Article

Study on Evaluation of Timber Security in China Based on the PSR Conceptual Model

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Abstract: In case of a shortage of China's domestic timber, the research of China's timber security has become increasingly more important. Using the pressure-state-response (PSR) conceptual model and the entropy method, the timber security of China during 1997–2017 was evaluated and analyzed to understand and master the situation of timber security in this paper. The results showed that: (1) The pressure of timber security in China during 1997–2017 was increasing in waves, with the condition of timber imports as the main factor; (2) the state of timber security in China presented a downward-then-upward tendency during 1997–2017, the main influencing factors of which were the domestic timber supply and forest resources condition; (3) responses to ensure the timber security of China almost indicated a steep rising trend, because both the timber industry technical progress index and the waste paper recovery rate improved the safety of timber in China; and (4) the changing trend of the comprehensive evaluation of timber security in China approximately agrees with that of the state evaluation, which showed that state indicators were key factors affecting the timber security of China. The pressures influencing the timber security of China are rising, while the state of timber security and the responses of the high-tech industry have been improving at a higher range than the pressures, which has led to an improvement of China's timber security.

Keywords: timber security; PSR model; entropy method; comprehensive evaluation

1. Introduction

Compared with other traditional raw materials (steel, cement, and plastic), timber is renewable and low emission, has relative low energy consumption in processing, and is widely used in construction and decoration engineering. Additionally, it is also the raw material of timber products, such as wood-based panels, furniture, paper, and paper products. With the continuous development of the economy and the continuous improvement of people's living standards, people increasingly prefer to buy green products. As the world's largest timber importer and second largest timber consumer, China has a huge demand for timber; however, China's total forest resources are relatively insufficient, with an insufficiently high quality and unbalanced forest resource structure. The proportion of young- and middle-aged forests is too high, while planted forests have a lesser proportion and are low in quality. The stock volume per hectare of planted forests is 52.76 m³, which is only half that of natural forests [1]. In addition, China also has a prominent structural contradiction between the domestic timber supply and demand, in that the supply of large-diameter timber is insufficient, low-end products have excess capacity, and famous and high-quality products rely mainly on imports. With the promotion of the full stop commercial logging policy on natural forests, the gap between the domestic timber supply and demand will further increase. Since the reform and opening up, the proportion

of timber imports in China has continued to rise, and the dependence of timber on foreign countries has increased from 9.8% in 1978 to 53.81% in 2017 [2,3]. In order to protect their forest resources, major timber exporters have raised tariffs on log exports or restricted or banned the export of logs. Some developed countries have established trade barriers, such as anti-dumping and countervailing, green product certification, green system certification (forest certification), green tariffs, etc., to protect their own interests. Additionally, some countries have passed legislation to restrict the import and export of timber products [4]. Therefore, it is becoming increasingly more difficult for China to rely on international trade to balance the demand for timber, and the situation of timber security is becoming increasingly severe. In this context, it is of great significance to evaluate China's timber security level and propose corresponding countermeasures.

