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Original Research

Assessment of Forest Health Value: A Case Study in Sanming City, Fujian Province, China

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Abstract

In recent years, with the rise of the health rehabilitation and recreation in forest (HRRF) industry in China, the ecological value of forests is no longer limited to wood and direct economic value. The forest health value has become an integral part in forest ecological value and service value evaluation. However, there is still a big gap in the field of research on forest health value evaluation, and there is considerable room for development. Based on "Specifications for assessment of forest ecosystem services in China (GB-T 38582-2020)", using data from the second type inventory of forest resources of Sanming City in 2019, it is concluded that the value of forest health in Sanming City is RMB 101.767 billion. Among them, the annual forest health value of tourism resources is RMB 21.067 billion. These results suggest that a large part of the potential health value is in Sanming City.

Keywords: valuation of forest health value, forest park, forest ecological service value, Sanming City

Introduction

As an emerging experience mode based on forest resources and service, health rehabilitation and recreation in forest (HRRF) is a new industry with forestry, medical treatment, pension, health maintenance, tourism, culture in one, which is one of the significant development directions of forest service industry in the future. The State Forestry Administration officially issued the "Thirteenth Five-Year" plan for Forestry Development on May 6th, 2016, which proposed to vigorously develop forest experience and HRRF, and stressed the need to promote the development of forest tourism, leisure, and rehabilitation industries. Although HRRF in China has received more attention of the industry and the public, some relevant research still cannot support the development of reality, especially the assessment of forest health value in which still exists a very big gap, therefore it cannot meet the urgent requirements of our country for the development and planning of forest resources in this period.

It has been a long time for the development of forest therapy in the world, represented by Germany, Canada, the United States, Australia, Japan, South Korea, Finland, New Zealand, Thailand, Cambodia, and other countries. According to forest resources and cultural characteristics, they actively explore and study forest therapy, and their main results are concentrated on the empirical research on the health effects of forest therapy. The research on HRRF industry in China

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is still in its infancy at present, and its research content is mainly about how forest environment influences the health effects of HRRF industry, such as the impact of light, temperature, humidity, phytoncide and negative oxygen ions on the health effects of HRRF industry, so it has a great development prospect in the calculation of forest health value. Against the background of increasing population aging and the gradual emergence of sub-health, Chinese scholars begin to pay attention to the development of HRRF industry and tourism construction from the theoretical and practical aspects [1].

Sanming city is one of China's five major forest healing base pilot construction cities, the city currently has a total of 20 national forest healing base pilot construction units, 2 national forest healing bases, and 4 listed in the first batch of demonstration bases for medical recuperation for employees in the province. But the healing bases in Sanming city are mainly developed by its forest parks, forest home and tourist attractions, then it is still staying at the stage of forest tourism for leisure, entertainment, and vacation in the form of walking, playing, seeing, and drinking [2]. Sanming city is remaining in the initial period in the field of HRRF industry, so evaluating Sanming city's forest health value is not only conducive to the healthy development of health rehabilitation and recreation in forest in Sanming city, but also has certain reference meaning for the evaluation of forest health value in other regions in China and other countries.

Literature Review

The term "health rehabilitation and recreation in forest (HRRF)" has evolved from "Shinrin-yoku", the Germans established the world's first forest bathing base and formed the concept of forest therapy in the early 1840s. Afterwards, the United States, Australia, South Korea, and other countries also carried out theoretical research on forest therapy in line with their national conditions. China introduced it in the 1980s and called it " health rehabilitation and recreation in forest (HRRF)" [3].

