Social Science, Humanities and Sustainability Research
ISSN 2690-3628 (Print) ISSN 2690-3636 (Online)
Vol. 5, No. 1, 2024
www.scholink.org/ojs/index.php/sshsr

Original Paper

Research on Constraints and Countermeasures of Forest Carbon Sink Economic Development in Sichuan Province

Ling Huang[1]

[1] School of Economics and Management, Sichuan Minzu College, Kangding, Sichuan, China

Received: December 5, 2023 Accepted: December 27, 2023 Online Published: January 10, 2024

doi:10.22158/sshsr.v5n1p37 URL: http://dx.doi.org/10.22158/sshsr.v5n1p37

Abstract

In response to global climate change, China has made a solemn commitment to achieve carbon peak by 2030 and carbon neutrality by 2060, with the development of carbon sink economy being an important approach to fulfill the dual carbon goals. Sichuan Province, with its abundant forest resources and vast territory, possesses a strong carbon sink capacity, which naturally lends itself to the development of a carbon sink economy. Based on Sichuan Province, this paper analyzes the current situation and challenges of carbon sink economic development, explores the ecological compensation mechanism for carbon sink economy under the dual drivers of ecological protection and economic development, harnesses the ecological functions of carbon sink economy, and contributes to the realization of the dual carbon goals, in line with the concept of "Clear waters and green mountains are invaluable assets".

Keywords

Sichuan Province; low-carbon economy; forest carbon sink; carbon neutrality

1. Introduction

Climate change has become one of the most pressing challenges facing the world today. There is immense pressure for global greenhouse gas emissions reduction, and as a major emitter of carbon dioxide, China plays a crucial role in global climate governance. On September 22, 2020, China announced at the 75th session of the United Nations General Assembly that it strives to peak its carbon dioxide emissions by 2030 and achieve carbon neutrality by 2060. The establishment of the "dual-carbon" goals represents a solemn commitment by China in response to global climate change after the Copenhagen Conference. It also reflects the significant strategic decision made by the Central Committee of the Communist Party of China in addressing unprecedented changes and embodies the profound interpretation of China's pursuit

of ecological civilization and the construction of a community with a shared future for mankind. China's commitment to peak carbon emissions and achieve carbon neutrality in a shorter time frame than developed countries not only demonstrates its role as a responsible major country but also showcases its strong determination and will to contribute to global ecological security (Feng, 2021).

According to the IPCC Sixth Assessment Report, even if global warming is maintained within the range of 1.5-2.0℃, some regions will still face severe agricultural drought disasters. When global warming reaches 4℃, approximately 50% of human habitations will be affected by drought (Jiang & Wang, 2021). The emissions of greenhouse gases, represented by CO2, have already impacted human survival and development. Low-carbon emissions reduction has become the basic national strategy for most countries, and decarbonized transition and development have become a consensus worldwide, leading to what is known as the fourth green revolution. Mitigation and adaptation to climate change have become the shared consensus of the international community, with the core approach being to reduce greenhouse gas emissions from human activities and increase carbon stocks in terrestrial and marine ecosystems (Gao et al., 2013), addressing both carbon sources and carbon sinks. On one hand, carbon emissions can be controlled at the source through structural adjustments, energy conservation, environmental protection, and the development of renewable clean energy. On the other hand, in the terminal carbon sink market, the emitted carbon dioxide is absorbed, including technology-based carbon sequestration (CCUS carbon sequestration) and natural based carbon sequestration (NBS ecological absorption). Forests and grasslands are globally recognized as the most effective and cost-efficient natural means of biological carbon sequestration, with forest carbon sinks being more efficient and economical than other emission reduction methods. They have become an important pathway for many countries to achieve carbon neutrality (Xu & Yi, 2022). Therefore, the development of forest carbon sinks economy has become a critical approach to addressing global climate change and ensuring sustainable economic development. According to Xinhua News, by 2060, national carbon emissions may be around 2.5 billion tons, and the carbon sink from forests and grasslands could reach 15-18 billion tons, contributing over 60% to China's carbon neutrality efforts.