The concept of timber security in China is not uniform, and is mostly used to characterize a state or capacity of timber sources where the supply of timber resources is not affected. Cheng Baodong and Miao Dongling believe that timber security involves not only supply security but also security on timber production, trade, and the related environment [5,6]. At present, there is no definition of timber security and no research on timber security in foreign countries, and related research mainly focuses on the timber supply and demand, forest product trade, and the impact of China's forestry policy on forest resources and the timber supply [7–10]. Mili G and Bhaskar S analyzed the situation of the wood supply in India from such perspectives as policies and decrees, and proposed countermeasures to ensure the balance of the supply and demand of wood [11]. Reiko Y, Kazuhiro A et al. analyzed and predicted the supply and demand of Japanese timber and logs from a microscopic perspective [12]. Domestic studies on timber security issues have mainly used qualitative methods to analyze the current situation of the timber supply and demand and the import and export of forest products, and put forward countermeasures to ensure timber security based on these situations [13–16]. However, there are few studies focusing on timber security evaluation. For example, Chen Yong [2] used a mathematical model to evaluate China's timber security, but the weights were assigned by subjective expert scoring methods. The results showed that China's timber security is in an unsafe state. Cheng Baodong [6] evaluated China's timber security level by using the principal component analysis method, and analyzed the trend of China's timber security level from 1995 to 2007. From the perspective of industrial security issues caused by timber resource security, the ecological security issues of resource use, and trade security issues of resource acquisition, Yang Hongqiang [17] constructed a comprehensive evaluation model of “resources-industry-production-trade” and made a systematic analysis of China's timber resource security issues. It was concluded that the level of China's low timber resource supply is relatively low, China's utilization of timber resources caused no effect on global ecological security, and that the trade security of imported resources has large risks. There are not many studies on timber security evaluation, and a certain theory and method system has not yet been formed. In the selection of some research indicators, the factors considered are mainly at the state level, which is arbitrary and subjective to a certain extent.

The conceptual model of PSR refers to the pressure–state–response model, which is an extension of the pressure–response model. Then, it was formally proposed as an ecological assessment model by the Organization for Economic Cooperation and Development (OECD) and the United Nations Environment Programme (UNEP) [18,19]. The operation mechanism of the PSR (pressure–state–response) model considers that human activities exert pressures on the environment, which in turn changes the original state of the environment, and threatens human production and development, and then human society responds to these changes through certain measures to repair the environment, thereby forming the pressure–state–response relationship between the human activities and the environment [19,20]. The model, in which pressures act as driving forces for environmental issues, the state is the result of the pressures, and the response stands for the measures, which better reflects the causal relationship between economic society and the natural environment. Based on the PSR model, the causality of timber security problems can be well analyzed, and the selection of indicators can be more scientific, objective, and comprehensive. Therefore, on the basis of defining the

concept of timber security and the PSR model, in this study, a Chinese timber security evaluation index system was built with the indicators selected from the perspectives of pressure, state, and response. Based on the time series data of 1997–2017, the entropy method and the linear weighting method were used to evaluate the level of China's timber security, analyze its changing tendency, and propose corresponding policy recommendations. The results of this study supplement and enrich the theory of timber security evaluation of the world or China, provide a scientific basis for an early warning of the world's or China's forestry industry and responding to timber security risks, and provide a decision-making reference for the formulation of sound forest resource protection policies and timber industry development policies.

2. Methods and Index

2.1. Definition

This research involves the concepts of timber and timber security. In order to ensure the accuracy and scientific nature of the evaluation, the term timber in this study does not refer to logs in a narrow perspective but includes logs and their derivatives, such as sawn timber, veneer, particleboard, plywood, fiberboard, wood products, wood pulp, paper and paper products, and waste paper. The term timber security means that a country or region can obtain timber resources required for economic and social development at a reasonable price and in a sustainable, stable, and sufficient amount; and refers to a state or capacity ensuring the supply–demand balance of timber raw materials required for the healthy and sustainable development of timber-related industries, and ensuring a good ecological environment.

2.2. Evaluation Index System Construction

Drawing on the ideas of the PSR model and based on the relevant studies on resource and energy security conducted by domestic and foreign scholars, this paper covers as comprehensively as possible the situation of various aspects of timber security. Through expert consultation and the availability of index data, 14 indicators were selected from the three aspects of pressure, state, and response to build an evaluation index system of China's timber security (see Table 1). The pressure criterion (B1) includes the social pressure factor (C1), economic pressure factor (C2), resource and environment pressure factor (C3), and trade pressure factor (C4), which comprehensively reflect all aspects of the pressures facing China's timber security. The state criterion (B2) includes the resource and environment state factor (C5), supply state factor (C6), industry state factor (C7), and trade state factor (C8), which comprehensively show the current state of China's timber security. The response criterion (B3) includes the industrial technology response factor (C9), which comprehensively presents the improvement on industrial technology for the state of timber security.

