

## Prior Development Evaluation on Multifunctional Forest Resource: Illustrated by the Case of Acer Mono Maxim. Resource

**Peng Yao<sup>1,2</sup>**

*<sup>1</sup>School of Economics and Management, Beihua University, Jilin 132013, Jilin, China*

*<sup>2</sup>School of Economics and Management, Beijing Forestry University, Beijing 100083, China*

**Rao Yao**

*Aeronautic College, Shanghai University of Engineering Science, Shanghai 201620, China*

**Dan Yang\***

*School of Economics and Management, Beihua University, Jilin 132013, Jilin, China*

*\*Corresponding author: Dan Yang*

### Abstract

Forest resource is most important material basis for the development of human society. In people's traditional knowledge, utilization of forest resource is mostly limited to timber, but which leads waste and also makes forestry production enterprises fall into the predicament of low value-added business. Though, multifunctional forest resource utilization has been becoming more and more important recently. Economic, ecological and social function will be controlled by each other, so multifunctional forest resource utilization is not in a position to get maximum interests in all functions. But the maximum single function is not equal with the maximum value of forest resource utilization. Therefore multifunctional forest resources development not only is a trend of modern forestry management, also is a return to sustainable development goals. Drawing lessons from industrial structure evaluation method, building the multifunctional development evaluation model, by Delphi method, weighted average method, weighted geometric mean method and TOPSIS method, this article researches the priority degree of Acer mono Maxim. every function. Through calculation results of the spearman rank correlation coefficient between both methods results, all liner correlations among 3 kinds of results are higher. Therefore, evaluate multifunctional development priority degree using the comprehensive evaluation with 3 results. On the basis of study in relationship between every function of Acer mono Maxim., this article establishes the multifunctional coordinating development linear programming model, taking advantage of this model for analysis. Then puts forward the comprehensive development planning, with steps and phases of concept, and guarantees there is a certain economic benefit in every stage of resource development, in order to provide theoretical basis for achieving a virtuous cycle of industrial clusters.

Key words: PRIOR DEVELOPMENT EVALUATION, MULTIFUNCTIONAL FOREST RESOURCE, ACER MONO MAXIM., DELPHI METHOD, TOPSIS METHOD



**2.2. Standardization Matrix**

Using index method to standardize matrix from  $X$  to  $A$ , then calculates  $a_i$  value ( $a_i = \sum_{j=1}^n \omega_j a_{ij}$ ).

**2.3. Evaluation Prior Grade**

For any  $x_k \in X$ ,  $x_i \neq x_k$  ( $i, k = 1, 2, 3, \dots, m$ ) and  $i \neq k$ , if  $a_k > a_i$ , a conclusion is that the item  $k$  is the best one, and it is the priority projects for development in all functions; on the contrary, for any  $x_k \in X$ ,  $x_i \neq x_k$  ( $i, k = 1, 2, 3, \dots, m$ ) and  $a_k < a_i$ , if  $a_k < a_i$ , a conclusion is that the item  $k$  is the worst one, and it is the last projects for development.

Specific multifunctional prior evaluation processes are shown as following figure 1.

**3. Multifunctional Resource Prior Development Evaluation Processing**

**3.1. Determination of Multifunctional Prior Development Evaluation Index**

Scientific multifunctional evaluation indexes are a basis of prior development evaluation to establish evaluation index system. Indexes number should be moderation, avoiding information missing caused by too little indexes number and standard repeat caused by too much indexes number. Information missing will lead a one-sided evaluation results, and standard repeat will lead to the evaluation results lack of differentiation.

This article follows the principle of comprehensiveness, from political, economic and social development needs, separately chooses 5 first grade indexes (Importance, Economic Benefit, Sustainable Development Grade, Technology Development Level and Difficulty of Industrial Development) and 12 second grade indexes (Needs of National Development, Technology diffusion and driving ability, Contribution for Social Economic Growth, Promotion for Employment, Available Resources Stock, Renewal Ability and Speed of Resources, External Benefit of Development, Technical Maturity, Technology Innovation Potential in the future, Infrastructure Cost,

R & D Cost and Policies, Regulations and Standards) to establish multifunctional prior development evaluation system.

