

Research Article

The Sustainable Development Research of Wild Plant Tourism Resources Based on the Entropy-AHP Evaluation Method

Jinglin Zhao and Yaowu Wang

School of Management, Harbin Institute of Technology, China

Abstract: In this study, the sustainable development evaluation index system of the wild plant resources in the GuangXi province is established based on the principles of scientific nature and operability, etc. Based on this evaluation index system and statistical data of GuangXi province from 2003 to 2011, comprehensive evaluation and analysis of the sustainable development condition of wild plant resources was carried out using the Entropy-AHP evaluation model and index weighting model. The results show that the sustainable development level has a steady upward trend, but the overall level is not high. The composite index of wildlife and habitat protection shows a rising trend while the comprehensive index change of economic resources is relatively stable. The comprehensive index of social development initially rises and then falls. Finally, some countermeasures have been put forward based on the results of this study, which has provided a theoretical basis for promoting the sustainable development of the wild plant resources in GuangXi and the country.

Keywords: AHP, entropy value method, evaluation, index weighting model, sustainable development

INTRODUCTION

China has provided excellent natural conditions for the formation and development of various types of biological and ecological systems due to its vast territory, varied climate, complex geographic conditions and its many rivers and lakes. In addition, it has also developed rich wild flora, making China a country that has the most types of wild plant resources and the most abundant biodiversity (Luo and Liu, 2009). The importance of wild plants can be seen in an assessment by the World Health Organization, which found that there are 80% of developing countries that mainly use traditional plant resources or their extracts as effective components in drugs, meaning there are 3 billion people that rely primarily on plants (The State Forestry Administration, 2010).

In both developed and developing countries, the management and utilization of unique species that have market potential have played a role in the country's economic development. In China, the cultivation and utilization of wild plants have become an important resource for production mode. However, due to huge economic interests, wild plants are facing the dual pressure of excessive use and a worsening environment for survival. This has caused a sharp drop in the number of species and resource reserves with a trend of further deterioration. According to statistics, China has nearly 4000 to 5000 threatened or endangered higher plant species, which accounts for 15-20% of the total number. There are 1009 kinds of endangered species,

accounting for 3.4% of the total number. Lastly, there are nearly 200 kinds of extinct species in China, which is 5-10% higher than the average world level (Luo and Liu, 2009).

The protection of plant resources in China has increased due to the implementation of national wildlife protection and construction of nature reserves. Remarkable achievements have been made in saving endangered species, building nature reserves, the origin of breeding and establishing genetic reserves (Chen Wenhui *et al.*, 2006). When looking at resource utilization, however, there is a more obvious contradiction between resource scarcity and the increasing rise in social demand. The rate of growth and way of growth of resources itself are extremely limited (Chen Wenhui *et al.*, 2006). Thus, it is important to encourage the development of wild plant cultivation and its rational utilization for the protection and management of wild plants in the near future. This will ensure that wild plant resources are continually developed for their ecological, economic and social benefits and it will promote a strategic shift from the primary use of wild resources to the use of artificially bred resources (Chen Wenhui *et al.*, 2006).

At present, the domestic research on wild plants utilization involves a wide range of disciplines, including ecology, botany and economics, among other fields. Scholars from different professions also analyze the use of wild plants and the present industrialization situation from different angles and starting points (Zhang Shibao *et al.*, 2011). Current research mainly

focuses on the sustainable development and utilization strategies for wild plants abroad (Zemedede Asfaw, 2001; Rao *et al.*, 2002; Satish *et al.*, 2003).

Zimbabwe is a country with rich wild plant resources. In order to promote the sustainable utilization of the local plant, *Moringa oleifera*, some policy suggestions have been put forward by Alfred Maroyi. For example, government should increase investment in wild plant use, provide technology support for the local people and promote the industrialization development of wild plant use (Alfred Maroyi, 2003). In a study conducted by the World Bank, the International Association of Mangrove Ecosystems (ISME) and the Centre for Tropical Ecosystems Research (cenTER Aarhus) on the sustainable management and utilization of mangrove forests, some strategies were put forward, including strengthening community cooperation and increasing promotion of local resident knowledge (World Bank *et al.*, 2005).

