Analysis of Forest Assessment Indicators Based on Hierarchical Analysis

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Abstract: Based on the 19th National Congress, the country put forward the strategic plan to accelerate the reform of ecological civilization system, promote green development and build a beautiful China, of which forest value is an important part of ecological civilization construction. This paper establishes a forest assessment model through hierarchical analysis, dividing the forest assessment model into three assessment sub-models according to the classification of forest value, i.e., from three levels: ecological environment, economic benefits and social culture. These three levels will be further divided into a number of indicators for analysis, and finally all the reference indicators will be aggregated to obtain a rating system applicable to developed forests, so as to develop appropriate forest management plans from three major aspects to create more economic benefits and spiritual wealth to meet the needs of the country, and also to provide forest managers with a better transition from the existing to the future by developing reasonable forest management plans. This will enable China to advance the construction of ecological civilization and green development in the future.

1. Introduction

Based on the 19th National Congress, the new pattern of ecological civilization has risen to an important strategic position, and the country needs to vigorously develop green and build ecosystems. For human beings, the ecological civilization of forests is important, and forest managers need to vigorously develop the economic benefits of forests based on the social culture of forests and promote forest ecological service systems to form a benefit chain. Based on this, this paper focuses on the level of forest assessment indicators, systematically sorting out the analysis of the three major levels of forest economic benefits, ecological environment and social culture, so as to analyze and develop appropriate forest management plans, improve the economic value of forests, promote the construction of national forest ecological civilization, and meet the new pattern of ecological civilization.

2. Forest Assessment Indicator Model

3. Forest Assessment Indicators

In addition to the forest's ability to sequester carbon, other factors need to be taken into account in the assessment of forest indicators, and additional considerations are needed to propose a decision model and help us identify which forests perform better in our decision model and then incorporate them into the proposed management plan.

A more complete forest value assessment framework system includes not only tangible assets but also intangible assets, including both stock and flow values, and requires more consideration of the value of material goods and ecological services provided by forests to humans.

We can divide the goal of finally designing the best forest management plan into three sub-goals, i.e., striving for the best management plan in each of the three aspects: ecological environment, economic benefits, and social culture. At the ecological environment level, according to Wang Hongwei's information [3], we simply know that we can divide the indicators of ecological environment into five indicator aspects: carbon sequestration and oxygen release, biodiversity, soil utilization, water conservation, and soil fertilization; at the economic benefits level, through the information of Huang Ying [4] and Chen Yongfang [5], we can divide the indicators into forestry resources, educational output, scientific and technological achievements, tourism, the peripheral products, and ecological construction harvest six index aspects; in terms of social culture, according to the data analysis proposed by Wang Xun [2], we simply divide the social and cultural indicators into five index aspects of leisure tourism value, historical and geographical value, scientific research and education value, aesthetic and artistic value, and traditional customs value.
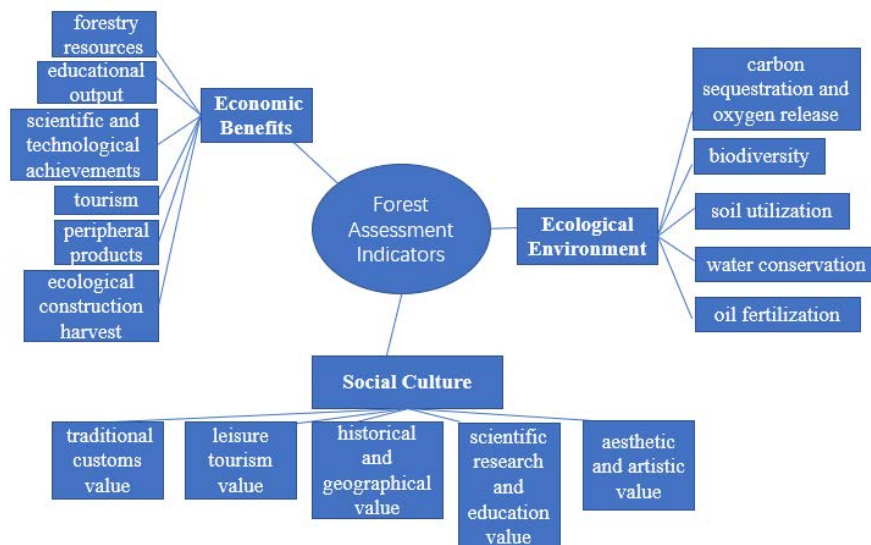

