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Original Paper

Ecology of Yuqing County Carbon Sink Calculation and Ecosystem Protection Measures

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Abstract

Based on the remote sensing statistical data of land use of terrestrial ecosystems in Yuqing County, this paper calculates the amount of carbon sinks in the county according to the existing carbon sink carbon density index, compares the amount of different types of carbon sinks, and analyzes their respective carbon sink potential. The results show that the forest carbon sink is the largest, about 2.2 million tons, accounting for 75% of the total carbon sink in the county, showing the great potential of forest vegetation to absorb CO_2 through photosynthesis, followed by the carbon sink produced by dry land (cultivated land), about 400,000 tons, accounting for 13% of the total carbon sink in the county; Although the amount of wetland aquatic carbon sink is small, its carbon density is very large, and it has the advantages of short renewal time and fast carbon sink, so it has great potential and can be artificially regulated to increase carbon sink. Based on the above research and analysis, combined with the spirit of the national carbon peak and carbon neutral policy and the natural law of ecosystem development, three measures to protect and increase carbon sinks in terrestrial ecosystems were put forward: (1) continuing to carry out forestry planting and do a good job in forestry protection; (2) stabilizing the surface water area and developing aquatic carbon sinks; (3) Establish a long-term monitoring system to ensure the contribution of carbon sinks, provide support for the protection of ecosystem and the development of carbon sink potential in Yuqing County from two aspects of science and management, and compare the amount of different types of carbon sinks, and analyze their carbon sink potential. On this basis, combined with the spirit of the national carbon peak and carbon neutral policy and the natural law of ecosystem development, three kinds of terrestrial ecosystem carbon sink protection and increase wording were put forward accordingly, which provided support for ecosystem protection and carbon sink potential development in Yuqing County from two aspects of science and management.

Keywords

Carbon neutrality, ecosystem, Yuqing, environmental protection, policy recommendations

1. Introduction

With global climate change, countries around the world have issued corresponding policy responses. In September 2020, China proposed to achieve "double carbon" of "carbon peak" and "carbon neutrality" in 2030 and 2060 respectively, reflecting China's determination to develop a green low-carbon economy and the responsibility of a big country. Subsequently, in January 2022, the State Council issued the document [2022] 2 , "Opinions of the State Council on Supporting Guizhou to Break a New Path in the Development of the Western Region in the New Era", which put forward requirements for Guizhou's future development, hoping to clearly point out that Guizhou should persevere in promoting the construction of ecological civilization. Guizhou actively promotes the development of low-carbon cycle, explores the implementation of Carbon Capture, Utilization and Storage (CCUS) demonstration projects, and carries out "ecological protection and restoration projects of important river and lake wetlands"; "Support Guizhou to explore the path of carrying out the rights and interests transaction of ecological resources and the asset securitization of ecological products"; "Actively promote the development of low-carbon cycle. Consolidate the carbon sink capacity of forest ecosystems and give full play to the benefits of forest carbon sequestration. Explore the implementation of carbon capture, utilization and storage (CCUS) demonstration project. The above policy opinions clarify the main direction and requirements of Guizhou's future work in the field of ecological environment and natural resources.

Terrestrial ecosystems fix one third of the carbon in the atmosphere, and different types of terrestrial ecosystems have different carbon capture capabilities. The area of forest and grassland ecosystems accounts for more than half of the area of terrestrial ecosystems, and at least 40% of global soil carbon is stored in forest ecosystems and 10%-30% in grassland ecosystems (Hu, Ma, Bai, Guo, Ren, & Zhao, 2021; Li, Huang, Zhang, et al., 2021; Kong, Yao, Peng, et al., 2010). The area of agricultural ecosystem accounts for 38.5% of the terrestrial ecosystem, which is the most active carbon pool in the process of carbon cycle of terrestrial ecosystem. The universality of agricultural activities and the dual attributes of significant carbon sequestration and release have attracted widespread attention of scholars at home and abroad in the study of carbon cycle (Kong, Yao, Peng, et al., 2010; Lv & Zhang, 2019; Deng, Xu, Li, Lin, Li, & Yu, 2022; Wu, Guo S. S., Guo P., Shan, & Zhang, 2022). Although wetlands account for the least area, they still occupy a place in the carbon cycle of terrestrial ecosystems by virtue of their high carbon sequestration efficiency. Therefore, quantitative analysis of forest, grassland, agriculture and wetland ecosystem carbon sinks is the basis of accurate accounting of terrestrial ecosystem carbon sinks. Compared with the more comprehensive accounting of ecosystem carbon sinks in western developed countries, China's research is limited to the regional carbon sink accounting of some vegetation and soil types, lacking a comprehensive assessment of the entire terrestrial ecosystem (Fang, Guo, Piao, & Chen, 2007; Li & Zhang, 2022; Cui, Wei, Liu, Zhang, & Li, 2019). Therefore, it is urgent to accurately calculate