Table 1. Evaluating index system of timber security.

Target Level	Criterion Level	Factor Level	Index Level
Evaluation of timber security (A)	Pressure (B1)	Social pressure (C1)	Urbanization rate (D1)
		Economic pressure (C2)	Timber consumption per unit of GDP (D2)
		Resource and environment pressure (C3)	Population per unit of forest volume (D3)
		Trade pressure (C4)	Import concentration (D4)
	State (B2)	State of resource and environment (C5)	Inflation rate (D5)
			Forest coverage rate (D6)
			Reserve-production ratio (D7)
			Volume per unit area (D8)
		State of supply (C6)	The proportion of timber plantation forest (D9)
		State of industry (C7)	The proportion of mature forest of timber (D10)
		State of trade (C8)	Total value of timber(D11)
			Foreign dependence (D12)
	Response (B3)	Response of industrial technology (C9)	Timber industry technological progress index (D13)
			Recovery rate of recovered paper (D14)

There is a specific indicator under the social pressure factor (C1), which is an inverse index D1—urbanization rate. D1 refers to the ratio of the urban population to the total population, which reflects the level of urbanization in a country or region. Timber is the main raw material for building and decoration. The urbanization process will promote large-scale construction of urban infrastructures and housings, which puts pressure on timber security.

There is a specific indicator under the economic pressure factor (C2), which is an inverse index D2—timber consumption per unit of Gross Domestic Product (GDP). D2 refers to the ratio of timber consumption to GDP, which is a main indicator of the level of timber consumption, reflecting the degree of timber utilization by a country's economic activities, and also reflecting changes in the economic structure and timber utilization efficiency. The greater the timber consumption per unit of GDP, the greater the pressure on China's timber security.

The resource and environment pressure factor (C3) has a specific indicator, which is an inverse index D3—population per unit of forest volume. D3 refers to the ratio of the total population to the forest volume, which partly reflects the per capita forest resources occupation, and is also the basis for determining the advantages and disadvantages of the ecological environment. The greater the population per unit of forest volume, the greater the pressure on China's timber security.

There are two specific indicators under the trade pressure factor (C4), both of which are inverse indicators D4—import concentration, and D5—inflation rate. D4, which is reflected by the Herfindahl–Hirschman index (hereinafter referred to as HHI) equal to the sum of the square of the ratio of imports from the country of import and total imports, reflects the concentration degree of import sources. A larger HHI means that the importing country of this product is relatively single and the degree of concentration is higher [21]. D5 refers to the ratio of the difference between the consumer price index (hereinafter referred to as CPI) value of the current year and the CPI value of the last year to the CPI value of the last year, which reflects the degree of inflation and the degree of currency depreciation, and partly reflects the level of timber prices. The larger the inflation rate, the lower the purchasing power of the currency.

There are three indicators under the resource and environment state factor (C5), all of which are positive indicators D6—forest coverage rate, D7—reserve-production ratio, and D8—volume per unit area. D6 is an important indicator reflecting the forest area occupation status or the richness of forest resources in a country or region. D7 refers to the ratio of the annual standing stock volume to the production volume of commercial timber, and is one of the important indicators to measure the reserves of timber resources [6]. The higher the reserve-production ratio, the longer the time available for harvesting, the longer the timber supply time, and the higher the security of the timber supply. D8 refers to the ratio of the forest stock volume to the forest area, which is not only one of the basic indicators reflecting the total scale and level of forest resources in a country or region but also an important indicator for measuring timber production.

The supply state factor (C6) has two indicators, both of which are positive indicators: D9—proportion of timber plantation forest, and D10—proportion of mature forest of timber. D9—proportion of timber plantation forest refers to the ratio of the volume of timber plantation forests to the forest stock volume, which reflects the supply capacity of timber plantation forests. The higher the proportion of timber plantation forests, the higher the timber supply capacity, and the higher the timber security. D10—proportion of mature forest of timber refers to the ratio of the mature forest stock volume to the forest stock volume, which reflects the short-term timber supply capacity. The higher the proportion of mature forests, the more adequate the short-term timber supply, and the higher the level of timber security.