**3.2. Value of Prior Multifunctional Indexes**

This study chooses 50 experts, including 20 forestry experts, 15 resource economy experts and 15 enterprise managers, to send them the prior development multifunctional evaluation questionnaire. This research adopts direct interview in 13 questionnaire surveys, E-mail questionnaires in 37 questionnaire surveys, then getting the value of prior multifunctional development evaluation indexes of Table 1 just as follows:

**Table 1.** Prior development evaluation indexes of multi-utilization

First Grade Indexes			Second Grade Indexes		
First Grade Indexes Name	Symbol	Weight ( $\omega_j$ )	Second Grade Indexes Name	Symbol	Weight ( $\omega_{jr}$ )
Importance	$G_1$	0.33	Needs of National Development	$G_{11}$	0.63
			Technology diffusion and driving ability	$G_{12}$	0.37
Economic Benefit	$G_2$	0.26	Contribution for Social Economic Growth	$G_{21}$	0.58
			Promotion for Employment	$G_{22}$	0.42
Sustainable Development Grade	$G_3$	0.16	Available Resources Stock	$G_{31}$	0.36
			Renewal Ability and Speed of Resources	$G_{32}$	0.43
			External Benefit of Development	$G_{33}$	0.21
Technology Development Level	$G_4$	0.12	Technical Maturity	$G_{41}$	0.45
			Technology Innovation Potential in the future	$G_{42}$	0.55
Difficulty of Industrial Development	$G_5$	0.13	Infrastructure Cost	$G_{51}$	0.41
			R & D Cost	$G_{52}$	0.33
			Policies, Regulations and Standards	$G_{53}$	0.26

**3.3. Classification of Multifunction of Acer mono Maxim. Resource**

Based on the investigation of 20 forestry experts and field survey, this article divides multifunction of Acer mono Maxim. into 8 types, such as timber, fuel power, medical, industrial adjuvant, edible health, arts & crafts, ecological protection and travel leisure.

Taking  $x_i$  ( $i=1,2,3,\dots,8$ ) as one index value of functions of Acer mono Maxim..  $x_1$  is index value of timber material function;  $x_2$  is index value of fuel power function;  $x_3$  is index value of medicinal function;  $x_4$  is index value of industrial adjuvant function;

$x_5$  is index value of edible health function;  $x_6$  is index value of arts & crafts function;  $x_7$  is index value of ecological protection function;  $x_8$  is index value of travel leisure function.

Among them, values of qualitative evaluation indexes, such as technology diffusion and driving ability  $G_{12}$ , promotion for employment  $G_{22}$ , renewal ability and speed of resources  $G_{32}$ , external benefit of development  $G_{33}$ , R & D cost  $G_{51}$ , infrastructure cost  $G_{52}$  and policies, regulations & standards  $G_{53}$ , are obtained by expert scoring, the amount falling into 0 ~ 100.

