Ecological Value Realization of Forests: A Case from China

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Abstract: In this paper, we will use the theory of ecological capital to present the concept of capitalization of forest ecological resources. Ecological capital theory provides a powerful tool for environmental improvement and will play an important role in reducing carbon dioxide emissions and global warming. This paper takes the forest ecological resources in Fujian province as an example. We choose one specific case from China to describe how forest ecological resources can be transformed into forest ecological assets and then into forest ecological capital, leveraging the value of forests to achieve carbon neutrality—providing theoretical references for maximizing the value of forest ecological resources and achieving the sustainable development of global forest resources. Based on the ecological capital theory, we discuss the ways and effects of forest ecological resources capitalization. In addition, we provide ideas for maximizing the use of forest value and reducing carbon emissions. We will discuss the value of forestry from an environmental aspect and an economic aspect. This paper further analyzes the possibility and prerequisite of promoting the Fujian model.

1. Introduction

Up to 25 billion tons of carbon dioxide are emitted globally every year. Global warming is a consequence that follows due to carbon dioxide emissions. Climate change has affected the world. Extreme natural phenomena, such as drought, heatwave, rainstorm, flood, and earth slip, arose worldwide. The main factor that causes extreme climate change is air pollution. The vital part of air pollution is the emission of carbon dioxide. Carbon neutrality refers to the balance between carbon emission from the atmosphere and carbon absorption in the carbon sink. The principal natural carbon sinks are soil, forest, and ocean.

China is a mountainous country, with 1.8 billion mu of arable land, more than 4 billion mu of forest land, 69% of the country's land area in the mountains, and more than 400 million in the mountains. In 2008, China's rural reform contracted 2.5 billion mu of communal forest land to households. To achieve coordinated development of various agriculture, forestry, and animal husbandry, farmers made full use of forest land resources and the advantages of forest shade to engage in forest planting, breeding, and other production operations. At the same time, people have now faced the problem of managing and protecting forest resources due to the uncontrolled use of forests. Since China is a country endowed with unique resources, how to maximize the value of forest ecological resources and promote the sustainable development of global forest resources is essential. It is of great significance in promoting the sustainable development of forest resources.

In this paper, we will use the theory of ecological capital to present the concept of capitalization of forest ecological resources. We choose one specific case from China to describe how forest ecological resources can be transformed into forest ecological assets and then into forest ecological capital, leveraging the value of forests to achieve carbon neutrality—providing theoretical references for maximizing the value of forest ecological resources and achieving the sustainable development of global forest resources. We will discuss the value of forestry from an environmental aspect and an economic aspect. In environmental aspect, we mainly focused on the value of nitrogen fixation and

oxygen production of the forestry. We calculate the value of forest purification in in Shunchang. In economic aspect, we introduce the division of labor and cooperation, and analyze its impact on the financial service system. In this paper, we used spatial analyze tools, such as GeoDa. Plus, we used the data from the National Bureau of Statistics to support our points and claims. In the end, we summarize our research, envision possible future research in this field and put forward some limitations in our paper.

2. The Environmental Value of forests

2.1 Forest coverage in Fujian Province

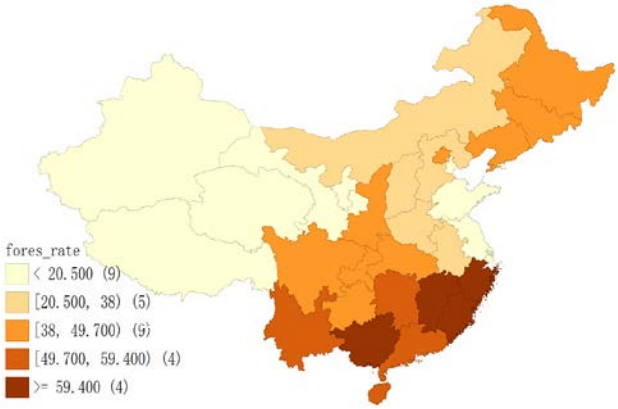

Figure 1. Forest coverage rate in China in 2019.