Although the forest carbon sink economy in China started relatively late, the academic attention is very high. Scholars have studied forest carbon sink economy from multiple perspectives. In terms of research areas, some scholars have studied forest carbon sinks in Shandong (Yang et al. , 2023), Shanxi (Cao et al. , 2023), Fujian (Zhang & Chen, 2021) and other provinces; in terms of research methods, some scholars have used biomass conversion factor method (Fang & Chen, 2001), BS option method (Zhou , 2023) to measure the value of forest carbon sinks; in terms of research perspective, some scholars have conducted research from perspectives such as ecological compensation (Lv & Liu, 2023), welfare effect (Luo et al., 2023), poverty alleviation (Gong et al., 2019); and some scholars have studied the carrying capacity of forest carbon sinks in China from the perspective of carbon footprint model (Huang et al., 2016). Overall, there are few studies on forest carbon sink economy in Sichuan Province. Based on existing research, this article studies the current situation of forest carbon sink economic development in

Sichuan Province, explores the constraints in its development process, and proposes targeted countermeasures to promote the development of carbon sink economy.

2. The Concept of Carbon Sink and Forest Carbon Sink

The term "carbon sink" comes from the *Kyoto Protocol* signed by the parties to the *United Nations Framework Convention on Climate Change,* which is a general term for the processes, activities, and mechanisms of removing CO2 from the air. (Jia et al., 2012) Whether through natural absorption or technological sequestration, greenhouse gases emitted into the atmosphere can be consumed or stored, and this process is called carbon sink.

The *United Nations Framework Convention on Climate Change* has given a clear definition of forest carbon sink. Forest carbon sink refers to the process and mechanism of forest absorbing carbon dioxide in the atmosphere and converting it into organic substances through photosynthesis. In real life, forest carbon sink is not only a process related to forest production and management activities, but also involves policies and management of carbon trading markets. Therefore, to some extent, forest carbon sink is an economic category.

3. The Economic Value of Forest Carbon Sink in Sichuan Province

Forests are the main body of terrestrial ecosystems and the largest carbon pool in terrestrial ecosystems, with the carbon sink function of removing CO_2 (Liu et al., 2023). Sichuan Province has a vast territory, with a wide coverage of forests and grasslands, and has natural advantages in developing a carbon sink economy. According to data from the National Bureau of Statistics, by 2023, the forest coverage rate in Sichuan Province had reached 40.2%, and the comprehensive vegetation coverage of grassland had reached 82.3%. The forest area ranked fourth in the country, making it one of the provinces with the largest natural forest area in China.

3.1 The Value of Forest Carbon Sequestration for Economic Development

Forest carbon sequestration, as one of the important ecological products of ecosystems, possesses characteristics of public goods and evident externalities. Public goods, as opposed to private goods, refer to goods that one person's consumption does not diminish the consumption of others. Public goods are non-rivalrous and non-excludable. When anyone consumes forest carbon sequestration, it does not affect others' consumption, and the marginal cost of production is zero. The consumption of forest carbon sequestration does not exclude others, and the ability to consume is not determined by whether or not payment is made. Externalities refer to the spillover effects on the public resulting from certain actions by individuals or organizations, which can be positive or negative. The cost of addressing externalities is usually high; therefore, for positive externalities, the government should provide subsidies, and for negative externalities, the government should impose taxes. Forests absorb carbon dioxide, store it, and release oxygen, resulting in significant positive externalities for society. The input of managers involved in forest carbon sequestration is not proportionate to the rewards they receive. The marginal personal

benefits of forest carbon sequestration are significantly smaller than the marginal social benefits, and there is a phenomenon of free-riding in society. Hence, forest carbon sequestration exhibits significant positive externalities (Tan, 2022).

3.2 The Significance of Forest Carbon Sequestration for Economic Development

Promoting the development of forest carbon sequestration is of utmost urgency and holds significant importance. Firstly, developing forest carbon sequestration is consistent with the national concept of ecological civilization and the policy of pursuing sustainable economic development. Secondly, Sichuan Province, as a western region, has fragile ecological conditions due to long-term extensive production and management. Additionally, the province's forests are located in remote areas with weak economic foundations. Developing the forest carbon sequestration economy can not only increase the income of local farmers and enhance the motivation of forest workers but also improve the system of ecological compensation and enhance forest ecological benefits. Furthermore, the development of the forest carbon sequestration economy can effectively transform a large number of forest resources in prohibited or restricted development zones into important sources of regional economy, promoting economic development and consolidating the achievements in poverty alleviation. The development of the forest carbon sequestration economy is an important approach to transforming "green mountains and clear waters" into "invaluable assets" (Ma, 2018).