**Table 2.** Prior development evaluation indexes of multi-utilization

Multifunctional Indexes Name		Timber	Fuel Power	Medicinal	Industrial Adjuvant	Edible Health	Arts and Crafts	Ecological Protection	Travel Leisure
	Symbol	$x_1$	$x_2$	$x_3$	$x_4$	$x_5$	$x_6$	$x_7$	$x_8$
Needs of National Development (project number) / amount	$G_{11}$	93	2961	1695	5	1	0	2121	283
Technology diffusion and driving ability (score by expert) / score	$G_{12}$	91	65	78	56	21	11	88	27
Contribution for Social Economic Growth (per unit area profit) / (yuan·hm <sup>2</sup> )	$G_{21}$	53784	1362	52542	1582	209	6950	25	16
Promotion for Employment (score by expert) / score	$G_{22}$	96	65	90	74	24	17	11	67
Available Resources Stock (available resource ratio)/%	$G_{31}$	2	20	22	22	40	2	98	30
Renewal Ability and Speed of Resources (score by expert) / score	$G_{32}$	6	91	98	10	89	4	98	98
External Benefit of Development (score by expert) / score	$G_{33}$	13	69	85	47	32	55	97	87
Technical Maturity (patent number) / amount	$G_{41}$	2089	3574	161	2291	55	120	58	2
Technology Innovation Potential in the future (article number) / amount	$G_{42}$	2215	2229	83	183	344	1210	5187	552
Infrastructure Cost (score by expert) / score	$G_{51}$	33	92	67	56	25	2	23	11
R & D Cost (score by expert) / score	$G_{52}$	15	97	86	44	56	4	47	23
Policies, Regulations and Standards (score by expert) / score	$G_{53}$	64	45	68	35	66	13	68	48

As to the quantitative indexes are obtained by mathematical statistics, obtaining the index value of needs of national development  $G_{11}$  in accordance with the national funded project number of each industry related technology, acquiring the index value of contribution for social economic growth  $G_{21}$  by multifunctional development profits per unit area, getting the index value of available resources stock  $G_{31}$  in compliance with the available percentage of development resource, calculating the index value of technical maturity  $G_{41}$  by related patents numbers of representative products, getting the index value of technology innovation potential in the future  $G_{42}$  according to the number of published academic papers relating multifunctional development, then getting the following Table 2.

**4. Data Standardization Processing**

As output indicators, including  $G_{11}, G_{12}, G_{21}, G_{22}, G_{31}, G_{32}, G_{33}, G_{41}, G_{42}$  and  $G_{53}$ , this article adopts processing method to standardized, taking  $\max x_{ij} \rightarrow 100$ :conversion formula (1) as follows:

$$u_{ij} = 100 \exp \left( \frac{x_{ij} - \max_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}} \cdot k \right), (i=1,2,3,\dots,8) \tag{1}$$

As input type indexes, including  $G_{51}$  and  $G_{52}$ , this article adopts processing method to standardized, taking  $\min x_{ij} \rightarrow 100$ :conversion formula (2) as follows

$$u_{ij} = 100 \exp \left( \frac{\min_i x_{ij} - x_{ij}}{\max_i x_{ij} - \min_i x_{ij}} \cdot k \right), (i=1,2,3,\dots,8) \tag{2}$$

$k$  in above formula is the accommodation coefficient, usually taking natural numbers. According to the experiences, if  $m$  is bigger, the value of is larger, the result is more reasonable. It is benefit to distinguish different prior development levels between different projects, which can provide decision-making for step development.

Owing to the amount of development item is 8, moderation of the number for utilization, this article chooses the value of  $k$  as 2, then getting the second grade indexes matrix  $U$ .

$$U = \begin{bmatrix} 5.47 & 100.00 & 100.00 & 100.00 & 4.98 & 5.31 & 4.98 & 28.73 & 17.43 & 35.58 & 70.13 & 80.40 \\ 100.00 & 37.72 & 5.37 & 33.48 & 8.74 & 79.98 & 36.79 & 100.00 & 17.58 & 4.98 & 4.98 & 28.52 \\ 27.73 & 61.42 & 93.30 & 80.92 & 9.30 & 100.00 & 65.14 & 5.69 & 4.98 & 11.46 & 7.10 & 100.00 \\ 5.00 & 26.91 & 5.43 & 46.00 & 9.30 & 6.03 & 16.77 & 34.04 & 5.28 & 16.53 & 27.52 & 16.53 \\ 4.98 & 7.24 & 5.03 & 7.88 & 16.32 & 75.03 & 9.81 & 5.21 & 5.80 & 46.46 & 18.69 & 89.66 \\ 4.98 & 4.98 & 7.33 & 6.15 & 4.98 & 4.98 & 22.31 & 5.50 & 9.66 & 100.00 & 100.00 & 4.98 \\ 42.70 & 89.36 & 4.98 & 4.98 & 100.00 & 100.00 & 100.00 & 5.22 & 100.00 & 49.66 & 24.98 & 100.00 \\ 6.63 & 9.07 & 4.98 & 35.93 & 11.94 & 100.00 & 69.97 & 4.98 & 6.56 & 74.08 & 54.18 & 33.59 \end{bmatrix} \tag{3}$$

