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Research Article

Sustainable Management Research on Forestry Resource in Jiangxi Province

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Abstract: Sustainable development is a priority research areas for technology philosophy in contemporary China. This article takes forestry resource in Jiangxi as the research object, collects data of forest resource in 2001and 2010, combines with previous research results of forestry sustainable development evaluation index, finally establishes evaluation indicators for sustainable forest resource management referring to a large number of literatures on the previous study. Secondly, using AHP method to carry out the forestry sustainable development comprehensive evaluation, which has extremely important and practical significance to scientifically determine the region forestry resource management, reasonably plan sustainable forest management measures and promote local forestry sustainable development and sustainable management.

Keywords: AHP, forestry resource, sustainable management

INTRODUCTION

Sustainable development is a priority research areas for technology philosophy in contemporary China and its core values as well as the criticism on environmental and development issues has become a common consensus to various social strata of China (Chen and Cheng, 2014; Liu, 2007). With the development of industrial revolution in early 20th century, the fact that forest resources were explored excessively has become a serious problem, which has been a threat to society development and citizen survival (UNDP (United Nations Development Programme) 2011). Forestry is the important foundation of economic and social sustainable development and is the main part of the ecological construction. Forestry sustainable development has the particular status (National Forestry Department, 2010). Forestry sustainable development has put forward in world environment and development conference the 1992. The concept of sustainable development has been deepened into each aspect, which has been put as one of national policy in China. State-owned forest farm is the main part of the forestry construction and sustainable development in China, which undertakes the important task of the cultivation of forest resources and ecological environment construction, therefore, forestry sustainable development is the foundation of realizing forestry sustainable development (Yao, 2008). Nowadays, all countries are studying and researching criteria and indicators for sustainable forestry management system, while only few studies focus on the forestry farms sustainable development (Chansarn, 2014).

On this basis, this article takes forestry resource in Jiangxi as the research object, collects data of forest resource in 2001 and 2010, combines with previous research results of forestry sustainable development evaluation index, finally establishes evaluation indicators for sustainable forest resource management referring to a large number of literatures on the previous study. Secondly, using AHP method to carry out the forestry sustainable development comprehensive evaluation, which has extremely important and practical significance to scientifically determine the region forestry resource management, reasonably plan sustainable forest management measures and promote local forestry sustainable development and sustainable management.

MATERIALS AND METHODS

Construction of evaluation indexes: The selection of indicators need to consider many factors. There are three goals, economic, society and ecology, which are needed for realizing forestry resource sustainable development strategy: Forestry economy achieves sustainable growth and constantly injects new development funds for the local economy, increases the local employment, improves the local infrastructure conditions, which is economic goal for sustainable development of forestry resource. Improving the forestry district standard of living, strengthening security of the local farmers are social goal for the forestry resource sustainable development .Increasing the forest coverage rate and volume, increasing the soil and water loss management and improving residents living environment are the ecological goa (Luo and Liu, 2009).

Table 1: Sustainable forestry management indicators building (Liang *et al*., 2010; Xie, 2011)

System layer	State layer	Index layer	Target layer	Standardized value 2001	Standardized value 2010	Entropy	AHP	Entropy-AHP	Evaluation 2001	Evaluation 2010
Ecology sustainable index A1	B1.Forestry resources ustainable index	C1Forestry category structure	87.4:12.6:0①	0.211	0.962	0.107	0.116	0.1115	0.0204	0.107
		C2Forestry age structure (%)	25②	1	1	0.037	0.06	0.0485	0.049	0.044
		C3Utilization rate of forestry land (%)	87.4①	0.784	0.935	0.047	0.091	0.069	0.054	0.06
		C4Ability to resist inspects (%)	1②	0.071	0.153	0.039	0.058	0.0485	0.003	0.008
	B2. Ecology benefit sustainable index	C5.Forestry coverage rate (%)	63①	0.749	1	0.043	0.043	0.043	0.032	0.043
		C6Proportion of ecological public welfare forestry (%)	80②	0.83	1	0.015	0.046	0.0305	0.025	0.031
		C7.Forestry volume (M3)	5①	0.584	0.79	0.032	0.028	0.03	0.018	0.024
		C8Biodiversity index	25.9③	0.8	1	0.013	0.013	0.013	0.01	0.013
		C9SHUITUBAOCHI (%)	95①	0.421	1	0.009	0.01	0.0095	0.004	0.001
Economy sustainable indexA2	B3. Economy level sustainable index	C10Forestry output value/GDP (%)	7.69③	0.666	1	0.033	0.038	0.0355	0.024	0.036
		C11Asset-liability ratio (%)	50.5③	0.832	0.922	0.093	0.04	0.0665	0.055	0.061
		C12.Average revenue for farmers	10000①	0.223	0.646	0.069	0.024	0.0465	0.01	0.03
		C13Average land output rate (m^3/Mu)	63①	0.85	0.974	0.064	0.011	0.0375	0.032	0.037
		C14Forestry land output value per hm^2	1130③	0.182	0.466	0.008	0.008	0.008	0.001	0.004
	B4. Economy benefit sustainable index	C15Average salary for forestry workers	20353③	0.301	0.952	0.098	0.077	0.0875	0.026	0.093
		C16Investment-output ratio (%)	13.3③	0.5	0.971	0.043	0.063	0.053	0.027	0.047
	B5.Life standard improved index	C17 Engel's coefficient (%)	45②	0.788	0.97	0.047	0.029	0.038	0.03	0.037
Society sustainable indexA3		C18 House area per people	25②	0.232	0.728	0.057	0.051	0.054	0.013	0.039
		C19Medical service index	28.31②	0.333	0.795	0.018	0.023	0.0205	0.007	0.016
	B6.Society improvement index	C20Increase rate of population (%)	5③	0.533	0.653	0.018	0.04	0.029	0.0155	0.019
		C21 Average education year of workers	9②	0.456	0.84	0.019	0.031	0.025	0.011	0.022
		C22 forestry area per people	2.117③	1	1	0.036	0.06	0.048	0.048	0.048
	B7Technology management index	C23Technology level (%)	50③	0.4	0.68	0.032	0.016	0.024	0.01	0.016
		C24.R and D investment/GDP (%)	0.34③	0.25	0.318	0.023	0.024	0.0235	0.006	0.007