Figure 1: Classification of forest assessment indicators

4. Hierarchical Analysis Evaluation

Before assessing forest indicators, it is necessary to first clarify the importance of each indicator and determine the weight of each indicator based on the level of importance [6]. The weight of the indicator reflects the role of each factor in the evaluation and decision-making process, and the determination of the weight of the indicator is related to the selection of the forest management plan

solution, as well as determining the indicators of the structure of each objective function [7]. The main methods of determining indicator weights are: hierarchical analysis (AHP), fuzzy judgment matrix method, Delphi (Delphi), principal component analysis, entropy method, etc. [8]. Hierarchical analysis method is a subjective assignment method, which is easy to apply, and this paper uses hierarchical analysis method to calculate weights.

For the economic benefit level, the judgment result values are expressed in a matrix, where a1 represents forestry resources, a2 represents educational output, a3 represents scientific and technological achievements, a4 represents tourism, a5 represents peripheral products, and a6 represents ecological construction harvest. Combining their assessment judgments of the forest yields the judgment matrix:

$$
\begin{bmatrix}
1 & 3 & 5 & 1 & 3 & \frac{1}{3} \\
\frac{1}{3} & 1 & 2 & \frac{1}{4} & 1 & \frac{1}{6} \\
\frac{1}{5} & \frac{1}{2} & 1 & \frac{1}{6} & \frac{1}{3} & \frac{1}{7} \\
1 & 4 & 6 & 1 & 4 & \frac{1}{2} \\
\frac{1}{3} & 1 & 3 & \frac{1}{4} & 1 & \frac{1}{3} \\
3 & 6 & 7 & 2 & 3 & 1
\end{bmatrix}
\tag{1}
$$

The weight value of a1 is 0.1893, the weight value of a2 is 0.0655, the weight value of a3 is 0.0369, the weight value of a4 is 0.2296, the weight value of a5 is 0.0821, and the weight value of a6 is 0.3966, as calculated by MATLAB editing.

For the ecological environment level, according to Geng Jianxin's study [1], this paper sets b1 to represent water connotation, b2 to represent soil conservation, b3 to represent carbon sequestration and oxygen release, b4 to represent nutrient accumulation, and b5 to represent biodiversity, while combining with Geng Jianxin's [1] study on the contribution value of ecological environment, it can be seen that this paper can compare the five indicators on the ecological environment level can synthesize the judgment matrix:

$$
\begin{bmatrix}
1 & 4 & 5 & 7 & 5 \\
\frac{1}{4} & 1 & 3 & 7 & 3 \\
\frac{1}{5} & \frac{1}{3} & 1 & 5 & 2 \\
\frac{1}{7} & \frac{1}{7} & \frac{1}{5} & 1 & \frac{1}{5} \\
\frac{1}{5} & \frac{1}{3} & \frac{1}{2} & 5 & 1
\end{bmatrix}
\tag{2}
$$

The weight value of b1 is 0.5152, the weight value of b2 is 0.2329, the weight value of b3 is 0.1233, the weight value of b4 is 0.0343, and the weight value of b5 is 0.0943, as calculated by MATLAB editing.

For the socio-cultural level, through Wang Xun's research [2], the judgment result values are expressed in a matrix, where c1 represents leisure tourism value, c2 represents historical-geographical value, c3 represents scientific research and education value, c4 represents aesthetic and nurturing art value, c5 traditional custom value, and the judgment matrix is derived by combining the value quantity:

$$\begin{bmatrix} 1 & \frac{1}{5} & \frac{1}{7} & 3 & 3 \\ 5 & 1 & \frac{1}{3} & 5 & 5 \\ 7 & 3 & 1 & 7 & 7 \\ \frac{1}{3} & \frac{1}{5} & \frac{1}{7} & 1 & 1 \\ \frac{1}{3} & \frac{1}{5} & \frac{1}{7} & 1 & 1 \end{bmatrix} \tag{4}$$

The weight value of c1 is 0.1007, the weight value of c2 is 0.2760, the weight value of c3 is 0.5232, the weight value of c4 is 0.0500, and the weight value of c5 is 0.0500, as calculated by MATLAB editing.