4. Factors Constraining the Development of Forest Carbon Sequestration Economy

In the dual goals of economic development and ecological conservation, the sustainable development of the forest carbon sequestration economy is of great importance. However, the development of forest carbon sequestration economy in Sichuan Province is still constrained by many factors.

4.1 Unclear Definition of Forest Carbon Sequestration Property Rights

Due to historical reasons, China's forest resources have multiple objects of property rights, resulting in unclear property rights, disputes over ownership, excessive logging, ecological destruction, lack of management, and severe forest disasters, which in turn affect the long-term accumulation of carbon sequestration. Although the country has gradually attached importance to it, forest resources have been effectively protected, but disputes over ownership easily arise when economic activities occur, limiting the endowment of carbon sequestration resources (Luo & Shan, 2023). As a public good, forest carbon sequestration naturally experiences the free rider problem. The prominent feature of public goods is the presence of significant externalities, where the personal benefits obtained by forest owners are generally lower than the social benefits. With the implementation of forest carbon sequestration projects, the costs of labor, management, and other aspects are increasingly high, while the investment returns are relatively low, resulting in low enthusiasm and initiative among forest rights owners for forest management, operation, and provision of carbon sequestration products in the market (Guan et al., 2021).

4.2 Imperfect Ecological Compensation Mechanism for Forest Carbon Sequestration

On one hand, according to the *Management Measures for the Forest Ecological Benefit Compensation Fund in Sichuan Province*, the subsidy for our province's forests is 14.75 yuan per mu, which is far lower than the subsidy levels in Western countries in absolute terms, neglecting the value of forest ecological services, especially the value of carbon sequestration (Zhao et al., 2023). On the other hand, forest carbon sequestration projects require large investments, have long cycles, and slow returns. The government does not have corresponding subsidy policies, and most of the investments are made by relevant companies. Moreover, domestic carbon prices have not aligned with international carbon prices. The carbon sequestration price in our province is about 40 yuan per ton, while the international price is ten times higher. This also leads to low investment enthusiasm for most carbon sequestration projects, and similarly, farmers cannot afford the high investment costs, resulting in slow development of forest carbon sequestration.

4.3 Insufficient Effective Demand in the Forest Carbon Sink Market

From the voluntary emission reduction targets before the United Nations Climate Change Conference in Copenhagen in 2009 to the "National Independent Contribution" at the United Nations Climate Change Conference in Paris in 2016, China's non-mandatory emission reduction gave enterprises with high carbon emissions a lot of room, which also hindered the development of the forest carbon sink market, resulting in insufficient demand for forest carbon sinks in the market. In 2017, the government proposed a "voluntary first, mandatory later" policy, but the mandatory purchase of carbon quotas are concentrated in the three industries with high carbon emissions, such as steel, thermal power, and chemicals. Other industries are still voluntarily purchasing, and the government issued quotas can basically meet the mandatory purchase share. Forest carbon sinks belong to voluntary offset projects, and most companies do not have the enthusiasm and initiative to purchase them on their own. Although Sichuan Province has a wide forest area, with large forest carbon sink reserves and potential, due to the limited number of truly achievable market effective demand in the carbon sink market, it currently only has market potential and has not yet formed the elements and functions of the market (Zhou & Li, 2021).

5. Countermeasure Suggestions for the Development of Forest Carbon Sink Economy in Sichuan Province

5.1 Clarify the Ownership of Forest Carbon Sink Property Rights

The clarification of carbon sink property rights is a prerequisite for forest resources to participate in the carbon market and integrate into social and economic development (Zhang et al., 2023). Among natural resources, as a public good, forest carbon sinks have particularly prominent externalities. Defining forest carbon sink property rights is a prerequisite for developing forest carbon sink pilot projects and solving environmental resource problems. In terms of defining forest carbon sink property rights, the government needs to formulate mechanisms such as forest resource assessment, supervision, monitoring, insurance, and forest right disputes resolution to provide guarantees (Guan & Shi, 2016). Furthermore, clarifying

forest carbon sink property rights can increase the enthusiasm of forest management entities and promote market demand.