According to the following formula (4), this article gets the weighted normalized matrix  $U'$ , just as-

$$U' = U \times \omega_{jr}^T \tag{4}$$

$$U' = \begin{bmatrix} 3.45 & 37.00 & 58.00 & 42.00 & 1.79 & 2.28 & 1.05 & 12.93 & 9.59 & 14.59 & 23.14 & 20.90 \\ 63.00 & 13.96 & 3.11 & 14.06 & 3.15 & 34.39 & 7.73 & 45.00 & 9.67 & 2.04 & 1.64 & 7.42 \\ 17.47 & 22.72 & 54.15 & 33.98 & 3.35 & 43.00 & 13.68 & 2.56 & 2.74 & 4.70 & 2.34 & 26.00 \\ 3.15 & 9.96 & 3.15 & 19.32 & 3.35 & 2.59 & 3.52 & 15.32 & 2.90 & 6.78 & 9.08 & 4.30 \\ 3.14 & 2.68 & 2.92 & 3.31 & 5.88 & 32.26 & 2.06 & 2.34 & 3.19 & 19.05 & 6.17 & 23.31 \\ 3.14 & 1.84 & 4.25 & 2.58 & 1.79 & 2.14 & 4.69 & 2.47 & 5.31 & 41.00 & 33.00 & 1.29 \\ 26.90 & 33.06 & 2.89 & 2.09 & 36.00 & 43.00 & 21.00 & 2.35 & 55.00 & 20.36 & 8.24 & 26.00 \\ 4.18 & 3.36 & 2.89 & 15.09 & 4.30 & 43.00 & 14.69 & 2.24 & 3.61 & 30.37 & 17.88 & 8.73 \end{bmatrix} \tag{5}$$

Then under formula (6) and (7), this article gets the first grade index standardized matrix  $A = [a_{ij}]_{8 \times 5}$

$$a_{ij} = \sum_{r=1}^2 \omega_{jr} u_{ij} (j=1,2,4) \tag{6}$$

$$a_{ij} = \sum_{r=1}^2 \omega_{jr} u_{ij} (j=3,5) \tag{7}$$

Matrix  $A$  just as follows:

$$A = \begin{bmatrix} 40.45 & 100.00 & 6.36 & 22.52 & 58.63 \\ 76.96 & 17.18 & 71.93 & 54.67 & 11.10 \\ 40.19 & 88.10 & 89.35 & 5.30 & 33.04 \\ 13.11 & 22.47 & 8.53 & 18.22 & 20.16 \\ 5.82 & 6.23 & 70.41 & 5.53 & 48.53 \\ 4.98 & 6.84 & 6.07 & 7.78 & 75.30 \\ 59.96 & 4.98 & 122.00 & 57.35 & 54.60 \\ 7.53 & 17.98 & 90.30 & 5.85 & 56.99 \end{bmatrix} \tag{8}$$

**5. Evaluation Results of Three Kinds of Calculation Method**

Then adopt three methods, weighted average method, weighted geometric mean method and TOPSIS method, to calculate the index value of multi-functional resource prior development.