There is one indicator under the industrial state factor (C7), which is a positive indicator D11—total value of timber. D11—total value of timber refers to the sum of the values of timber processing output, the timber-based panel manufacturing, and the timber product manufacturing, which reflects the development of the timber industry. The higher the total value of timber, the better the development of the timber industry, and the higher the level of timber security.

There is one indicator under the trade state factor (C8), which is an inverse indicator: D12—foreign dependence. D12—foreign dependence refers to the ratio of the sum of the import volume of logs and logs in timber products to the timber quantity supplied, which reflects the degree of dependence of a country's timber supply on foreign markets. The greater the foreign dependence, the more imported timber in China's timber consumption, the greater the dependence on imported timber, and the lower the level of Chinese timber security.

There are two indicators under the industrial technology response factor (C9), both of which are positive indicators: D13—timber industry technological progress index [22], and D14—recovery rate of recovered paper. D13—timber industry technological progress index refers to the ratio of the output of wood-based panels to the output of logs, which reflects the technological level of forestry-related industries and also reflects the utilization rate of timber. The higher the timber utilization rate, the lower the unit timber utilization, and the safer the timber. D14—recovery rate of recovered paper refers to the ratio of recovered wastepaper to paper and cardboard consumption, which reflects the level of timber saving and substitution. The higher the recovered wastepaper, the less the amount of timber utilized, and the higher the level of timber security.

2.3. Data Sources and Processing

In this study, 1997–2017 is determined as the evaluation period, and China's timber security is the evaluation object. The GDP and population data in this study were sourced from the *China Statistical Yearbook*; the data of forest product output, import and export trade volume, recovered wastepaper quantity, and import volume from the FAO database; the data of timber consumption from the *China Forestry Development Report*; the output value data of timber processing, wood-based panel manufacturing, and timber products manufacturing from the *China Forestry Statistical Yearbook*; the wastepaper recovery rate data from the *Almanac of China Paper Industry* and the website of China Technical Association of Paper Industry (<http://ctapi.org.cn>); the related data of forest resources from the *Statistics of National Forest Resources*; and the harvested commercial timber data from *China Forestry Statistical Yearbook*.

It should be noted that due to the change of statistical classification, there is no specific data of timber processing, timber-based panel manufacturing, and timber product manufacturing from 1997 to 1998, so the timber output value from 1997 to 1998 was calculated based on the average percentage of the total proportion of these three categories from 1999 to 2000. Since the cutting quota data is reported once every 5 years, and the amount of commercial timber harvested in each year cannot be determined, the average value was used for processing. In addition, China's forest resources inventory was conducted once every 5 years, specific values, such as forest area and stock volume, in each year could not be determined, and data were processed according to its average growth rate.

2.4. Evaluation Method

2.4.1. Calculation Method of the Evaluation Index Weight

Based on the above evaluation index system, the timber security level in China was evaluated, and the weight of the indicators was determined by using the entropy method. The specific steps were as follows:

2.4.2. Forming a Decision Matrix

Suppose that an index system consisting of m indicators is used to evaluate n objects; the eigenvalue of the i -th indicator of the j -th evaluation object is x_{ij} , the decision matrix is formed as: $X = (x_{ij})_{m \times n}$.

1. Forming a standardized decision matrix

In order to eliminate the influence of different index dimensions on the evaluation results, the decision matrix X is standardized to form a standardized matrix $V = (v_{ij})_{m \times n}$.