The research on forest therapy in foreign countries mainly focuses on the empirical research on the health effects of forest therapy. By collecting relevant data from empirical evidence, those forests with high-quality resources will be built into forest healing bases, and the bases will be certified. At the same time, relevant laws and regulations have been formulated to promote the development of the forest therapy industry. Li Q found that the forest bathing trip can increase the activity of NK cells, thereby releasing more anti-cancer proteins, which shows that the forest bathing trip has a certain preventive effect on the occurrence and spread of cancer [4]. Park Bum-Jin used the POMS survey method to prove that the forest and urban environment enhanced the mental vitality of 47 young male adults who received forest stay therapy. The study provides clear scientific evidence for the physiological effects of forest therapy [5]. The research on the forest healing base started in 2004 in the "Forest Heal Base Conception" issued by the Japanese Forestry Administration, which proposed the concept of "Forest Heal Base", and then the non-profit organization "Forest Therapy Association" was established. The Korean Forestry Agency issued the requirements for the feasibility assessment survey of natural recreation forests in 2012 and prepared the survey report. In order to strengthen the protection, utilization and management of forest therapy resources, Japan initially promoted the work of forest therapy in the form of "laws", The "Law on Special Measures to Improve Forest Health Functions" was formulated in 1985 and revised several times. South Korea promulgated the "Forest Culture and Cultivation Act" in 2005, and in 2015 the National Assembly approved the "Forest Welfare Promotion Act" [6].

While absorbing international research results, Chinese scholars are gradually paying attention to research on forest tourism, development suggestions, industrial development, and recuperative factors. Starting from the influencing factors of forest health tourism, Li Jiren and Xu Dong used the analytic hierarchy process to construct a forest health tourism evaluation index system [7]. Cong Li and Zhang Yujun put forward suggestions on the development of forest tourism to forest health tourism, and at the same time strengthen the study of forest health tourism policies and regulations, and build an index system for forest health tourism bases [8]. He Binsheng [9], Bai Fangmin [10], Liu Fujiang [11] and others took Sichuan, Hunan, and Liaoning as examples, respectively, and put forward suggestions on the development of HRRF industry. China's research on the construction and certification of forest healing bases is still in its infancy. Pan Yangliu and others have built an evaluation index system for the construction of forest healing base using expert consultation methods and theoretical analysis methods [12]. Liu Chaowang [13], Tan Yimin [14], Hu Qia [15] and others explored the construction of the forest healing base. Wang Fuguo and others have carried out many empirical studies on forest bathing in humans, and found that forest bathing can relieve the symptoms of hypertension in the elderly in some aspects, and has a good promotion effect on the health of elderly patients with chronic obstructive pulmonary disease (COPD) [16]. Through the research of domestic and foreign literatures about forest health care, it can be found that there is a very large gap in the calculation of forest health care value both at home and abroad. The health value of forests is an important part of the value of forest ecological services, and its value measurement is of great significance to both the forest health industry and the realization of the value of ecological products.

Evaluation Method of Forest Health Value

Evaluating the value of forest health is mostly based on the "Standards for Evaluation of Forest Ecosystem Service Functions (GB-T 38582-2020)" [17], and adjusting in its recommended methods. It is computed as:

$$U_r = 0.8U_k$$

where U_r is annual forest health value of tourism resources, unit: yuan*a^{-1}; U_k is the value of forestry tourism and leisure industry, and forest rehabilitation and recuperation industry in various administrative regions, including tourism income, directly driven other industries' output, unit: yuan*a^{-1}, we consider the value is the sum of forest recreation value and employment value provided by forests; k is the number of administrative region; 0.8 means that the number of tourists received and the tourism output value created by the forest park accounts for about 80% of the total scale of forest tourism in China.

$$U_f = 0.2\left[\frac{U_r}{S}(1-S)\right]$$

where U_f is annual forest health value of non-tourism resources, unit: yuan*a^{-1}; S is the ratio of the tourism forest area to the total forest area in Sanming city; as non-tourism forest resources have not been exploited, the value calculated directly in proportion to the forest area using the annual forest health value of tourism resources does not truly reflect its annual forest health value of non-tourism resources, we consider the actual annual forest health value is 20% of the annual forest health value of non-tourism resources calculated according to the proportion of forest area.

