Study on Eco-environmental Evaluation of Southwest Frontier Ethnic Areas Based on SWOT-AHP

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Abstract. The article uses the SWOT analysis framework to analyze the advantages, disadvantages, opportunities, and threats of the environment in the ethnic minority areas of the Southwest Frontier, then judges the importance of each dimension of influence in the SWOT. In order, the environmental governance model of the southwest ethnic region was put forward, and strategic choices were made for the environmental governance of the southwest ethnic region.

1. Introduction
In recent years, the advancement of the “Belt and Road” initiative has prompted southwestern border areas such as Yunnan and Guangxi to become the frontier channels and geographically advantageous areas in Southeast Asia. The frequent flow of people, logistics, and information has made environmental issues in the southwest borderland increasingly prominent. Although a lot of measures have been adopted in recent years to promote the healthy development of the ecological environment, the area still faces many environmental challenges. This article analyzes the strengths, weaknesses, opportunities, and threats affecting the southwestern ethnic border areas to build a SWOT model, then uses the AHP method to assign values and prioritize the weights of factors that affect the environment.

2. SWOT analysis of environmental assessment
The SWOT analysis model was proposed by the American scholar Wake. Its main point is to list the influencing factors related to the research topic and divide them into “Strength, Weakness, Opportunity, and Treats”. An analysis model consisting of four dimensions, and using this model to analyze the strengths, weaknesses, opportunities and threats that affect the environmental assessment in the southwestern border ethnic areas, construct a SWOT environmental assessment model, and lay the foundation for the next AHP analysis.

2.1. Internal Advantage Analysis (S)
Southwest Frontier Ethnic Areas are rich in overall environmental resources, diverse in geological and geomorphological structure, and unique in nature and environment. Abundant water resources, high forest coverage, and high annual sunshine hours.
2.2. *Internal Vulnerability Analysis (W)*

The effective irrigation rate of farmland is low, the soil pollution index is high, the comprehensive index of rice pollution per hectare is high, the fertilizer utilization rate is generally high, the cultivated land per capita is generally less, and the comprehensive index of agricultural water pollution is higher.

2.3. *Analysis of External Opportunities (O)*

Since the Belt and Road Initiative, national policies have begun to vigorously support policies to protect the ecological environment in the southwestern border region. At the same time, local governments have actively assisted and supported the management, continuously reformed management mechanisms, continuously improved environmental assessment technology and capabilities, and provided substantial subsidies to the state and local governments. Farmland can be cultivated and nurtured.

2.4. *External threat analysis (T)*

Due to its special geographical location, the southwestern frontier region is connected to the surrounding environment and geographical environment. However, due to the development of neighboring countries, the concept and system of environmental protection are different. Therefore, it is easy to cause spillover of the surrounding environment to the ecological environment of the southwestern frontier. Potential threat.

To sum up, the environmental assessment in the southwestern ethnic region is composed of four dimensions: internal advantages, internal disadvantages, external opportunities, and external threats, and each dimension is composed of corresponding indicators. As shown in the following table:

| Table 1. Hierarchical analysis structure of ethnic regions in the Southwest Frontier. |
|-----------------|-----------------|-----------------|
| Target layer | Criterion layer | Indicator layer |
| Southwest Frontier Ethnic Regions Environment Evaluation | A1 Internal Advantage (S) | A11 Rich environmental resources |
| | | A12 Diversity of geological environment |
| | | A13 Abundant water resources |
| | | A14 Forest coverage rate |
| | | A15 Annual sunshine hours |
| | A2 Internal Disadvantage (W) | A21 Soil pollution index |
| | | A22 Fertilizer use rate |
| | | A23 Per capita arable land |
| | | A24 Agricultural water pollution ratio |
| | A3 External Opportunity (O) | A31 One Belt One Road Policy |
| | | A32 Frontier political policy |
| | | A33 Frontier fiscal policy |
| | A4 External threats (T) | A41 Great economic development in neighboring countries |
| | | A42 Differences in surrounding environmental protection |

3. **Weight assignment based on AHP method and its priority**

After the environmental assessment model for the southwest frontier ethnic region is determined, the indicators in the model must be weighted and prioritized in order to observe the environmental
assessment level more clearly and intuitively. In this study, the AHP method (also known as the analytic hierarchy process) is used to assign index weights. The AHP method can express complex problems using a hierarchical model. Based on the quantitative description on the basis of qualitative analysis, the weight assignment of each factor in the intuitive observation model and relative importance, and finally provide quantitative basis for decision makers. Specific to this study, the basic ideas are as follows:

3.1. Construction of judgment matrix
To form a scientific and reasonable judgment matrix, first, 13 experts with knowledge and experience were invited to make a comparison based on the relative importance of each factor to construct a judgment matrix. In the process of constructing the judgment matrix, T. Starr’s 1-9 ratio scaling method (relative importance ranking table) is introduced to assign relative importance to the relative importance of two factors relative to a certain criterion and shape. The idea of transformation is converted into a quantified operating value, and the importance of the two factors that are compared with each other is analyzed and judged by specific values. The two factors can be judged whether they are good or bad. T. Star's 1-9 ratio scale is shown below:

| Scale | Means |
|-------|-------|
| 1     | Indicates that two factors are of equal importance compared. |
| 3     | Indicates that two factors are slightly more important than the other. |
| 5     | Indicates that two factors are significantly more important than the other. |
| 7     | Means that two factors are more important than the other. |
| 9     | Indicates that two factors are extremely important compared to the other. |
| 2, 4, 6, 8 | Median value of the above two adjacent judgments |
| reciprocal | The factor i and j are compared to determine bij, then the factor i and j are compared to judge bij = 1 / bij |

(Source: T.L. Saty. Analytic Hierarchy Process—Application in Resource Allocation, Management and Conflict Analysis [M]. Beijing: Coal Industry Press, 1988 Edition)

According to T. Starr’s 1-9 ratio scale table, the importance of each index in the criterion layer is relatively compared. The comparison structure is the judgment matrix, which can be expressed by A:
Each element $a_{ij}$ in the matrix $A$ represents a proportional scale of the relative importance of the column index $Ai$ to the row index $Aj$. If $a_{ij} < 1$, it means that $Ai$ is more important than $Aj$; $a_{ij} = 1$, it means that $Ai$ and $Aj$ are equally important; $a_{ij} > 1$, it means that $Aj$ is more important than $Ai$.