Our group collected information from the National Bureau of Statistics and created a map of the forest coverage rate in China in 2019. As it can be seen according to fig.1., Fujian Province is heavily forested, so the value of forests there can be fully exploited.

2.2 The value of nitrogen fixation and oxygen production

According to the survey data, the growth process of trees is the process of photosynthesis. Thus, for every 162g dry matter produced by forest growth, 264g CO_2 should be absorbed (fixed) and 192g O_2 released. For every 1t of dry matter formed by trees, 1.63t CO_2 was absorbed (fixed) and 1.2t O_2 was released (Chen, 2007). According to Nanjing City Forest Research 45% of a tree is dry matter.

A storage capacity of state-owned forests farm in Fujian Province:

2,962,674m^3

Dry matter mass:

2962674 x 0.45=1,333,203t

The amount of CO_2 absorbed:

1333203t x 1.63=2,173,121t

The amount of O_2 released:

1333203t x 1.2=1,599,843t

According to the above calculation data, forests absorb a large amount of carbon dioxide and release abundant oxygen, which plays a huge role in reducing greenhouse gases and carbon neutralization. So how to develop the environmental value of the forest plays a positive role in the protection of the environment.

2.3 The value of forest purification

Absorption of sulfur dioxide: according to the data in the "Economic Value of Biodiversity in China" prepared by Nanjing Research Institute of the State Environmental Protection Administration, the absorption capacity of broadleaf forest for sulfur dioxide is 88.65 kg/hm^2. So, the amount of sulfur dioxide absorption = 215.6 × coniferous forest area (hm^2) + 88.65 × broadleaf forest area (hm^2).

Fluoride uptake: The price of absorbing hydrogen fluoride is 0.16 Yuan/kg, which is the average of the funding standards such as air pollutant emission charges for coal-fired kilns. The value of

fluoride absorption = 0.16 × [4.65 × broad-leaved forest area (hm^2) + 0.5 × broad-coniferous forest area (hm^2)].

Absorption of nitrogen oxides: According to the Korea Science and Technology Agency, when 1067, 000 t of nitrogen oxides occurred, the uptake amount was 6.0 kg per hectare of forest, and the possible uptake rate was 3.5 %. And the amount of nitrogen oxide absorption = 6.0×forest area (hm^2).

Value of dust retention and reduction: it is measured that the dust retention capacity of broad-leaved forest is 10.11t/hm^2 and that of coniferous forest is 33.2t/hm^2. The amount of dust reduction = 10.11 × broad-leaved forest area (hm^2) + 33.2 × coniferous forest area (hm^2).

Sterilization: forest sterilization value = 15% × total forest stock value × (1/0.1-1).

Noise reduction value: Forests have the function of noise reduction, and sound waves are reflected or absorbed by the dense branches and leaves without direction. The value of forest noise reduction is estimated in the same way as the value of sterilization to estimate the value of noise reduction. According to the relevant information, the noise reduction value of forest = 10% × the total value of forest stock × (1/0.1-1).

2.4 Calculation results of the value of forest purification in Shunchang County

Nowadays, China's air quality is being seriously damaged, making people's quality of life continuously reduced. But the forest can absorb pollutants to achieve the purpose of decomposition and metabolism of pollutants, effectively reduce the harmful substances in the atmosphere.

Amount of environmental purification: Amount of sulfur dioxide absorbed = 88.65 × broadleaf forest area (hm^2) = 685886(t); Absorption of fluoride = 4.65 × broad-leaved forest area (hm^2) = 35977.1(t); NOx uptake = 0.6 x broadleaf forest area (hm^2) = 4642.21(t); Amount of dust reduction obstruction = 103 × 10.11 × broad-leaved forest area (hm^2) = 78221200(t).