5.2 Improve the Ecological Compensation Mechanism for Forest Carbon Sinks

Due to the positive externalities of forest carbon sinks, certain ecological benefits spill over, and the general public is the beneficiary of this ecological benefit. Therefore, compensation should be given to the producers of ecological benefits (Zeng & Zhang, 2021). Therefore, the government should further improve the ecological compensation mechanism for forest carbon sinks to turn them into financial assets. The Sichuan Forestry and Grassland Bureau should conduct a census of the current situation of ecological resources in Sichuan Province in a timely manner, accurately grasp the total amount of forest carbon sinks and subsidy support, and carry out scientific planning and construction. The compensation mechanism for forest carbon sinks should not only be integrated with the carbon trading market, but also be integrated with international carbon prices. Carbon sink projects should be selected according to local conditions to build a modern ecological industry system, achieve strategic improvement of regional resources, promote low-carbon economic development under the perspective of green economy, not only promote the development of carbon sink markets, but also maintain sustainable development of the ecological environment (Chen, 2022).

5.3 Establishing a Sound Forest Carbon Market Mechanism

5.3.1 Primary Market Led by the Government

In the primary market, carbon quotas are primarily allocated by the government to high-emitting enterprises, with only a small portion being sold. Drawing on the experience of developed countries in Europe and America, all carbon quotas are priced uniformly and made available for individuals or organizations through a unified auction. The funds generated from the auction are used for the development of forest carbon projects or compensation for forest management entities. Additionally, government authorities establish benchmark emission values for different industries and implement a higher purchasing ratio for individuals or organizations that exceed their allocated emissions to offset their carbon emissions.

5.3.2 Secondary Market Led by the Market

In the secondary market, forest carbon and quota trading activities are determined by the invisible hand of the market. Individuals or organizations with surplus carbon quotas can engage in autonomous transactions in the secondary market, while those with insufficient quotas have the option to autonomously purchase them, with prices determined by the market. With the relaunch of CCER projects, it is also possible to purchase CCER projects to offset excessive carbon emissions. Forest carbon projects are a popular type of CCER project in the carbon trading market.

By utilizing both an active government and an efficient market, a sound forest carbon market mechanism is established. The government should actively guide individuals or organizations required to purchase carbon quotas, gradually fostering a voluntary purchasing mindset. Incentives and recognition should be

provided to individuals or organizations voluntarily participating in the market, encouraging broader participation and expanding market demand (Zhang etc., 2023).

6. Conclusion

Sichuan Province possesses natural ecological advantages for the development of forest carbon economy, but it also faces various constraints. However, measures such as clarifying forest carbon property rights, improving forest carbon ecosystem compensation mechanisms, and establishing a sound forest carbon market mechanism can effectively promote the development of forest carbon economy in the region. This not only contributes to the sustainable development of the local economy and the improvement of people's living standards but also facilitates ecological conservation and the response to global climate change. This article provides important guidance and references for further research and practical implementation.

Author Biography: Huang Ling (1985—), female, Han nationality, born in Meishan, Sichuan Province, lecturer, master of economics, mainly engaged in research on regional economy and ecological economy, member of the Northwestern Sichuan Ecological Economic Development Research Center. Email: 343974480@qq.com.

Reference

Cao, H., Wang, D., & Zhao, P. (2023). Evaluation of the economic value of forest carbon sequestration in Shanxi Province and research on the establishment of a trading evaluation system. *Economic Issues*, *7*, 120-128.

Chen, H. W. (2022). "Double carbon" goals and the development of ecology and economy. *Journal of Henan Forestry Science and Technology*, *42*(1), 33-35.

Fang, J. Y., & Chen, A. P. (2001). Dynamic changes and significance of China's forest vegetation carbon pool. *Chinese Bulletin of Botany*, *2001*(9), 967-973.

Feng, J. P. (2021). The key role of forestry in carbon neutrality. *China Forestry Industry*, *3*, 2.

Gao, Y., He, N. P., & Wang, Y. F. (2013). Carbon sequestration characteristics of ecosystems and research progress. *Journal of Natural Resources*, *28*(7), 1264-1274.