### 3.2. Hierarchical single ordering and consistency check

After the judgment matrix is established, the weighting of each factor begins to be calculated, that is, single-level hierarchy. For an indicator element of the target layer or the criterion layer, the weighting of all factors on the next level is assigned and prioritized. Finally, all factors on each level are obtained. Importance and ranking. The values of each indicator reflect the understanding of the relative importance (pros and cons, preferences, strengths, etc.) of each factor in each level of quantification. Finally, the hierarchical total sorting is performed based on the data of single sorting at each level, and the final total sorting result is the weight assignment and priority ranking of each factor affecting the competence model of township cadres in the border region of Yunnan.

The basic calculation problem of the analytic hierarchy process is how to calculate the corresponding feature vector of the judgment matrix. The commonly used mathematical methods include "square root method", "power method" and "sum product method". This paper intends to use the root-of-squares method, taking the judgment matrix $A$ as an example, to describe the weighting process and prioritization process of $A_1$ (internal advantage), $A_2$ (internal disadvantage), $A_3$ (external opportunity), and $A_4$ (external threat).

1. **Calculate the geometric mean of all elements in each row of the judgment matrix**

The geometric mean, $\bar{a}_i = \sqrt[n]{a_{i1} a_{i2} \cdots a_{in}}$, $i = 1, 2, \ldots, n$

Get $\bar{a}_i = Y_1^{\left[\begin{array}{c} \omega_1 \\ \vdots \\ \omega_n \end{array}\right], \omega_i}_{1,2,\ldots,n}$

Normalize $\omega$, Calculate,

$$\omega_i = \sum_{j=1}^{n} \bar{a}_{ij}$$

2. **Calculate the maximum eigenvalue of the judgment matrix, $\lambda_{max}$**

$$\lambda_{max} = \sum_{i=1}^{n} \left( B\omega \right)_i$$

Where $\left( B\omega \right)_i$ is the i-th element of vector $B\omega$.

3. **Inspection consistency**

The consistency check is performed to determine the satisfactory consistency of various factors. The formula for calculating the consistency index is:

$$C.R. = \frac{C. I.}{R. I.}$$

Where is the comparison matrix consistency index, $R. I$. Is the average random consistency index, and its value is obtained by
looking up the table (As shown in Table 3). When C.R. is less than 0.1, it can be judged that the hierarchical single-ranking result has satisfactory consistency. Only if the satisfactory consistency is met, the value will be scientific. Otherwise, you need to go back to the previous step and readjust the relative importance assignment and judgment matrix.

| Table 3. R. I. values of the multi-order comparison matrix. |
|----------------|----------------|----------------|----------------|----------------|----------------|
| Order          | 2              | 3              | 4              | 5              | 6              |
| R. I.          | 0              | 0.52           | 0.89           | 1.12           | 1.26           | 1.36           | 1.41           | ...

(Source: T.L. Saty. Analytic Hierarchy Process——Application in Resource Allocation, Management and Conflict Analysis [M]. Beijing: Coal Industry Press, 1988 Edition: 57.)

3.3. Weight assignment and ranking
According to the above calculation method, 4 digits after the decimal point are retained to obtain the relative weight and ranking of the target layer A. Among them, CR <0.1, it can be judged that the hierarchical single ordering is satisfactory consistency, as shown in the following table:

| Table 4. Assignment and ranking of A weightings. |
|-----------------------------------------------|
| Environmental Evaluation of Southwest Frontier Ethnic Areas (A) | A1 | A2 | A3 | A4 |
| A1 | 1 | 1/3 | 1/3 | 1/5 |
| A2 | 3 | 1 | 1 | 1/2 |
| A3 | 3 | 1 | 1 | 1/2 |
| A4 | 5 | 2 | 2 | 1 |

(Note: Imax = 4.004; CI = 0.001; RI = 0.9; CR = 0.002)
According to the analysis in the table above, CR = 0.002, less than 0.1, and has satisfactory consistency. Among them, the internal advantage has the highest weight, with a weight of 0.4486, ranking first; followed by the external opportunity, with a weight of 0.2348, ranking second; and finally, the internal disadvantage, with a weight of 0.0819, ranking fourth. It can be concluded that the internal advantages and internal opportunities of environmental assessment in the southwestern frontier ethnic regions are more important. During the evaluation process, attention should be paid to these two dimensions of assessment. At the same time, internal disadvantages and external threats can be effectively avoided, especially in frontier ethnic regions relatively lagging development, long border lines, many hot spots in neighboring countries, and instability in the surrounding areas.

4. Summary
Comprehensive environmental management has been continuously strengthened, and greening construction needs to be further improved. In light of the needs of ethnic regions, the industrial structure must be further optimized to improve energy efficiency. At the same time, it is necessary to improve the government's public service capabilities, clearly implement its responsibilities, conduct regular supervision, and strictly conduct environmental assessments in ethnic areas.

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