The positive indicators are standardized using Equation (1):

$$v_{ij} = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)}. \quad (1)$$

The reverse indicators are standardized using Equation (2):

$$v_{ij} = \frac{\max(x_j) - x_{ij}}{\max(x_j) - \min(x_j)}. \quad (2)$$

- Calculating the characteristic proportion of the i -th evaluation object under the j -th index:

$$p_{ij} = \frac{v_{ij}}{\sum_{i=1}^m v_{ij}}. \quad (3)$$

- Calculating the entropy value e_j of the j -th index:

$$e_j = -\frac{1}{\ln(m)} \sum_{i=1}^m p_{ij} \ln(p_{ij}). \quad (4)$$

- Calculating the difference coefficient $d_j = 1 - e_j$ of the j -th index. If the entropy value is smaller, it indicates that the difference coefficient between the indexes is larger, and the index is more important.
- Determining the weight of each indicator:

$$w_j = \frac{d_j}{\sum_{k=1}^n d_k}. \quad (5)$$

2.4.3. Calculation Method of the Comprehensive Evaluation Value

The comprehensive evaluation value of China's timber security in each year was determined by the multi-objective linear weighting method. The following calculation formula was used:

$$S = \sum_{i=1}^n Y_i \sum_{j=1}^n W_{ij} V_{ij}, \quad (6)$$

where S is the comprehensive evaluation value of China's timber security, Y_i is the weight of the i -th criterion level, W_{ij} is the weight of the j -th index of the i -th index level, and V_{ij} is the evaluation value of the j -th index of the i -th index level (normalized value).

3. Results

3.1. Evaluation Index Weight

The weight of each indicator determined by the above entropy method is shown in Table 2. The greater the weight of the indicator, the greater its impact on the evaluation results, and vice versa.

As can be seen from Table 2, among the pressure criteria, the weight of the trade pressure factor is the highest, the social pressure factor and the resource and environment pressure factor are second, and the economic pressure factor is the smallest, which indicates that the state of timber trade is the most important factor affecting China's timber security, while social pressure and resource environment pressure are also important factors. Among the state criteria, the supply state accounts for the

largest weight followed by the resource and environment state factor, and the industry factor takes the smallest weight; meanwhile, that the weight of the positive indicator is much greater than that of the reverse indicator indicates that the current level of timber security in China is relatively optimistic. Among the response criteria, the weight of the technological progress indicator and the weight of the timber saving and substitution indicator are not much different, which shows that technological progress and timber saving and substitution have changed China's timber security situation.

Table 2. Weights of evaluation indicators.

Target Level	Criterion Level	Weight	Factor Level	Weight	Index Level	Weight		
Evaluation of timber security (A)	Pressure (B1)	0.2164	Social pressure (C1)	0.2354	Urbanization rate (D1)	0.2354		
			Economic pressure (C2)	0.1629	Timber consumption per unit of GDP (D2)	0.1629		
			Resource and environment pressure (C3)	0.2349	Population per unit of forest volume (D3)	0.2349		
			Trade pressure (C4)	0.3669	Import concentration (D4)	0.1677		
	State (B2)	0.6426	State of resource and environment (C5)	0.3197	Inflation rate (D5)	0.1991		
					Forest coverage rate (D6)	0.0659		
					Reserve-production ratio (D7)	0.0834		
					Volume per unit area (D8)	0.1704		
			State of supply (C6)	0.3407	The proportion of timber plantation forest (D9)	0.0490		
					The proportion of mature forest of timber (D10)	0.2917		
					State of industry (C7)	0.1610	Total value of timber (D11)	0.1610
					State of trade (C8)	0.1786	Foreign dependence (D12)	0.1786
	Response (B3)	0.1411	Response of industrial technology (C9)	1.0000	Timber industry technological progress index (D13)	0.5459		
					Recovery rate of recovered paper (D14)	0.4541		

3.2. Analysis on Evaluation Results

The pressure–state–response comprehensive evaluation values of China's timber security from 1997 to 2017 are shown in Table 3.

Table 3. Timber security evaluation of China during 1997–2017.