However, the studies on the utilization of wild plant resources at home and abroad mainly focus on qualitative statements while quantitative research is rarely reported. Without these data, laws on the sustainable development of these resources cannot evolve. Quantitative research on the relationship between the protection and utilization of resources is the basis for analyzing the current trend of sustainable development. Analysis of its overall trend is the precondition of sustainable development, which has important theoretical and practical significance for wildlife resource and habitat protection as well as maintaining ecological balance (Chang *et al.*, 2012).

This study is a case study of the GuangXi province. Based on access to large amounts of data, we develop the wild plant resources sustainable development index system and employ the entropy-AHP method and index weighting evaluation model to study the weight and comprehensive values of the target layer, state layer and the system layer. Moreover, the overall effect of the sustainable development of wild plant resources is analyzed and policy recommendations are suggested, which provide a certain theoretical basis for promoting the sustainable development of the wild plant resources in GuangXi, China.

DATA SOURCES AND EVALUATION METHODS

Data sources: The data is from the China Forestry Statistical Yearbook (National Forestry Department, 2003-2011), which includes 26 indicators, such as wildlife conservation and nature reserve construction in the GuangXi forests, basic situations in the forest workstations, the number of workers in the GuangXi forest regions, average wage of on-the-job workers, employee and labor remuneration according to the

industries, the complete investment situation, output value of the GuangXi forest calculated at current prices, the number of imports and exports of GuangXi wild plants, number of graduate students in forestry colleges and other forestry institutions in GuangXi and so on.

Evaluation methods:

The construction of the evaluation index system:

The first priority for the evaluation of the sustainable development of wild plants is to establish an evaluation index. By referring to the protection of wild plant resources and the standard and index system framework of sustainable development at home and abroad, the sustainable development evaluation system is built under the scientific, operational, representative and regional principles (Lu *et al.*, 2000; United Nations, 1996; Ma and Li, 2004; Maini, 1990).

The wild plant resources sustainable development index system is divided into target layer, system layer, state layer and index layer 4 (Table 1). The target layer describes the current trend of the sustainable development of wild plant resources of the whole situation; the system layer includes three subsystems: protection of wild plants and habitat (A1), social development (A2) and economic resources (A3). The state layer (B) decides the main steps of each subsystem and its eleven key components, such as wildlife habitat protection, construction of wild plant protection infrastructure and construction of professional protection infrastructure. The index layer (C) uses measured or available access indicators to conduct direct measurement on the performance and intensity of the state layer and includes 26 indicators, e.g., wildlife nature reserve areas, number of wild plant scientific research and testing institutions and wildlife import and export management fees.

Construction 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 wild plant resources sustainable development, the index weighting evaluation model is conducted to calculate comprehensive evaluation values of the sustainable development of wild plant resources sustainable development of the indicators at all levels.

The model expression is:

$$A = (P_1^{w1} * P_2^{w2} * \dots * P_n^{wn})^{\frac{1}{\sum w_i}}, i = 1, 2, \dots, n \quad (1)$$