Since the state-owned forest in Shunchang County is mainly composed of broad-leaved trees, the value of environmental purification is mainly calculated by using the area of broad-leaved trees. The area of broad-leaved forest is 7737.01hm^2.

Absorption of sulfur dioxide: The value of sulfur dioxide absorption = 0.6 × 88.65 × broadleaf forest area (hm^2) = 411532 (yuan);

Fluoride uptake: the value of fluoride absorption = 0.16 × 4.65 × broadleaf forest area (hm^2) = 5756.34 (yuan);

Absorption of nitrogen oxides: value of nitrogen oxide absorption = 1.34 × 0.6 × broadleaf forest area (hm^2) = 6220.56 (yuan);

Value of dust retention and reduction: the value of dust reduction = 0.56 × 103 × 10.11 × broadleaf forest area (hm^2) = 43803900 (yuan);

Sterilization: value of broadleaf forest sterilization = 15 % × 1433381 × (1/0.1-1) = 1935060 (million yuan);

Noise reduction value: noise reduction value = 10% × 1433381 × (1/0.1-1) = 1290040 (yuan).

According to the above calculation, as we can see, forests can effectively absorb harmful substances from the air. Due to the environmental purification effect of forests, a large amount of national financial expenditure which spending on the environmental protection can be reduced every year. But the forest resources are also limited, and with the increase of population, the forest coverage rate gradually decreases. Therefore, we need to protect the forest, and realize the value of the forest for the environment. We should insist on rational logging and put an end to excessive logging, because forest is an important part of maintaining ecological balance.

3. The Economic Value of forests

3.1 From the forest end: division of labor and cooperation

Originally, foresters had to be responsible for the whole process, but when the state-owned forest farm took over the land, it could achieve a good division of labor. And under the system of "Forest Ecological Bank", the state-owned forest farm of Shunchang County in Fujian Province centralized the scattered land of farmers for professional management through four ways: purchase, share

cooperation, lease and trusteeship. The purchase method means that if foresters do not want to continue operating, the "Forest Ecological Bank" will buy up their forestland management rights and forest ownership rights. In terms of the share cooperation method, if the forester intends to joint operation, the forester can take forest resources as assets to become the shareholder, and the "Forest Ecological Bank" will share the profit of the forestry to the forester. For the leasing method, foresters who have idle forestland may lease the forestland and obtain rental returns. For the last trusteeship method, it is mainly targeted at low-income families. During the trusteeship period, the foresters can gain early access to the benefits of forests, which means they don't need to wait for the trees to be cut down to get the money, but the state-owned forest farm will pay them in advance the expected revenue of the forests, and after logging, the foresters will get more than 60% of the share. Therefore, under the unified management of the government, a good division of labor can be formed. For example, the scientific institute is responsible for cultivating superior seeds, the small-scale forest farmers are responsible for planting trees, the state-owned forest farm is responsible for professional logging, and the processing enterprises are actively responsible for the processing and sales of wood. Each process has a professional division of labor, which improves the quality and quantity of wood output. On the one hand, through intensive and efficient management, the increment of timber output is 117m3, which is about 25% higher than that of small-scale forestry management mode. On the other hand, unified FSC certification can be carried out due to large-scale operation, and cooperation with processing enterprises downstream of the industrial chain can increase the wood price by 100 yuan per cubic meter.