Year	Evaluation of Pressure	Evaluation of State	Evaluation of Response	Comprehensive Evaluation
1997	0.5657	0.5374	0.0132	0.4696
1998	0.5618	0.5188	0.0000	0.4549
1999	0.4380	0.4264	0.1704	0.3928
2000	0.4185	0.3471	0.1166	0.3300
2001	0.4442	0.3084	0.0663	0.3036
2002	0.4238	0.2580	0.1565	0.2796
2003	0.3706	0.2505	0.1751	0.2659
2004	0.4182	0.2307	0.1890	0.2654
2005	0.4322	0.2336	0.2380	0.2772
2006	0.4175	0.1665	0.3676	0.2492
2007	0.3961	0.1663	0.4736	0.2594
2008	0.4690	0.1880	0.5006	0.2929
2009	0.6555	0.2048	0.5797	0.3552
2010	0.4904	0.2717	0.6244	0.3688
2011	0.5356	0.2235	0.7033	0.3587
2012	0.6498	0.2637	0.7444	0.4150
2013	0.6016	0.3234	0.8053	0.4516
2014	0.6291	0.3741	0.9402	0.5091
2015	0.6331	0.4222	0.9267	0.5390
2016	0.6171	0.4746	0.9803	0.5768
2017	0.6413	0.4881	0.9886	0.5918

3.2.1. Analysis of the Evaluation Results of China's Timber Security Pressure

The pressure evaluation values of China's timber security from 1997 to 2017 are shown in Figure 1. As can be seen from Figure 1, the overall pressure on China's timber security shows a rising trend. As can be seen from Table 2, the urbanization rate and population per unit of forest volume had a higher weight, and thus had the biggest effect on the pressure of China's timber security. From 1997 to 2017, the continuous progress of urbanization in China led to an increasing demand for wood in China, resulting in an increased pressure on wood security. At the same time, the effect of the wood import concentration and inflation rate has led to fluctuation of the wood security pressure. China implemented a zero-tariff policy for raw sawn timber, which led to a change of China's timber import quantity and sources. In addition, increasingly more countries have formulated log export restriction policies, which have also led to the constant change of China's timber import source. The above two aspects may be the deep-seated reasons that led to the increase of the pressure level of China's timber security.

Figure 1. Pressure evaluation of timber security in China during 1997–2017.

3.2.2. Analysis of China's Timber Security State

The evaluation values of China's timber security state from 1997 to 2017 are shown in Figure 2. As can be seen from Figure 2, the trend of the evaluation values of China's timber security state from 1997 to 2018 was U-shaped. From 1997 to 2006, the evaluation value of China's timber security state decreased year by year, and reached the lowest point in 2007 at 0.1726, and then remained at a low level from 2007 until 2011. After 2011, with the improvement in the quantity and quality of forest resources, the proportion of timber plantation and the output value of the timber industry remarkably increased, and China's timber security state began to improve.

3.2.3. Analysis of China's Timber Security Response

The evaluation values of China's timber security response from 1997 to 2017 are shown in Figure 3. As can be seen from Figure 3, the evaluation values of China's timber security response from 1997 to 2013 showed a straight upward trend, but a small fluctuation occurred during 1997 to 2001. During this period of 1997–2001, the response evaluation values were generally low. However, since 2001, the response evaluation values showed an almost straight upward trend, which is mainly affected by the year-on-year increase in the level of industrial technology and the level of timber saving and substitution.

Figure 2. State evaluation of timber security in China during 1997–2017.

Figure 3. Response evaluation of timber security in China during 1997–2017.