In view of this study, forestry resource sustainable management evaluation indicators are divided into 3 layers: target layer, state layer and index layer (Table 1).

ONSTRUCTION OF THE EVALUATION MODEL

Considering that there is a strong interaction between the subsystems and that sustainable development emphasizes the coordinated development between indices in forestry resources sustainable development, the index weighting evaluation model is used to calculate comprehensive evaluation values of the sustainable development of forestry resources sustainable development of the indicators at all levels. The model expression is:

$$A = (P_1^{W1} * P_2^{W2} * ....P_n^{Wn})^{\frac{1}{\sum Wi}}, i = 1,2,...n \tag{1}$$

where in,

A = The integrated evaluation index of one factor in this layer

n = The numbers the factor includes

wi = The weight of index i

Pi = The evaluation value of index i (Table 2)

Table 2: The level division of sustainable development

Comprehensive Score	Sustainable level	Basic Description
0.90~1	Ⅰ	Totally sustainable state or strongly sustainable state
0.80~0.90	Ⅱ	Sustainable state
0.60~0.80	Ⅲ	Basically sustainable state
0.40~0.60	Ⅳ	Weakly sustainable state
0.40以下	Ⅴ	Non-sustainable state

Calculation process:

Index standardization process: Target value index method is used to do standardized process. The target value is indicated in Table 1. Z = Index evaluation value, P = Real value, S = Reference value. For positive value, Z = P/S; when evaluation value is bigger than target value, Z = 1; For negative value, Z = S/P; when evaluation value is smaller than target value, Z = 1.

Weighting calculation: The weighting calculation was done by adopting a combination of the subjective and objective entropy-AHP method (Guiping, 2007; Lu *et al*., 2000; Xiaofang, 2010).

Using the analytic hierarchy process to determine the subjective weight: AHP is a decision-making method that break the elements related to the decision into several layers, such as objectives, principles and schemes, to make qualitative and quantitative analyses. There were some shortfall in the weight calculation during the past study, however and improvement is needed. Therefore, the volume method is adopted when determining the weight:

- Standardized judgment matrix:

$$\overline{b_{ij}} = \frac{b_{ij}}{\sum_{i=1}^{n} b_{ij}}, i, j = 1,2,...,n$$

- Add the standardized matrix according to line:

$$\overline{W_i} = \sum_{j=1}^{n} \overline{b_{ij}}, i, j = 1,2,...n$$

- Standardized weight matrix *W*:

$$W_i = \frac{\overline{W_i}}{\sum_{j=1}^{n} \overline{W_j}}, i, j = 1,2,...n$$

- Calculating the matrix maximum characteristic root, $\lambda_{\max}$:

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^{n} \frac{BW_i}{W_i}$$

- Judging the consistency of matrix:

$$CI = \frac{\lambda_{\max} - n}{n-1}$$

Then $W = (W_{1,} W_2,...,W_n)^T$ is the characteristic vector, namely the weight of each index. At this point, a consistency test for the matrix is needed.

Using the entropy weight method to determine the objective weight: In comprehensive evaluations, the traditional entropy weight method has been widely used in the sustainable natural resources development, such as animal, plant and land resources, due to its high credibility in determining weight value.

According to the definition of the entropy value method, the calculation process is shown as follows:

- Information entropy of the index *j* (Q_j):

$$Q_j = (-\frac{1}{Inn}) * (\sum_{i=1}^{n} P_{ij} * Inp_{ij})$$

- Different coefficient of index j (D_j):

$$D_j = 1 - Q_j$$

- Weight (Z_j) of the index *j*:

$$Z_j = \frac{D_j}{\sum_{j=1}^{m} D_j}$$

- Comprehensive value (W_{ij}):

$$W_{ij} = \sum_{j=1}^{m} Z_j * X'_{ij}$$

As a result, the comprehensive value is the entropy weight value.