wherein,

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

n = The numbers the factor includes

Table 1: The evaluation index of wild plants resources sustainable development

Target layer	System layer	State layer	Index layer	
The evaluation index of wild plants resources sustainable development	(A1) Wildlife and habitation protection	(B1) Wildlife habitat protection	(C1) Number of wild plants protection reserve	
			(C2) Area of wild plants protection reserve (10 thousand hm ²)	
		(B2) Nation protection and management ability	(B3) Grassroots protection	(C3) Accomplishment limit of wild plants protection reserve construction(million)
				(C4) The management number of wild plants protection station
			(B4) Infrastructure construction grassroots protection station	(C5) Wild plants import management fee (10 thousand Yuan)
				(C6) Wild plants export management fee (10 thousand Yuan)
				(C7) Number of new grassroots protection station
				(C8) Proportion of grassroots station with identification of wild plants protection
	(A2) Social progress and development	(B5) Wild plant scientific research and testing level	(C9) Proportion of grassroots station with own offices	
			(C10) Proportion of grassroots station with own transportation	
			(C11) The proportion of grassroots station with own communication facility	
			(C12) Number of wild plant scientific research and testing institutes	
		(B6) Wild plants protection professionals construction	(C13) Number of professionals	
			(C14) Professionals proportion of wild plants natural reserves construction / (%)	
			(C15) Professionals proportion of grassroots station/ (%)	
			(C16) Graduate number with wild plants protection major	
	(B7) Absorb social labor ability	(B8) On-the-job workers social welfare	(C17) Proportion of high-school education background in grass root station	
			(C18) Number of on-the-job workers in wild plants protection	
		(B9) Wild plant breeding	(C19) Number of on-the-job workers in natural reserves management	
			(C20) Number of workers in the other industry	
	(A3) Resources economics	(B10) Wild plants leisure and entertainment	(C21) Average salary per year of wild plants protection on-the-job workers	
			(C22) Average retirement salary per year of wild plants protection retired workers	
		(B11) Wild plants international trade	(C23) The number of Wild plants breeding station	
			(C24) The number of Wild plants parks	
				(C25) Wild plants import limit
				(C26) Wild plants export limit

Table 2: The level division of sustainable development

Comprehensive score	Sustainable development	Description
0.95~1	I	sustainable development
0.85~0.95	II	Middle level sustainable development
0.70~0.85	III	Primary level sustainable development
0.50~0.70	IV	Transition stage from traditional development to sustainable development
0.50	V	Traditional upward development

w_i = The weight of index i

P_i = The evaluation value of index i

For the total evaluation value, it is judged according to the standard of Table 2 (Zhou, 2007).

Index standardization process: In order to eliminate the influence of different index dimensions and unify the quantitative and qualitative indicators, an index standardization process is needed. The initial data matrix of N evaluation indices for M years is as follows:

$$X = (x_{ij})_{m \times n}, i = 1, 2 \dots n, j = 1, 2 \dots m \quad (2)$$

In order for the improved AHP method and Entropy Weight Method to be used at the same time, the following standardization method is used:

$$y_{ij} = x_{ij} / \sum_{i=1}^n x_{ij} \quad (3)$$

The result is a standardized evaluation matrix:

$$W = (w_{ij})_{m \times n}, i = 1, 2 \dots n, j = 1, 2 \dots m \quad (4)$$

Weighting calculation: The weighting calculation was done by adopting a combination of the subjective and objective entropy-AHP method (Zhou, 2007; Guo Ruixin *et al.*, 2005; Zhang Chenglin *et al.*, 2004).

Using the improved analytic hierarchy process to determine the subjective weight: AHP is a decision-making method that breaks the elements related to the decision into several layers, such as objectives, principles and schemes, to make qualitative and quantitative analyses (Thompson and Strickland, 2001). 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:

$$\bar{b}_{ij} = \frac{b_{ij}}{\sum_{i=1}^n b_{ij}}, i, j = 1, 2, \dots, n \quad (5)$$

- Add the standardized matrix according to line:

$$\bar{W}_i = \sum_{j=1}^n \bar{b}_{ij}, i, j = 1, 2, \dots, n \quad (6)$$

- Standardized weight matrix W:

$$W_i = \frac{\bar{W}_i}{\sum_{j=1}^n \bar{W}_j}, i, j = 1, 2, \dots, n \quad (7)$$

Then $W = (W_1, W_2, \dots, W_n)^T$ 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 (Zhang and Shang, 2009; Li, 2004).

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

- Information entropy of the index:

$$j(Q_j): Q_j = (-\frac{1}{\ln n}) * (\sum_{i=1}^n P_{ij} * \ln P_{ij}) \quad (8)$$

- Different coefficient of index:

$$j(D_j): D_j = 1 - Q_j \quad (9)$$

- Weight (Z_j) of the index j :

$$Z_j = \frac{D_j}{\sum_{j=1}^m D_j} \quad (10)$$

- Comprehensive value (W_{ij}):

$$W_{ij} = \sum_{j=1}^m Z_j * X'_{ij} \quad (11)$$

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:

$$w_j = \alpha(w'_j) + (1 - \alpha)(w''_j), (0 \leq \alpha \leq 1) \quad (12)$$

wherein, 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 $\alpha = 1$, it corresponds with the AHP method. When $\alpha = 0$, it corresponds with the entropy weight method. There is much discussion on how to reasonably define the value of α . After comprehensive consideration, $\alpha = 0.5$ (Liang *et al.*, 2010).