So, the final forest health value in Sanming city can be written as follows:

$$U = U_r + U_f$$

Assessment Method of Forest Recreation Value

We use contingent valuation method to evaluate forest recreation value. The advantage of the contingent valuation method is that it can effectively evaluate the non-use value of the recreation area, and it is suitable for the assessment of the recreation value of different nature and different development stages [18]. In the absence of tourists' survey data, the development coefficient method can be used to evaluate forest recreation value using related statistical data, the specific method is as follows:

forest recreation value = annual maximum recreational income of regional forests*regional development coefficient

annual maximum recreational income of regional forests = annual maximum environmental capacity for forest recreation*recreational income per person

$$\text{regional development coefficient} = \frac{1}{1+e^{3-\frac{1}{engel\ coefficient}}}$$

Assessment Method of Forest Employment Value

We evaluate forest employment value uses the "human capital approach", that is the value of labor is used to reflect the value of forestry system. The specific calculation formula of direct employment value is:

$$V = R \times W$$

where R is the number of employees, we select the number of employees in each unit of the forestry system. According to the World Bank's research, the value-added index of direct employment provided by the forestry system is 2.2~4.2, we choose 3.2 as the value-added index. The specific calculation formula of indirect employment value is:

indirect employment value = the number of direct employments*3.2*regional average wage

Results and Discussion

Overview of Sanming City

Sanming City, located in the middle of Fujian Province, has 1 county-level city, 2 municipal districts and 9 counties. The total area of the whole territory is 22,965 square kilometers, and the territory is mainly middle-low mountains and hills. The terrain is high in the southwest and low in the northeast. Sanming City is the birthplace of China's "two mountains" theory. In 2019, the forest area was 1.9 million hectares, accounting for 82.7% of the land area, the forest coverage rate was 78.73%, and the forest stock volume was 182 million cubic meters. Therefore, it is known as the "Green Capital of China". With 6 national forest parks, 19 provincial forest parks and 2 national wetland parks in Sanming City, the development of forest health care industry is in the ascendant.

The abundant forest resources of Sanming City have laid a solid foundation for the development of the forest health industry. The average concentration of negative oxygen ions in the city's forests is 1500/cm^3, even more than 5000/cm^3 in some state-level nature reserves and forest parks, such as Junzifeng State-level Nature Reserve, Castanopsis Kawakamii Forest Park, etc., in line with the world "Freshness" standards set by the WHO. And its ambient air quality has reached

or surpassed the national secondary standard in the past eight years. In addition, the use value of water resources in Sanming City is very high. The river health qualification rate is 100%. It has mineral water rich in carbon dioxide, calcium, magnesium and other elements, and hot springs rich in trace elements such as lithium and metasilicate acid [19].

At present, Sanming City has issued the "Sanming City's Opinions on the Development of the Whole Region Forest Rehabilitation Industry" and "Sanming City Forest Rehabilitation Base Evaluation Method (Trial)", and successively signed a Cooperation Framework Agreement on Forest Rehabilitation with the State Academy of Forestry and Grassland Administration, Beijing Forestry University, Fujian Forestry Administration, and China Sleep Research Society. The top ten forest health care bases such as Datian Taoyuan's most oxygen sleep town and Sanyuan Castanopsis have been built. A number of key enterprises such as Taining Danya, Sanyuan Castanopsis Forest Tourism, Fujian Tiandou Ecological, etc. have also been identified. All this shows that Sanming City is gradually advancing the entire region's forest rehabilitation industry, and continues to expand and strengthen the forest rehabilitation industry [20].

Data Source

The forest resource data used in the evaluation is based on the second-class forest resource survey data of Sanming City in 2019, with the county as the statistical unit, including detailed information such as the area and stock volume of various forests; The price information used in the evaluation mainly comes from the relevant technical documents and statistical data of the Sanming Forestry Bureau, the Statistics Bureau and other departments.

