.21
Liangzhong city	0.37

Table 3　Ecological civilization construction level classification and evaluation

level	Evaluation index	Evaluation result
1	>0.75	100
2	0.50-0.75	90
3	0.25-0.50	80
4	<0.25	60

Table 3 shows combined classification, the level of ecological civilization construction and Gaoping District ShunQingOu better level of ecological civilization construction Jialing District, Langzhong, Sichuan, Sichuan and Nanbu County in general, West County, Peng Yingshan County and poor construction of ecological civilization level.

AHP method steps according to the index system and the evaluation of ecological civilization construction, the weighted average of each sub-goals rule level experts constituted scale value pairwise comparison matrix A3 × 3. Use Matlab software to calculate the matrix λ_max = 3.018, CI = 0.009, RI = 0.580, CR = 0.016, matrix through consistency test, the calculated maximum eigenvalue matrix corresponding normalized feature vector α = (0.1219, 0.3196, 0.5584). Which

shows that the guidelines layer of pollution control for the construction of ecological civilization Nanchong influence weight of 0.1219, for the construction of ecological civilization Nanchong affecting the right to environmental protection weight of 0.3196, economic and social development of ecological civilization Nanchong influence weight of 0.5584.

Comprehensive evaluation index calculated here need the help of the calculated overall objective criterion layer on layer of heavy weight and Table 1 in the index weight, using the following calculation formula:

$$\text{ESI} = \sum_{j=1}^{5} a_1 w_j + \sum_{j=6}^{11} a_2 w_j + \sum_{j=12}^{15} a_3 w_j$$

Which a_1, a_2, a_3 are pollution control, environmental protection and economic and social development of ecological civilization Nanchong affect weight, the conclusion that the construction of ecological civilization Nanchong City, the total level of comprehensive evaluation index ESI = 0.34, ecology Nanchong the general level of civilization.

(1) from each of the evaluation indicators, air quality compliance rate environment, the utilization of industrial solid waste disposal, urban green area and the rate of urbanization is affecting the level of ecological civilization construction of Nanchong City, the most important of the four indicators. Wherein the weight ratio of the ambient air quality standard is 0.1763, it is the highest of all the indicators, their impact on the construction of ecological civilization maximum Nanchong City. Followed by the disposal and utilization of industrial solid, weight is 0.1665, the level of importance of ecological civilization construction of Nanchong City after air quality compliance rate environment. Urban green area weight of 0.1421, its impact on the construction of ecological civilization Nanchong City ranked third. The urbanization rate level impact on the construction of ecological civilization Nanchong City ranked fourth, weight is 0.1361.

(2) From Nanchong City, three districts under the jurisdiction of five counties and one city, the level of construction of ecological civilization have six counties (districts, municipalities) to achieve "normal" or more. Among them, ShunQingOu highest ecological civilization construction level, the comprehensive index is 0.71, have reached the "good" level of construction. Construction of the level of ecological civilization West County, Pengan and Yingshan minimum, comprehensive evaluation index of about 0.21,0.12 and 0.12, are "poor" level of construction.

Conclusion

The methods described herein with reference to the construction of the main indicators of national and ecological county in Sichuan Province, built ecological civilization construction evaluation index system of 15 indicators Nanchong City a total of three targets, using AHP and Entropy Combination of Nanchong City in 2013 and three districts under the jurisdiction of the level of ecological civilization construction five counties and one city were out of style quantitative evaluation, the results have a certain rationality and feasibility. But the construction of ecological civilization is a complex task involves many economic, environmental, institutional, cultural and social factors, the weight calculation in AHP and entropy method have mang binding manners, thus establishing a more comprehensive evaluation of ecological civilization construction system, strengthening the AHP and entropy method or in combination with other empowerment law, also require subsequent further study.

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