The evaluation calculation: When the entropy-AHP weight values and various indices of the 2003-2011 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 evaluation 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.

THE EVALUATION RESULTS AND ANALYSIS

The index weight of wild plant resources sustainable development in Guangxi: The most important index from the system level is wildlife and habitat protection (A1) (Table 3). Using the entropy method, the weight is calculated as 40.48%, as 45.73% using the AHP method and as 43.11% using the entropy-AHP method. The result shows that the sustainable development system is a resource system based on renewable resources, which takes wildlife and habitat protection as the core part and takes the ecological balance as the premise. At the state level, the entropy-AHP weight value is 12.99% for wildlife habitat protection (B1) and 10.55% for national management ability (B2). They are the most important parts for wild plants and habitat protection (A1). In the terms of the index layer, the entropy-AHP value for amount of wildlife reserve construction (C3), was 4.99%, 4.52% for the number of wildlife protection station management (C4) and the number of new grassroots protection stations (C7) take the highest weight at 6.42%. According to statistics, however, current protection stations face several problems. For example, many grassroots protection stations do not have fixed office locations, transportation, or communications equipment.

Social progress and development is critical to the sustainable development of resources with an entropy-

Table 3: The weighting index of using entropy method, AHP and entropy -AHP method

System layer	Entropy value	AHP	Entropy -AHP	State layer	Entropy value	AHP	Entropy-AHP	Index layer	Entropy value	AHP	Entropy-AHP			
A1	0.4048	0.4573	0.4311	B1	0.0893	0.1706	0.1299	C1	0.0338	0.0515	0.0427			
								C2	0.0326	0.0422	0.0374			
								C3	0.0229	0.0769	0.0499			
				B2	0.1371	0.0729	0.1050	0.0905	0.1202	0.1054	C4	0.0511	0.0394	0.0452
											C5	0.0440	0.0216	0.0328
											C6	0.0420	0.0119	0.0269
											C7	0.0455	0.0830	0.0642
				B3	0.0879	0.0936	0.0908	0.0879	0.0936	0.0908	C8	0.0450	0.0373	0.0411
											C9	0.0325	0.0428	0.0377
											C10	0.0299	0.0118	0.0209
											C11	0.0255	0.0390	0.0322
A2	0.3837	0.1265	0.2551	B5	0.1595	0.0472	0.1033	C12	0.0250	0.0143	0.0196			
								C13	0.0570	0.0117	0.0343			
								C14	0.0425	0.0213	0.0319			
				B6	0.0605	0.0202	0.0308	0.1011	0.0333	0.0672	C15	0.0350	0.0109	0.0229
											C16	0.0350	0.0060	0.0205
											C17	0.0265	0.0033	0.0149
											C18	0.0201	0.0229	0.0215
				B7	0.0616	0.0259	0.0308	0.0616	0.0259	0.0308	C19	0.0455	0.0103	0.0279
											C20	0.0355	0.0140	0.0247
											C21	0.0295	0.0077	0.0186
											C22	0.0321	0.0042	0.0182
A3	0.2048	0.4162	0.3105	B9	0.0485	0.2250	0.1367	C23	0.0485	0.2250	0.1367			
				B10	0.0435	0.1235	0.0835	C24	0.0435	0.1235	0.0835			
				B11	0.1164	0.0678	0.0921	C25	0.0565	0.0272	0.0418			

Table 4: The evaluation index of wild plants for sustainable development of each subsystem