This article gets the result of  $\rho_{1i}$  under weighted average method.

$$\rho_{1i}^T = (50.6888, 49.3727, 55.3970, 16.3419, 21.7772, 15.1146, 54.5824, 29.7189) \tag{11}$$

**5.2. Result of Weighted Geometric Mean Method**

According to the formula (12),

**5.1. Result of Weighted Average Method**

According to the formula (9),

$$\rho_{1i} = \sum_{j=1}^n \omega_j \times a_{ij} = \sum_{j=1}^5 \omega_j \times a_{ij} \tag{9}$$

$$\sum_{i=1}^8 \omega_i = 1, (0 \leq \omega_i \leq 1) \tag{10}$$

$$\rho_{2i} = \prod_{j=1}^n (a_{ij})^{\omega_j}, (a_{ij} \geq 1) \tag{12}$$

This article gets the result of  $\rho_{2i}$  under weighted geometric mean method.

$$\rho_{2i}^T = (37.2342, 38.4645, 42.8170, 15.4910, 11.5587, 8.3826, 34.5669, 17.7366) \tag{13}$$

**5.3. Result of TOPSIS Method**

According to the formula (14), (15) and (16),

$$S_i^- = \sqrt{2 \sum_{j=1}^5 (a_{ij} - a_j^-)^2} \tag{15}$$

$$S_i^* = \sqrt{2 \sum_{j=1}^5 (a_{ij} - a_j^*)^2} \tag{14} \quad \rho_{3i} = \frac{S_i^-}{S_i^* + S_i^-} \tag{16}$$

This article gets the result of  $\rho_{3i}$  under TOPSIS method.

$$\rho_{3i}^T = (0.4898, 0.4995, 0.5600, 0.1254, 0.2607, 0.1717, 0.6675, 0.3663) \tag{17}$$

**5.4. Correlation Test**

Because the product moment Correlation Coefficient is relatively strict with test Data, the Spearman Correlation Coefficient on the original Data is broad, sample size and sample population distribution, compared does not affect the test result of the two variables, this study adopts the Spearman's

Correlation Coefficient for Ranked Coefficient, three methods of evaluation of sorting results Correlation inspection.

$$r_\rho = 1 - \frac{6 \sum_{i=1}^n d_i^2}{n(n^2 - 1)} \tag{18}$$

**Table 3.** Orders of three evaluation methods

Index Name	Weighted Average Method	Weighted Geometric Mean Method	TOPSIS Method
Timber	3	3	4
Fuel Power	4	2	3
Medical	1	1	2
Industrial Adjuvant	7	6	8
Edible Health	6	7	6
Arts & Crafts	8	8	7
Ecological Protection	2	4	1
Travel Leisure	5	5	5

**Table 4.** Results correlation of three evaluation methods

Index Name	Weighted Average Method	Weighted Geometric Mean Method	TOPSIS Method
Weighted Average Method	1	0.8810	0.9286
Weighted Geometric Mean Method	0.8810	1	0.7857
TOPSIS Method	0.9286	0.7857	1

**5.4. Correlation Test**

Owing to the former consequence, there are strong linear correlations among results of above three

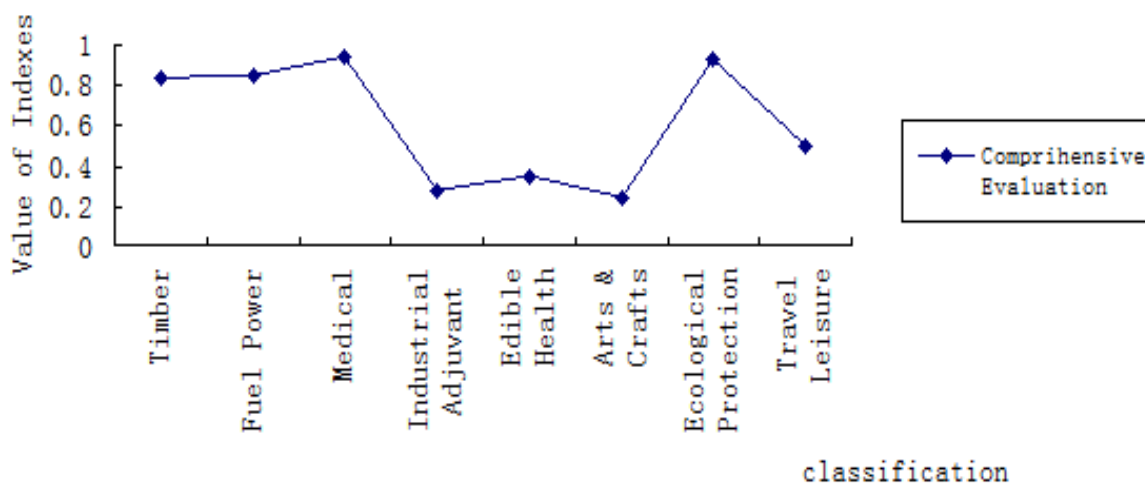
methods, so this article can get the comprehensive result  $b^T$ .