5. Sensitivity Analysis of Model Parameters

In Model 2, the forest assessment model analyzes three aspects, namely, ecological environment, economic benefits and social culture. Since ecological environment and social culture can be assessed by information query, but the uncontrollability of certain factors in economic benefits, such as two not very important indicators for educational output and technological output, for example, two important indicators for tourism income and ecological construction income, we adopted the control variable method to adjust the rating of these indicators up or down to look at the indicators on the assessment of economic benefits in a comprehensive manner.
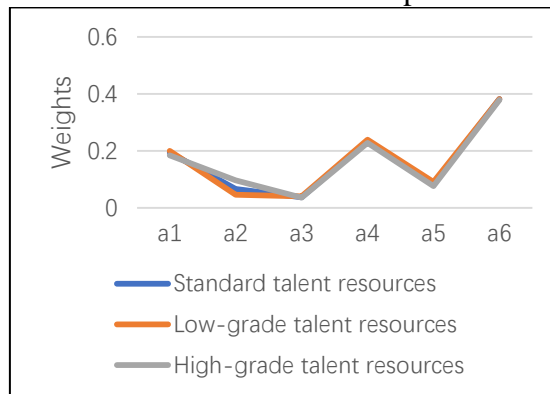

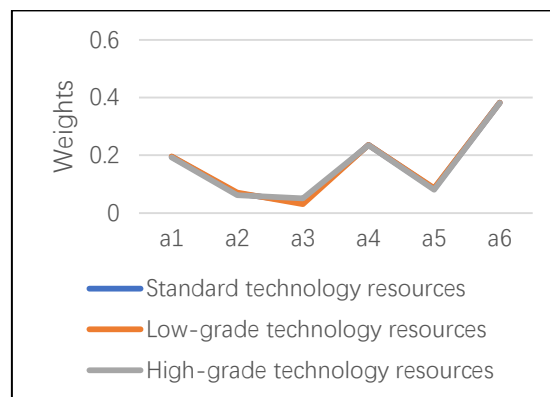*Figure 2: Sensitivity analysis of talent resource*

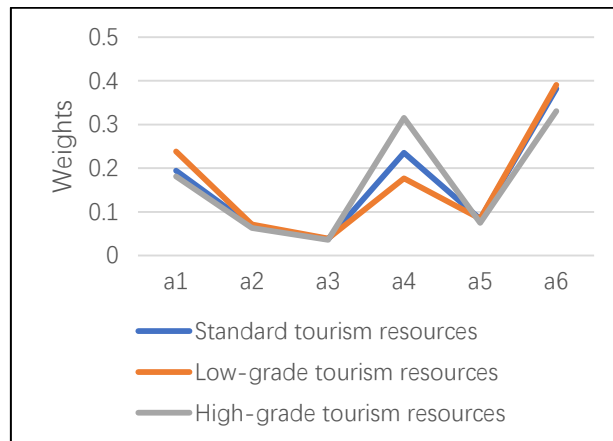*Figure 3: Sensitivity analysis of technological resource*

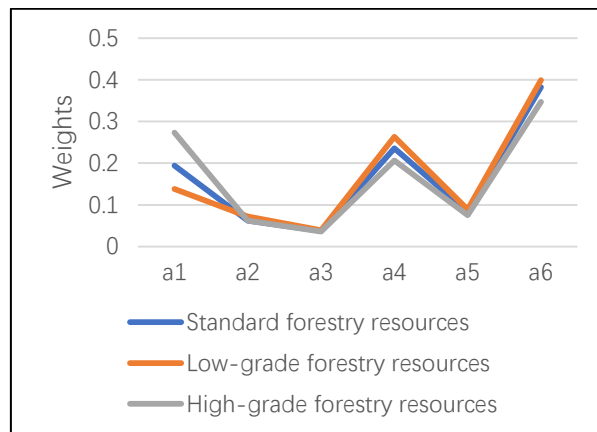*Figure 4: Sensitivity analysis of forestry resource*