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
2003	0.2567	0.1938	0.2050	0.1382	0.5899	0.1839	0.6302	0.1750	0.9695	0.3873	0.5796
2004	0.2567	0.1938	0.2050	0.1382	0.3166	0.1199	0.5150	0.2126	0.9385	0.4601	0.6330
2005	0.2947	0.1974	0.2086	0.1147	0.1018	0.0467	0.3526	0.2027	0.9322	0.4410	0.2942
2006	0.2802	0.3214	0.6546	0.5090	0.3586	0.0101	0.2623	0.1509	0.9409	0.2943	0.2240
2007	0.3332	0.3643	0.5247	0.6045	0.4479	0.0855	0.0652	0.0438	0.2561	0.1007	0.0796
2008	0.7660	0.7954	0.7338	0.4851	0.7485	0.2134	0.6880	0.1681	0.9179	0.3642	0.2610
2009	0.8155	0.6861	0.7105	0.4654	0.4045	0.0760	0.3904	0.1609	0.9027	0.4289	0.4229
2010	0.4075	0.9559	0.8299	0.2622	0.3190	0.1962	0.6610	0.2765	0.9909	0.4073	0.3760
2011	0.4467	0.9654	0.6612	0.2856	0.4362	0.1129	0.4806	0.1513	0.9147	0.4318	0.4188

Table 5: The evaluation index of wild plants for sustainable development of each subsystem using entropy-AHP

	Composite index of wildlife and habitat protection A1	Resources economics comprehensive index A2	Composite index of social progress and development A3
2003	0.342	0.403	0.636
2004	0.342	0.297	0.728
2005	0.351	0.180	0.614
2006	0.761	0.199	0.456
2007	0.787	0.164	0.136
2008	0.998	0.464	0.513
2009	0.915	0.263	0.579
2010	0.533	0.371	0.554
2011	0.997	0.301	0.551

Table 6: The comprehensive evaluation of wild plants resources of sustainable development

Year	The comprehensive evaluation of wild plants resources of sustainable development	Sustainable development level	Description
2003	0.4273	V	Traditional backward development
2004	0.4106	V	Traditional backward development
2005	0.4762	V	Traditional backward development stage
2006	0.3910	V	Traditional backward development stage
2007	0.4122	V	Traditional backward development stage
2008	0.5761	IV	Transition stage from traditional development to sustainable development stage
2009	0.4930	V	Traditional backward development stage
2010	0.4922	V	Traditional backward development stage
2011	0.5516	IV	Transition stage from traditional development to sustainable development

AHP value of 25.51%, which shows the importance of professional wild plants protection employees. According to the analysis, however, it indicates that the level of wild plants protection professionals construction is relatively low with an entropy-AHP value of 3.08%. The social welfare level of workers is low as well with an entropy-AHP value of 3.08%, which is shown by the low detection and number of scientific research institutions for wild plants as indicated by its entropy-AHP value of 1.96%. Due to the lack of field data, it is difficult to achieve macroeconomic regulation and control of wild plant resources. The proportion of staff in the protection stations who have a college degree or above is low with an entropy-AHP value of 1.49%. The wages of the on-the-job workers each year for wild plants protection is low with an entropy-AHP value of 1.86%. The above factors will undoubtedly affect the establishment of wildlife and habitat protection.

Resource economics provides momentum in promoting sustainable development with an entropy-AHP value of 31.05%. Wild plant breeding has the biggest contribution to resource economics with an entropy-AHP value of 13.67%. The second largest contribution index is the international trade of wild plants with an entropy-AHP value of 9.21%). Import and export trade have the same weights at 4.18% and 5.02%, respectively.

The state layer's composite index of wild plant resources sustainable development index system: The wildlife habitat protection composite index shows a trend of first increasing from 0.2567 in 2003 to 0.8155 in 2009, then decreasing to 0.4467 in 2011. The change in trend for the infrastructure construction index of the grassroots protection stations is similar to the change in trend for the wildlife habitat protection composite index, increasing from 0.1382 in 2003 to 0.6045 in 2007, then decreasing to 0.2856 in 2011. The composite index of state management ability and grassroots protection composite index have a steady upward trend. The former increases from 0.1938 in 2003 to 0.7954 in 2008 and finally reaches 0.9654 in 2011. The latter increases from 0.2050 in 2003 to 0.8299 in 2010 and finally drops to 0.6612. The composite indicates of wild plant scientific research and testing levels and wild plants protection professionals construction have small changes. The former stays around the levels of 0.3 to 0.7 with a peak appearing in 2008 at 0.7485. The latter stays around the levels of 0.1 to 0.2 with a peak appearing in 2008 at 0.2134. The comprehensive index of attracting ability of social labor and wild plant breeding composite index show a trend of first decreasing then increasing. The former decreases from 0.6302 in 2003 to 0.0652 in 2007 and then goes back up to 0.6610 in 2010. The latter decreases from 0.9695 in 2003 to 0.2561 in 2007 and finally goes back to 0.9909