Gong, R. F. et al. (2019). Analysis of the poverty alleviation effect of forest carbon sink based on farmers' perception. *South China Economy*, *9*, 84-96.

Guan, B., & Shi, Z. (2016). Study on the definition of collective forest resource ecological property rights. *Environmental Protection*, *44*(9), 44-46.

Guan, L., Zhang, J. J., & Zhang, Y. N. (2021). The impact of China's forest carbon sink mechanism construction on the reform performance of collective forest rights. *Tax and Economy*, *2021*(5), 69-76.

Huang, Y. S., Qu, J. S., & Liu, L. N. (2016). Research on the differences of carbon footprint and carbon bearing capacity in China's provinces. *Ecological Economy*, *32*(6), 38-43.

Jia, J. D., Wei, X., & Jin, S. Q. (2012). The enlightenment of Australia's development of carbon sink agriculture to China. *Journal of Agricultural Science and Technology*, *14*(2), 7-11.

Jiang, D. P., & Wang, X. X. (2021). Interpretation of drought changes in the IPCC's sixth assessment report. *Journal of Atmospheric Sciences*, *44*(5), 650-653.

Liu, X. M. et al. (2023). Carbon sequestration approaches for China's artificial forest ecosystems in serving the dual carbon targets. *Ecological Science*, *43*(14), 5662-5673.

Luo, S. J., & Shan, S. P. (2023). The way to consolidate and improve forest carbon sinks in state-owned forests: A case study of Qixingguan State-owned Forest Farm in Guizhou Province. *China Forestry Industry*, *2023*(2), 82-83.

Luo, S. L. et al. (2023). The welfare effects of rural economic forests carbon sequestration projects from a relative perspective. *Journal of Nanjing Forestry University* (Natural Sciences Edition), *47*(4), 253-261.

Lv, J. W., & Liu, B. (2023). Preliminary discussion on the establishment of China's forest carbon sequestration ecological compensation mechanism. *Agricultural Economy*, *8*, 116-117.

Ma, N. (2018). Research on forest carbon sink and carbon sink economic development in ethnic areas. *Guangxi Ethnic Studies*, *4*, 124-133.

Tan, W. T. (2022). *The evaluation of the economic value and influencing factors of forest carbon sinks in Guangxi*. Guangxi University of Science and Technology.

Xu, J. T., & Yi, Y. Y. (2021). Double Carbon" targets and nature-based solutions: Potentials and policy needs for forest carbon sequestration. *Issues in Agricultural Economics*, *2022*(9), 11-23.

Yang, M. L. et al. (2017). Evaluation of the economic value of forest carbon sequestration: A case study of Shandong Province. *Journal of Shandong Agricultural University* (Social Sciences Edition), *19*(2), 77-84.

Zeng, X. X., & Zhang, Z. C. (2021). The generation and connotation of compensation rights for forest ecological benefits. *Hebei Agricultural Machinery*, *2021*(4), 166-168.

Zhang, J., & Chen, Q. (2021). Evaluation of the economic value of forest carbon sequestration: A case study of Fujian Province. *Journal of Southwest University* (Natural Science Edition), *43*(5), 121-128.

Zhang, Q., Diao, G., & Zhao, R. (2023). An exploratory analysis of the path to realize the value of China's forestry carbon sinks from the perspective of the "forest resources-carbon market-social economy" system [J/OL]. *World Forestry Research*: 18 [2023-12-27].

Zhang, X. R. et al. (2023). Analysis of forestry carbon sink development countermeasures in Handan City under the background of "double carbon" goals. *Qinghai Forestry Science and Technology*, *2023*(3), 56-60+105.

Zhao, Z. B. et al. (2023). Research on the compensation mechanism of forest ecological benefits based on carbon sink trading in Hebei Province under the background of “double carbon” goals. *Forest Resources Management*, *2023*(2), 10-16.

Zhou, J. H., & Li, X. (2021). The potential of forest carbon sink development in western Hunan. *Resources Information and Engineering*, *36*(6), 112-115.

Zhou, Q. C. (2023). *Research on the evaluation of carbon emission asset value based on the improved BS model*. China University of Mining and Technology.