3.2.4. Analysis of the Comprehensive Evaluation of China's Timber Security

The comprehensive evaluation results of the pressure, state, and response evaluation value can be used to obtain the comprehensive evaluation value of China's timber security level. It can be seen from Figure 4 that the comprehensive evaluation value of China's timber security from 1997 to 2018 presented a downward-then-upward tendency; China's timber security level was at a relatively low level from 2002 to 2008, which is consistent with previous research conclusions. After 2008, with the continuous development of the economy and society, the continuous increase in forest coverage, the timber output value, the timber industry technology, and the timber saving and substitution, China's timber security level gradually improved, and its comprehensive evaluation value began to rise year by year. Referring to both Figures 2 and 4, it can be found that the changing trend of the comprehensive evaluation value of timber security in China approximately agrees with that of the state evaluation value, which showed that state indicators are key factors affecting the timber security of China. The continuous improvement of forest resource quality and timber supply capacity and the healthy development of the timber industry are the main factors to ensure China's timber security. Therefore, we should strengthen the cultivation of forest resources, improve the quantity and quality of forest resources, and improve the supply capacity of forest resources.

Figure 4. The comprehensive evaluation of timber security in China during 1997–2017.

4. Conclusions and Discussion

In this research, based on the PSR model, and on the basis of following the principles of scientificity, globality, representativeness, comparability, and operability, a set of China's timber security evaluation index system was constructed, and China's timber security level from 1997 to 2017 was evaluated and its changing trend was analyzed by weighting the indicators objectively using the entropy method and through the multi-objective linear weighting method. The following conclusions were made:

- (1) During the study period, the evaluation value of China's timber security pressure increased in a wave, indicating that China's timber security pressure has been increasing, and the largest proportion of the trade indicator is the main factor causing the timber security pressure. The response evaluation value presented almost a steep rising trend, which indicates that the technology in the timber industry and timber saving and substitution have gradually been improving the state of timber security in China. Both the comprehensive evaluation value and the state calculation value of China's timber security level showed a downward-then-upward trend. In recent years, the state and response indicators have increased at a higher range than the pressure, so China's timber security level has continuously improved.
- (2) The trend of the comprehensive evaluation value and the state evaluation value of China's timber security situation during the study period are basically the same, indicating that the state indicators are the main factors influencing China's timber security level, and the supply capacity and industrial development of forest resources are the foundation of timber security. Based on the results of the indicator weights, the supply indicator and the resource and environment indicator occupy higher weights in the state criterion, which indicates that the state of timber security is mainly affected by the quantity, quality, and supply capacity of domestic forest resources. Therefore, we should strengthen afforestation, improve the level of forest management, and develop timber plantation to enhance the quality and supply capacity of China's forest resources and ensure China's level of timber security.
- (3) Based on the above analysis, the situation of China's timber security is optimistic, because this study was based on the premise that there is no restriction on timber imports. In recent years, increasingly more countries with rich forest resources, such as Gabon, Russia, and some African countries, have introduced policies to restrict or ban the export of logs. Now, more than 100 countries have issued export bans on logs. The level of China's timber security could decline if major exporting countries sharply reduce their timber exports, coupled with the implementation of comprehensive protection policies for natural forests in China. For other countries with a large

- consumption of timber and insufficient domestic self-sufficiency, attention should also be paid to the issue of domestic timber security. The study might provide a reference for ideas and methods.
- (4) Based on the conclusion, this study proposes countermeasures and suggestions to further enhance China's timber security level: Improve the quality of existing forest resources through scientific management; develop timber plantation and fast-growing high-yielding forests; strengthen the construction of reserve forest bases; accelerate the pace of forestry resource export and promote the development of overseas forest resources and cooperation of overseas timber processing; upgrade the technological level of the timber industry and enhance the timber industry's international competitiveness; vigorously expand the supply of medium and high-quality timber; promote the recovery and saving of alternative and waste timber resources; and facilitate forest certification, so as to achieve the harmony of timber production and the ecological environment's protection.
 - (5) In this study, the entropy method was used to determine the weight, which is an objective weighting method. The entropy value was used to judge the dispersion degree of an index. The greater the dispersion degree of the index, the greater the influence of the index on the comprehensive evaluation. Based on the characteristics of the original data, the entropy method was chosen to determine the weight. However, this method of weighting only relies on the actual problem, so it also has its disadvantages, such as poor participation of decision-makers, no consideration of the subjective intention of decision-makers, and more complicated calculation methods.

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