the current and future carbon sequestration potential of terrestrial ecosystems in China to achieve carbon neutrality. In this context, Yuqing actively integrates its own ecological environment advantages and actively explores new ways of high-quality development. In this paper, the carbon sink of various terrestrial ecosystems in Yuqing County is calculated, and the potential of carbon sink contribution is analyzed. According to the policy guidance and the development plan of Yuqing County, the corresponding carbon sink protection countermeasures are put forward to promote the transformation between ecological resource assets and economic value, broaden the path of realizing the value of ecological products, and more effectively transform “green mountains and rivers” into “golden mountains and silver mountains”.

2. Calculation of Carbon Sequestration under Different Land Use in Yuqing County

Through the remote sensing image data, with the help of ArcGIS software, the basic pre-processing work such as clipping is carried out, and the projection transformation is carried out, and finally the remote sensing image data of equal area projection is obtained (Liu & Yan, 2016; Xie, 2017; Cheng, Wang, Ma, & Qian, 2020; Zhao, Feng, Cheng, & Li, 2020). When classifying land types, 8 types are classified according to the standard of Classification of Land Use Status, including forest land, grassland, wetland, garden plot, water area, paddy field (cultivated land), dry land (cultivated land) and construction land (Liu, Zhan, Si, Liu, Wu, & Zhang, 2020). Specific classification contents are shown in Table 1:

Table 1. Classification of Land Use of Terrestrial Ecosystem in Yuqing County

Classification of land use	Classification meaning
Woodland	It refers to broad-leaved forest and green coniferous forest, with a vegetation coverage rate of more than 40%, which plays an important role in climate regulation and water conservation.
Grassland	It refers to all kinds of grasslands with herbaceous plants as the main growth and coverage of more than 5%, including shrub grasslands dominated by grazing and sparse forest grasslands with canopy density of less than 10%.
Wetlands	It refers to the land in flat and low-lying areas, in a long-term humid state, with the characteristics of poor drainage, long-term humidity, seasonal or perennial water accumulation, and the growth of herbaceous plants on the surface.
Plantation land	It mainly refers to the land planted with perennial woody and herbaceous plants and managed by collecting fruits and leaves, with a vegetation coverage of about 10%.
Waters	It mainly includes rivers, lakes, rivers, reservoirs, ponds, ditches, etc. It refers to the land below the perennial water level in the surface water area.
Paddy field	It refers to the cultivated land with guaranteed water supply and normal irrigation

(cultivated land)	function in normal years, which is used to grow aquatic crops such as rice and lotus root, including the cultivated land with rotation of rice and dry land crops.
Dry land (cultivated land)	It refers to the dry crop cultivated land with water sources and irrigation facilities, which can be irrigated normally in general years.
Land for construction	It refers to the land used by rural residents except Kaixian Town and those independent of towns. It includes land types mainly including factories and mines, industrial areas, oil fields, salt fields, quarries, traffic roads, airports and other land facilities, as well as other land for special purposes.