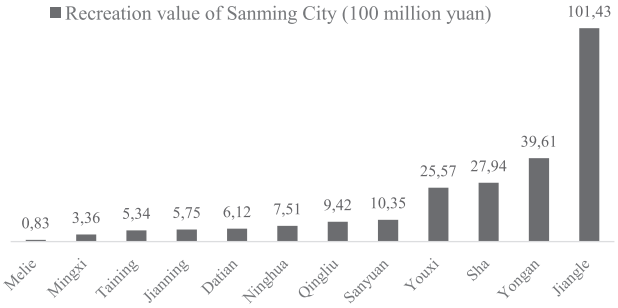

Fig. 1. Comparison of forest recreation value of various districts and counties in Sanming City in 2019.

Result Analysis of Forest Health Value

According to the demographic statistics and Engel coefficient statistical data in the "Sanming City Statistical Yearbook" and the forest tourism statistics data in the "Sanming City Forestry Statistical Yearbook", the estimated annual forest recreation value of Sanming City is 24.323 billion yuan. Among them, Jiangle County has the highest forest recreation value at 10.143 billion yuan, followed by Yong'an City at 3.961 billion yuan, and Meilie District has the lowest forest recreation value at 83 million yuan. The recreational value includes the value of tourism resources and health care bases such as forest parks, nature reserves, forest homes and health care bases (Table 1).

According to the number of employees and the average annual salary of employees in each district in the "Sanming Forestry and Forestry Statistics

Table 1. Results of forest recreation value in Sanming City in 2019.

District	Number of recreational visitors per year (10^4)	Total annual income (¥10^4)	Number of permanent residents (10^4)	Forest area in 2019 (Km²)	Recreation value in 2019 (¥10^4)
Melie	69.60	2263.70	18.6	296.247	8256.72
Sanyuan	21.77	3524.00	20.5	677.203	103533.71
Mingxi	12.80	188.42	10.3	1478.316	33637.81
Qingliu	21.72	3629.80	13.7	1542.007	94212.62
Ninghua	31.81	2233.30	28.7	1865.589	75070.11
Datian	37.50	1598.80	32.1	1739.536	61161.33
Youxi	29.16	2701.00	36.2	2840.173	255713.73
Sha	33.80	1733.40	23.3	1457.767	279397.08
Jiangle	83.80	12360.00	15.3	1957.137	1014310.31
Taining	1180.82	818769.00	11.5	1262.951	53438.63
Jianning	41.77	1237.80	12.1	1369.837	57490.78
Yongan	50.43	2940.00	35.7	2523.577	396072.44

Table 2. The total value of employment opportunities provided by forests in Sanming City in 2019.

District	Number of employees in the unit	Average annual salary of on-the-job employees (¥)	Direct value ($¥10^4$)	Indirect value ($¥10^4$)	Total value ($¥10^8$)
Sanyuan	395	91246	3604.22	11533.49	1.51
Meilie	184	86687	1595.04	5104.13	0.67
Mingxi	341	77211	2632.90	8425.26	1.11
Ninghua	363	77750	2822.33	9031.44	1.19
Qingliu	458	68381	3131.85	10021.92	1.32
Yongan	745	65971	4914.84	15727.49	2.06
Datian	477	94518	4508.51	14427.23	1.89
Youxi	949	99136	9408.01	30105.60	3.95
Sha	837	90758	7596.44	24308.62	3.19
Jiangle	543	72075	3913.67	12523.75	1.64
Taining	218	75526	1646.47	5268.69	0.69
Jianning	294	82623	2429.12	7773.17	1.02

Yearbook", the total value of employment opportunities provided by the city's forests in 2019 is 2.011 billion yuan, of which the direct value is 479 million yuan, and the indirect value is 1.532 billion yuan. (Table 2)

According to the value of forest recreation and the value of employment opportunities provided by forests, it can be calculated that the value of forest health in Sanming City in 2019 is 101.767 billion yuan, of which the annual forest health value of tourism resources is 21.67-billion-yuan, accounting for 20.7%; the annual forest health value of non-tourism resources is 80.7-billion-yuan, accounting for 79.3%.