3.2 From the capital end: financial service system

Trees usually take 10-20 years to grow before they can be cut down, so it is difficult for foresters to turn forest resources into cash immediately. But the "Forest Ecological Bank" can solve this problem. Take the "carbon sink loan" between the state-owned forest farm of Shunchang County and the Xingye bank as an example. Because of the carbon dioxide emissions permits can be traded between different departments in the society, so if an enterprise's carbon dioxide emissions exceed its emission limits, it will purchase forest carbon sinks from forest farms to offset their own carbon emissions. So, the forest farm can take the unsold carbon sink as a pledge, and borrow money from the bank because the farm can guarantee a stable cash flow in the future. In this case, based on the trading price of carbon emission permits in the current market, Xingye Bank made a loan of 20 million yuan to the forest farm. Ultimately, the forest farm paid back the loan after it sold the permits to the enterprises. Until November 2019, Fujian province has issued 12 projects with a total of 1.84 million tons of carbon sink, which is expected to realize more than 30 million yuan of trading funds. Through carbon sink trading, farmers have more avenues for income growth, and rural economic revitalization is strongly boosted. So "carbon sink loan" has primarily helped the forest resources turn into the wealth smoothly. In other words, foresters no longer need to take the houses as mortgages to borrow money but can take the forests as mortgages for loans, which solves the problem of long conversion cycle of forest value.

3.3 From the rural economic structure end

The secondary sector usually includes manufacturing, construction and other basic industries. Fujian Province has the highest proportion of secondary industry in GDP in China.

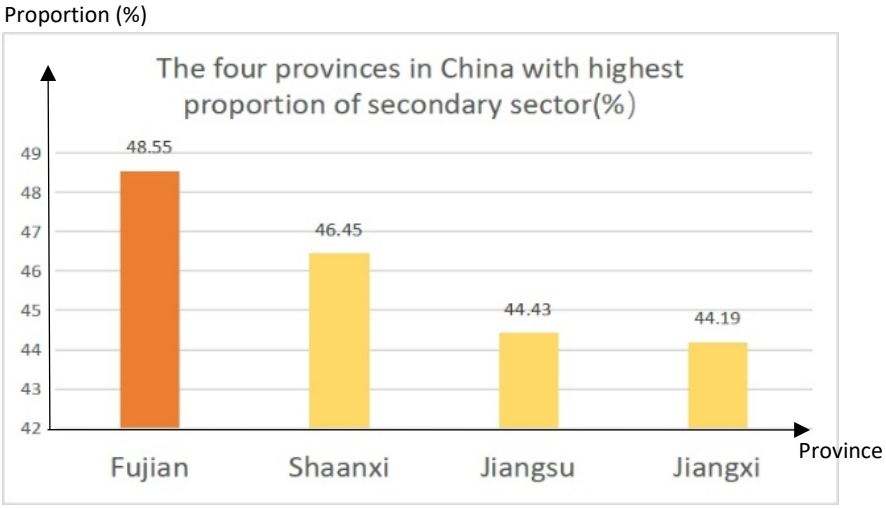

Figure 2. The four provinces with highest proportion of secondary sector.

And the tertiary sector includes finance, tourism and other service industries. Fujian Province has the lowest proportion of tertiary industry in GDP in China.