Figure 5: Sensitivity analysis of tourism resources

The results of the two not very important indicators can be known, although a_2 and a_3 have some influence on other indicators, but the degree of influence is not very large, and even its weight value can be replaced by the original value, but the weight value on a_6 is the largest, so it may not affect the effect, but the final result is that the sensitivity of the model can be proved to be good.

From the results of the two important indicators can be known, in the time of raising or lowering the rating of this indicator, it is found that the weight values have changed significantly, although it is known that the weight value of a_6 is still very maximum, but we can know that the change in their weight values is only for itself, there is not much impact on the other weight values, so that when calculating economic returns, the function simulation will be more dependent on its own weight values, which can also indicate the good sensitivity of the model.

6. Forest management plan based on forest assessment model

6.1 Design of Forest Management Plans

First of all, we need to pay attention to the forest ecology protection and measures, on the one hand, we should plant more trees to increase the water storage of the forest, on the other hand, we should also pay attention to the changes of the soil and timely fertilization and adjustment to ensure

the balance of carbon sequestration and oxygen release, consider the whole forest ecosystem, to ensure the biological diversity. Secondly, we should improve the economic profit of the forest, on the one hand by increasing the income from tourism and forestry products, but also pay attention to our protection of the forest, on the other hand we can promote the economy of the forest by strengthening people's educational significance and technical contribution to the forest. Finally, we need to explore the socio-cultural value of the forest, we can increase people's awareness of the forest based on forest festivals and promote people's contribution to the forest based on its culture of faith.

However, we have established a more complete forest assessment model, and when we use the model to assess the rest of the forest, we need enough data to support the completion of the calculation, so the decision model is applicable to developed forests, for example, forest managers have to make a series of management of the forest under the premise of affecting the normal growth of the forest, then there will be enough data and characteristics to support our calculation and assessment, so the management scope of the decision is developed forests.

Through Deng Xiaoxian's cultural theory [9] and the socio-cultural perspective of the hierarchy analysis, there is the phenomenon of the forest as a human belief, when the forest manager should maintain the freedom of the forest as much as possible, let it grow freely and stop logging, and respect the spiritual life of the local residents. After Chen Jingqiang's reminder [10], there is also the fact that the forest is extremely rare and its growth cycle is slow, so forest managers need to reduce the risk, avoid logging and protect the natural growth of the forest.

The applicability of the forest assessment model to all forests is based on the selection of age-appropriate forests for deforestation to obtain economic benefits. Therefore, for different types of forests, individual adjustments to the deforestation scheme can ensure the generality of the forest assessment model, i.e., the transition point is the deforestation scheme of the forest, and different deforestation schemes can be specified in different situations based on each country's forest management plan.

6.2 Impact of Forest Management Plans

For short-term impacts, in countries where forest management is still under construction or where the forest area is below the international average, short-term forest management plans are designed to help forest managers lay the foundation for managing forests, such as educating local people about forest management and actively planting trees to expand the base forest area. For long-term impacts, if the entire forest system is well developed and the forest area allows for human intervention in forest growth, then a forest management plan can be used to promote smooth forest growth while directly benefiting human life from the forest.

7. Conclusion

This paper is based on the hierarchical analysis method, in which three levels of economic benefits, ecological environment and social culture are analyzed separately, so that the results of the three analyses can be integrated to create a forest value assessment indicator system. The final forest management plan is designed based on these three levels, and the weighting of each forest assessment indicator affects the focus on certain indicators at that level. Therefore, this paper focuses on the weighting of the assessment indicators at each level to weigh the importance of the approach and then develop a better and appropriate forest management plan in that case, while comparing the current forest management plan with the management plan to help forest managers

make the best judgment and better transition to the management plan.

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