in 2010. The composite index of on-the-job workers social welfare and wild plants leisure and entertainment have small changes. The former keeps stable at about 0.1 to 0.2, while the latter keeps stable at about 0.2 to 0.4. The peak for the comprehensive index of wild plants international trade appears at 0.6330 in 2004, falls to 0.0796 in 2007 and finally reaches 0.4188 in 2011. The comprehensive indices of each layer are shown in Table 4.

Comprehensive index of the wild plant resources sustainable development subsystem: Overall, in the GuangXi wild plant resources sustainable development system, the composite index of wildlife and habitat protection shows a trend of increasing from 0.342 in 2003 to 0.998 in 2008, then decreases to 0.553 in 2010 and finally reaches 0.997 in 2011. The changes in the resource economics comprehensive index are relatively stable, from 0.403 in 2003 falling to the bottom at 0.164 in 2007, then rebounding to the peak of 0.484 before finally reaching 0.301 in 2011. The composite index of social progress and development shows a trend of first increasing from 0.636 in 2003 to the peak of 0.728 in 2004, then decreasing to 0.136 in 2007 and finally reaching 0.551 in 2011. The results are shown in Table 5.

Comprehensive evaluation of wild plant resources sustainable development in the GuangXi province: From 2003 to 2011, the sustainable development level of wild plant resources in the GuangXi province has a steady upward trend, but the overall level is not high (Table 6). It keeps steady at 0.3910 to 0.42373 from 2003 to 2007, during the stage of the traditional development. The comprehensive evaluation value reached 0.5761 in 2008, during the transition stage from traditional development to sustainable development. The comprehensive evaluation value in 2009 and 2010 are 0.4930 and 0.4922, respectively, during another stage of traditional development. It went back to the transition stage from traditional development to sustainable development in 2011. These results are shown in Table 6.

CONCLUSION

In this study, the sustainable development evaluation index system of the wild plant resources in the GuangXi province is established based on the principles of scientific nature and operability. Based on this evaluation index system and statistical data from 2003 to 2011 in the GuangXi province, comprehensive evaluation and analysis of the sustainable development condition of the wild plant resources in GuangXi province was carried out using the Entropy-AHP evaluation model and index weighting model. The evaluation results show that the sustainable

development level of wild plant resources in GuangXi has a steady upward trend, but the overall level is not high.

The infrastructure construction of wild plant protection stations is relatively backwards: Wildlife and habitat protection is the foundation of wild plant resources sustainable development. Although the composite evaluation value of wild plants is improving, there are still many imperfect aspects when it comes to the construction of basic facilities construction. For example, many primary protection stations do not have fixed office locations or transportation and communications equipment (Table 3). This is because forestry construction in China starts late. In recent years, although forestry construction in our country has gained attention, government funding for wild plants protection is still not enough compared with the protection demand of wild plants and their habitats. Lack of funding is also one of the main reasons for insufficient natural reserve construction. The incomplete construction of primary protection station infrastructure will seriously affect the staff's enthusiasm during daily patrols, which, in turn, affect wildlife nature reserve construction.

The construction level of wild plant protection professionals is low: At present, construction level of wild plant protection professionals is relatively low and the social welfare level of workers is poor. It is obviously shown by the low number of monitoring and scientific research institutions for wild plants and lack of field data, thus making it difficult to achieve macroeconomic regulation and control of wild plant resources. Moreover, the welfare level of wild plant protection workers is low and it is difficult to attract professional talents to work in the primary station. This results in a smaller proportion of workers with college degrees or above in the basic protection stations. In addition, most of wildlife nature reserves in GuangXi are located in the underdeveloped area where traffic is inconvenient and information is blocked. The residents have little consciousness in regards to environmental protection and do not have high enthusiasm for participating in wild plant protection. The current way of using wild plant resources is relatively backwards, which affects wildlife and habitat protection.