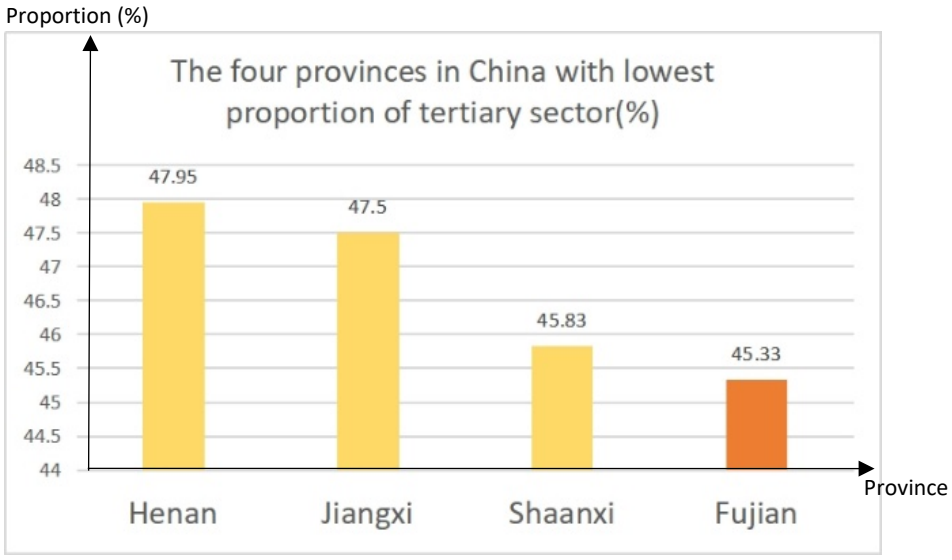

Figure 3. The four provinces with lowest proportion of tertiary sector.

Fig.2.and Fig.3. show the industrial structure in different provinces in China. In mentioning industrial structure, it is generally believed that whether a country is developed and whether people's living standards are improving in that place is mainly measured by the proportion of tertiary sector in GDP. As can be seen from the charts, the secondary sector in Fujian Province accounts for a large proportion while the tertiary sector accounts for a small proportion. So, the charts indicate that Fujian Province needs to vigorously develop the tertiary sector to adjust its GDP structure. For example, tourism should be vigorously developed there. Just like the "Forest Ecological Bank", through the loan from the financial company mentioned above, the farmers there can have funds to build some basic facilities in the places which are not suitable for planting to attract the tourists. If they can build some hotels that will attract tourists who want to enjoy the wonderful scenery, and if they can build some restaurants that will attract tourists who want to taste the fresh foods. Besides, the tourism can indirectly trigger other service industries such as the civil aviation industry, the railway industry and so on.

4. Conclusion

1) The reference significance of forest ecological bank

In order to attain carbon neutrality, not only do organizations need to promote the forest resources,

as mentioned in the above section, but we also need to enforce nationwide legislation. Since CO_2 concentration in the air depends on both forest coverage rate and CO_2 emission, regions should maintain a balanced ratio for forest coverage and sources of CO_2 emission. In other words, given the current forest coverage rate, how many factories should there be, or how much more forest coverage is required? Government should encourage research on related topics and financially support researchers with deriving the ratio. Based on CO_2 absorption and emission in different regions, the government should issue tradable emission permits and distribute them proportionally to previous pollution levels. The proportion may vary from region to region and make it difficult for smaller firms to operate: low emission limits may force smaller firms to sell the permits and shut down. In this case, the government shall provide financial support to smaller businesses that are willing to relocate. Government can also restrict emissions by levying Pigouvian taxes, which should be calculated and updated regularly based on the ratio and data in different regions. Regions with lower taxes will attract more firms. As for exploiting the economic value of forests, the priority should be given to poor areas with rich ecological resources, and poverty alleviation and sustainable development should be promoted at the same time, so that poor people can benefit more from ecological protection and restoration.

2) Future studies

Under the increased forest conservation situation, farmers who previously relied on the land for agriculture may feel threatened by the reduction of available land. However, an efficient way called under-economy forest can ameliorate this situation. Because there are lots of open spaces between trees, so farmers can make full use of them to grow some vegetables and precious medicinal materials. This kind of economic advantage of forest shade to engage in forest planting, breeding, and other production operations allows farmers to make full use of their woodlands and achieve a livelihood without cutting down trees.

In addition, most forest-rich areas are more isolated and less educated, which leads to farmers' resistance to new changes. Due to the lack of media popularity, farmers are not clear about the policy of forest rights mortgage. Therefore, the government needs to publicize more to the farmers, let the villagers understand the benefits of forestry financial projects, and let the villagers participate in these projects more actively. In addition, the lack of credit guarantee institutions makes financing difficult. So, it is necessary for the government to legislate for forestry financing projects and use the laws to constrain the borrowings and loans.

3) Limitations

Due to the limited available data about the state-owned forest farm in Shunchang County, we took the value of broad-leaved forest as the main object of calculation when analyzing the environmental purification value of forests, ignoring the value of some other trees.

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