Sanming City has very rich forest health resources, but it can be seen from Fig. 3 that the current value of Sanming City's Forest health and health has not been maximized. The value of forest health that can really play a role only accounts for 20.7%. This part of the forest health value is mainly composed of the value of relying on forest resources to develop leisure tourism and quality development, and the value of employment provided by HRRF industry, among them, the value brought by relying on forest resources to carry out leisure tourism and quality development is much higher than other values, and it is also the part that needs to be paid attention to in the future development process. A large part of the value exists in the forest ecosystem environment outside of tourism resources, such as the value generated by the special effects of forests on human health in terms of essence, oxygen, and negative oxygen ions. There is also the value brought by the integration of forests and pension, traditional Chinese medicine, education, sports, and other industries, etc. All the above needs to be brought into play in the process of rational development of forest resources by Sanming City on the basis of insisting on the principle

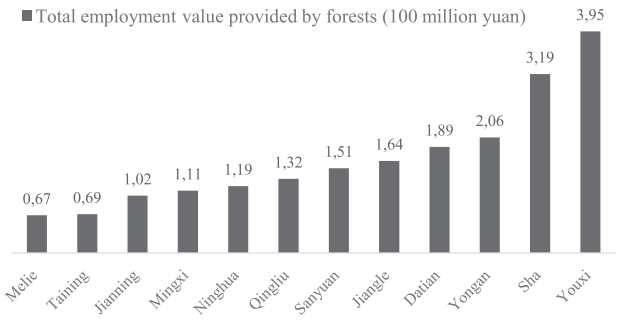

Fig. 2. Comparison of the value of employment opportunities provided by forests in various districts and counties of Sanming City in 2019.

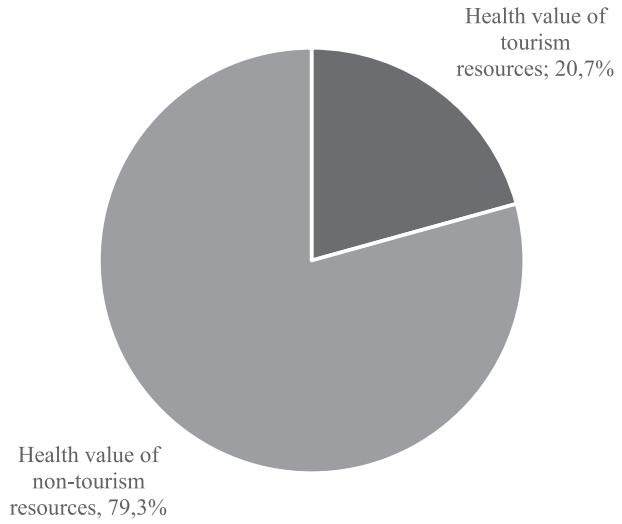

Fig. 3. The proportion of the value of forest health in Sanming City.

of protection first and scientific development and utilization.

Conclusions

According to the data of Sanming City in 2019, it can be calculated that its forest health value is 101.767 billion yuan, of which the annual forest health value of tourism resources is 21.06 billion yuan, and the annual forest health value of non-tourism resources is 80.7 billion yuan. It shows that there is still a large part of the potential health value in Sanming City. Affected by the new coronavirus pneumonia epidemic, people's health concepts have undergone a very big change. They have shifted from focusing on treatment over prevention, and focusing on elderly care over health preservation, to a health care concept that covers the entire life cycle of medical treatment, rehabilitation, health care, health preservation, and elderly care, covering all age groups[21], which has promoted the development of the HRRF industry. Under the current background, Sanming City strives to promote the construction of the HRRF industry, combining local characteristics to integrate HRRF with culture, sports, education, and other industries. It not only promotes the forestry ecological civilization, improves the level of public resource services, solves employment and economic pressures, but also enriches the HRRF product system and drives a large number of peripheral products, which greatly enhances the forest health care value. It not only meets the requirements of my country's "green development" and conforms to the concept of "healthy China", but also highlights the urban positioning of Sanming City as "China's Green Capital · Most Oxygen Sanming", "Lin Shenshui Beauty Longevity" and "China Green Capital".

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Conflict of Interest

The authors declare no conflict of interest.

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