Import and export trade levels of wild plants is low: Along with the continuous search for the value of wild plant resources, foreign demand for wild plants has increased and the international market has gradually become important in the sales of wild plant products. However, due to the unique business model of the wild plant industry development in our country, the industry faces the challenges of low technology content, low production efficiency, poor product quality and a weak

ability to adapt to the market, which seriously weakens the international competitiveness of wild plant products. The impact of the wild plants products market from developed countries is very serious, especially after China obtained access to WTO. Although the international competition is beneficial in terms of promoting the development of the wild plant resources industry in China, the impact has also affected the efficient development of the wildlife resource utilization industry (Yang, 2012). Table 4 shows that the integrated index of wild plants leisure entertainment and the comprehensive index of import and export trade in the GuangXi province are both low and keep at the level of 0.2 to 0.5. According to the division standard of Table 1, both are in the levels of traditional and backwards development.

Caveats: This study uses the entropy-AHP method to build wild plant resources sustainable development indicators and conducts evaluation of the GuangXi province. Since there are so many factors that impact the sustainable development of wild plant resources and this article only selects the indicators with high-use frequency in previous studies, it is difficult to fully and accurately cover all of the indicators for the established index system. In some studies, some pressure indicators are suggested for the evaluation system, such as the proportion of local endangered wild plants and the satisfaction degree of wild plant demand, because human activities will produce a certain influence on natural resources. However, since these indicators are difficult to obtain, they are not chosen for this system, which will weaken the effect of human activities on natural resources to a certain extent. Therefore, the next direction of study is to further improve the wild plant resources sustainable development index system from multiple perspectives.

In addition, according to Table 3, there are huge differences between weights which are calculated by the entropy value method and the AHP method, respectively. For example, the social progress and development indicator (A2) and the wild plant breeding index (B9). The symbol α is given the value of 0.5 in the formula $w_j = \alpha(w_j') + (1-\alpha)(w_j'')$, ($0 \leq \alpha \leq 1$), but the accuracy is worth discussing.

POLICY SUGGESTIONS

Increasing the investment towards wildlife reserves and building a community co-management system: Protection of wildlife and habitat is the precondition for the sustainable development of wild plant resources. To achieve a significant protective effect, the construction of nature reserves and protection stations should be firstly strengthened by increasing the net inflow investment of wildlife reserves, improving the construction of protection station infrastructure at the

grass-roots level and conducting protective patrols. In addition, a community co-management system should be built. For example, strategies should be implemented to build up the enthusiasm for wildlife protection of the surrounding residents. Reserve management should include the production and living of the local people as well as cultural, so as to improve the protection consciousness of the local residents. This will change the way wildlife resources are utilized and allow them to realize the effective protection of wild plants and habitats.

Improving the talent team recruitment and staff's welfare level: At present, there is a great shortage of professionals in the construction of wild plant industry in China. It is necessary to accelerate the recruitment of relevant professionals during the industrialization development of wild plant resources. With the enlargement of the wild plants area, it has supplied a very broad space for professional employment in wild plant resource utilization and product development. Therefore, the government should improve the talent team recruitment and attract high-quality personnel to become involved in the protection of wild plants by improving the staff's welfare level.

Reasonable construction of the domestic trade market, actively opening up the international market and enhancing the international competitiveness of Chinese wild plant products: To enhance the international competitiveness of Chinese wild plant products during the development of wild plants industrialization, international markets should be actively opened up, so as to promote the sustainable development. There are several methods to expand into the international market, which mainly include simplifying product export procedures, speeding up the export examination and approval in order to reduce the loss of the international market competitive advantage caused by the long approval process, strengthening the research in processing technology, improving the added-value of wild plant products and providing export preferential policies for wild plant product exports with legal sources such as implementing a differential cost rate for export charges. Charging high-cost rates for wild plants obtained from the field can also increase the export costs and achieve export control. For artificially cultivated wild plants, a low-cost rate or zero rate should be charged in order to reduce export costs and achieve the purpose of expanding exports and enhancing the international competitiveness of China's enterprises.