Using the Entropy-AHP method to determine the final weight: To overcome the caveat of the AHP method's subjective randomness, the entropy weight W_{ij} is used to fix the weight coefficient obtained from the AHP method.
Its formula is:

$$w_j = \alpha(w_j') + (1-\alpha)(w_j''), (0 \le \alpha \le 1)$$

where in, w_j' is the weight determined by the improved AHP method, w_j'' is the weight determined by entropy weight method. The combination weight changes along with the change of α. When α = 1, it corresponds with the AHP method. When α = 0, it corresponds with the entropy weight method. There is much discussion on how to reasonably define the value of α. After comprehensive consideration, α = 0.5 (Liang *et al*., 2010).

The evaluation calculation: When the entropy-AHP weight values and various indicies of the 2005,2010 standard numerical values are inputted into the formula (1), the index layer evaluation of the wild plant resources sustainable development index system is computed. When the evalution and entropy-AHP weight values are inputted into the formula (1), the state layer evaluation is computed; Similarly, the target layer evaluation in this system can also be obtained.

RESULTS

Calculation result:

Comprehensive evaluation result of state layers: Forestry resource sustainable index was 0.2838 in 2001 and it was 0.6335 in 2010; Ecology benefit index was 0.6976 in 2001 and it was 0.9454 in 2010; Economics level index was 0.6544 in 2001 and it was 0.7090 in 2010; Economics benefit index was 0.3191 in 2001 and it was 0.5211 in 2010; Life standard index was 0.2563 in 2001 and it was 0.6887 in 2010; Society

Table 3: Comprehension evaluation value of forestry resource sustainable development

Content		Weight			Evaluation value	
		Entropy	AHP	Entropy-AHP	2001	2010
State layer	B1	0.230	0.311	0.2705	0.2838	0.6335
	B2	0.112	0.140	0.1260	0.6976	0.9454
	B3	0.267	0.121	0.1940	0.7090	0.6544
	B4	0.188	0.181	0.1845	0.3191	0.5211
	B5	0.075	0.073	0.0740	0.2563	0.6887
	B6	0.073	0.134	0.1035	0.7386	0.8543
	B7	0.055	0.040	0.0475	0.3042	0.5351
System index	A1	0.342	0.451	0.3965	0.3777	0.7194
	A2	0.455	0.302	0.3785	0.4804	0.5862
	A3	0.203	0.247	0.2250	0.4324	0.7210
Evaluation value	2001	2011				
	0.4265	0.6661				

improvement index was 0.7386 in 2001 and it was 0.8543 in 2010; Technology management index was 0.3042 in 2001 and it was 0.5351 in 2010.

All of the indexes statement was better between 2001 and 2010 and indexes which obviously changed were forestry resource index, economics index, life standard index, technology management index. Ecology benefit index was being totally sustainable statement in the last 10 years, which shown that ecology benefit in Jiangxi province is better; Society improvement index was being sustainable statement in the last 10 years.

Comprehensive evaluation result of system layers: According to formula (1), it can be calculated that A1 was 0.3771 in 2001 and it was 0.7194 in 2010; A2 was 0.4804 in 2001 and it was 0.5862 in 2011; A3 was 0.4324 in 2001 and it was 0.7210 in 2010. All of these indexes result were shown in Table 3.

Comprehensive evaluation result of forestry resource sustainable management: Comprehensive evaluation result of forestry resource sustainable management was 0.4265 in 2001 and it was 0.6661 in 2010. According to the result, forestry resource in Jiangxi was being weakly sustainable statement and it was being basically sustainable statement in 2010.

CONCLUSION

- The evaluation result is consistent with the specific management condition from investigation to forestry resource in Jiangxi province, which shows that the index system is reasonable and has a certain scientific nature and feasibility.
- Moreover, according to the analysis, it can be gotten that the main factors to improve forestry resource sustainable level are: forestry category structure, forest farm total production value, forestry land utilization rate, average wage income of workers per year, asset-liability ratio, average forestry area, the output value per unit woodland area, etc. Thus, to improve the state of forest resource sustainable management, it should emphasize from the above several aspects. The reasons for the improvement of sustainable management condition of Jiangxi forest resources mainly have the following aspects:
- The implementation of the natural forest protection project, the six major afforestation and soil and water conservation engineering, makes the forest resources management have transition from mainly on economic construction to ecological construction. The importance of forestry soil and water conservation, oxygen supplement and forest tourism have been paid attention, which makes the ecological function of the forest resources greatly enhanced.
- Under the support from the national and local government, population development and compulsory education policy have been gradually implemented, which makes the education level of forest resources workers and level of forestry science and technology improved obviously.
- **Development of under-forestry economics:** Development of under-forestry economics can increase the revenue of local forestry workers and government. It can not only decrease the cutting rate of timber, but can protect ecology public benefit forestry. Moreover, development of under-forestry economics can bring impact to forestry resource sustainable management through influencing forestry industry structure.

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