$$b^T = (0.8395, 0.8460, 0.9463, 0.2816, 0.3512, 0.2419, 0.9309, 0.4998) \tag{19}$$

**6. Conclusions**

6.1. As to multifunctional resource, Acer mono Maxim., the development rank of 8 functions just as

following fig. 2. This comprehensive prior development rank result will be a reference for factories to do a business decision.



**Figure 2.** Flow chart of prior development evaluation

6.2. The prior development evaluation method will be suitable for another forest multifunctional resource prior evaluation.

**Acknowledgements**

This work was supported by Jilin Province Social Science Foundation (2015BS53), Jilin Province Education Science 'the 12th Five-Year Plan' Project (GH13091), Jilin Province Education Department 'the 12th Five-Year Plan' Social Science Research (2015, No. 92), Jilin Province Social Sciences Organization, Beihua University Students Innovative Project, National Natural Science Foundation of China (61303098) and Task-Oriented Knowledge Team Project (2013td14).

**References**

1. Klemperer, W. D.(1996) *Forest Resource Economics and Finance*. New York: Mc Graw Hill Incorporated.
2. Costanza, R. D.(1997). The value of the world's ecosystem services and natural capital. *Nature*, 187, p.p.233-240.
3. Pimental, D., Wilson, C., Cullum, C.(1997). Economic and environmental benefits of biodiversity. *Bioscience*, 387(45), p.p.253-260.
4. Rudolf, S., Matthew, A.(2000). A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological Economy*, 41(20), p.p.393-408.
5. Ronde, P.(2003). Delphi analysis of national specificities in selected innovative areas in Germany and France. *Technological Forecasting and Social Change*, 70(14), p.p. 419-448.
6. Taeyoung, S., Hong, S. K., Hariolf, G.(1999). Technological Foresight Activities in Korea and in Countries Closing the Technology Gap. *Technological Forecasting and Social Change*, 60(18), p.p. 71-84.
7. Martin, R. B.(2000). Matching Social Needs and Technological Capabilities Research Foresight and the Implications for Social

- Sciences (Paper presented at the OECD Workshop on Social Sciences and Innovation). Tokyo: United Nations University.
8. Li, Hongling, Mei, Le(2006). Technology Foresight: from the application of the method to the construction of the system. *Science and Technology Management*, 12(8), p.p. 47-51.
  9. Qiu, Lixin (2010). Evaluation and selection of priority development areas of high tech industry: An Empirical Study Based on Technology Foresight. *Science and Technology Management*, 14(12), p.p.62-65.
  10. Yao, P., Zhang, C., Yao, R.( 2013). Analysing and improving teaching based on a random sample investigation. *World Transactions on Engineering and Technology Education*, 11(4), p.p.532-536.
  11. Yao, P., Zhang, C., Yao, R.(2013). Analysing TCI Efficiency Based on NCD System. *International journal of applied mathematics and statistics*, 51(24), pp.484-490.



### Group Events Raised by Network Public Opinion Based on CA

**Jing Wei, Hengmin Zhu**

*School of Management, Nanjing University of Posts&Telecommunications, Nanjing 210046, Jiangsu, China*

**Ruixiao Song**

*School of Economic and Management, Nanjing University of Aeronautics and Astronautics, Nanjing 210016, Jiangsu, China*

**Shibing Jiang**

*School of Management, Brock University, St. Catharines, L2S 3A1, Ontario, Canada*