REFERENCES

Alfred Maroyi, 2003. The Utilization of *Moringa oleifera* in Zimbabwe: A Sustainable livelihood Approach.

- Chen Wenhui *et al.* 2006. The influence of Green economics to wildlife industry. [J]. *Wildlife Magazine*: 33-34.
- Chang, H.K., J.C. Liou and W.W. Chen, 2012. Protection priority in the coastal environment using a hybrid AHP-TOPSIS method on the Miaoli coast, Taiwan. *J. Coastal Res.*, 28: 369-374.
- Guo Ruixin, Li Jing 2005. Economics development research based on AHP method [D]. Da Lian: Da Lian Science university.
- Liang, H.M., S.K. Peng and W.L. Zi, 2010. Forestry Farm sustainable development evaluation based on AHP method. *J. Nanjing Forestry Univ., Nat. Sci. Edn.*, 34: 93-96.
- Li, H.X., 2004. The competition analysis of regional logistics development based on AHP-Entropy. *Southeast Univ., J.*, 34(3): 398-401.
- Lu, Z.S., S.K. Peng *et al.*, 2000. The study of effective forestry indexes. *Forestry Resour. Manage.*, 1: 3-8.
- Luo, Y.P. and J.C. Liu, 2009. Wildlife industrialization utilization and suggestions. M.S. Thesis, Bei Jing Forestry University, China.
- Ma, K. and J.P. Li, 2004. A suggestion of forestry sustainable development [J]. *Northeast Forest. Coll. J.*, 24(2): 73-76.
- Maini J.S., 1990. Sustainable development and canadian forest sector [J]. *The Forestry Chronicle*, 66(4): 346-349.
- National Forestry Department, 2003-2011. China Forestry Statistics Year Book. National Forestry Publishment, Beijing.
- Satish M.N. alawade. Abhay P. Sagare, 2003. Studies on tissue culture of Chinese medicinal plant resources in Taiwan and their sustainable utilization. *Bot. Bull. Acad. Sin.* 44: 79-98.
- Thompson, A. and A. Strickland, 2001. *Strategic Management: Concepts and Cases*. 9th Edn., Infra-M, Moscow.
- The State Forestry Administration, 2010. Wild plants resources. [EB/OL]. <http://www.forestry.gov.cn/portal/main/s/1078/content-115092.html>
- United Nations, 1996. *Indicators of Sustainable Development Framework and Methodologies* [M]. New York: United Nations.
- V. Ramanatha Rao and Toby Hodgkin, 2002. Genetic diversity and conservation and utilization of plant genetic resources. *Plant Cell*. 68: 1-19.
- World Bank, ISEM, Thompson A, Strickland A J. 2005. *Strategic management: concepts and cases* [M]. New York: Mc Graw Hill Companies, Inc.
- Yang, X., 2012. Wildlife sustainable development evaluation system study [J]. *Ecol. J.*, 12(32): 7230-7238.
- Zhang, X. and J.P. Shang, 2009. The land sustainable development evaluation based on entropy method [J]. *Land Resour. Res.*, 4: 33-35.

- Zhou, G.P., 2007. The research on the evaluation system of economic development based on the method of entropy and AHP. M.S. Thesis, Dalian University of Technology, China.
- Zhou, X.F. and J.Y. Zhang, 2010. Problems and strategies on the industrialization of wild plants in China. *Hebei J. Forestry Orchard Res.*, 24: 369-372.
- Zhang Shibao, Peng Shikui. Zi wuling, 2011. Forestry Farm sustainable development evaluation based on AHP method [J]. *Ning Jing forestry University Journal*. 34(3): 93-96.
- Zemedet Asfaw, 2001. Prospects for Sustainable Use and Development of Wild Food Plants in Ethiopia. *Economic Botany* 55(1): 47-62.
- Zhang Chenglin and Shang Jianping, 2004. The land sustainable development evaluation based on entropy method [J]. *Land and resources research*. (4): 33-35.