In this paper, the carbon density index method of each terrestrial ecosystem under different land use is used to calculate the carbon sink of each type in Yuqing County. The calculation principle is to calculate the carbon sink of the ecosystem based on the carbon density coefficient proposed in the existing research based on the difference of land use (Zou, He, Ye, Zhao, Xu, Xiao, & Duan, 2020). The calculation results are shown in Table 2:

Table 2. Calculation of Carbon Sink of Each Terrestrial Ecosystem Subsystem in Yuqing County

	Wood land	Grassland	Wetlands	Plantation land	Waters	Paddy field (Cultivated land)	Dry land (Cultivated land)	Construction Land use
Area (10,000 hectares)	9.432	0.018	0.001	0.928	0.446	1.282	2.557	0.843
Carbon density coefficient (Ton C/hm2)	23.29	7.55	27.53	12.18	10.2	13.08	15.42	3.61
Carbon sink (10,000 tons)	219.665	0.133	0.018	11.299	4.552	16.769	39.431	3.012
Proportion (%)	74.493	0.045	0.006	3.832	1.554	5.687	13.372	1.021

The carbon density coefficient refers to the mass of carbon absorbed and fixed under the land use mode per unit area, and the unit is (ton C/hm2).

It can be seen from the analysis of the calculated values in Table 2 that the total carbon sink of each terrestrial ecosystem subsystem in Yuqing County is 2,944,790 tons, with various types of ecological carbon sink types. The main carbon sink potential comes from the forest carbon sink, which is 2,196,650 tons, accounting for 74.493% of the county's carbon sink potential. Vegetation in forest ecosystem

absorbs atmospheric CO_2 through photosynthesis, which is recognized as the most important type of carbon sink in the world. Internationally, a large number of forestry planting areas are being increased to achieve the purpose of artificially changing land use types and artificially increasing forestry carbon sink. Yuqing County has been sticking to forestry planting for a long time, showing good policy guidance and government execution. Secondly, it is the dry land (cultivated land) carbon sink, accounting for 13.372% of the total carbon sink, which is similar to the forest carbon sink. Planting crops through cultivated land also uses the photosynthesis of plants to absorb and reduce atmospheric CO_2.

The above forestry carbon sinks and dry land carbon sinks are realized by the photosynthesis of terrestrial plants, while plants in water (aquatic plants) can also form carbon sinks. The main mechanism process is that soluble rocks (mainly limestone and dolomite) in karst areas absorb CO_2 in the atmosphere through weathering and form dissolved inorganic carbon (DIC). It enters the surface water body through the water cycle, and then forms stable organic carbon through the photosynthesis of aquatic plants, which is fixed and stored, and finally forms a carbon sink. This is the carbonate weathering carbon sink (CCW) theory of coupling aquatic photosynthesis summarized by Liu and Wolfgang (2015), Liu (2012).

It can be seen from Table 2 that the carbon density of aquatic photosynthetic carbon sinks is very large, especially in wetlands. According to CCW theory, in wetland areas with weak hydrodynamic conditions, low water level and lush aquatic plants, aquatic photosynthesis is strong (Yang, , Liu, , Sun, , Yang, & Chen, 2016; Yang, Liu, Sun, Yang, & Chen, 2017), so the carbon density coefficient of wetlands is large. Yuqing County is backed by the Wujiang River Basin and has strong water resources. It is worth emphasizing that the county has a national wetland park-Feilonghu Wetland Park, which can fully rely on the strength of science and technology to upgrade the scenic area and form a model of prosperity through science and technology (Yu, 2011).

3. Countermeasures for Carbon Sink Protection of Terrestrial Ecosystem in Yuqing County

3.1 Continue to Carry out Forestry Planting and Protect Forestry

Forest is the main component of terrestrial ecosystem, and its structure is extremely complex. The diversity of tree species enables the ecological function of forest resources to be brought into full play. With the sustainable development of social economy, the protection of forest for the ecological environment has been gradually strengthened. In order to ensure the sustainable development of forestry ecological protection, it is necessary to give full play to the ecological service function of forests. If the ecological environment is not protected, it will cause the destruction of the ecological environment.

Firstly, artificial intervention can build a good environment for the growth of trees, so that the ecosystem can repair itself in a relatively short period of time. In view of the actual situation of Yuqing County, the ecological environment can be improved by closing hillsides to facilitate afforestation and artificial afforestation to help restore damaged vegetation. Carrying out ecological environment protection in a scientific and reasonable way can effectively promote the sustainable development of forestry ecological protection. In the process of closing hillsides to facilitate afforestation, it is necessary to choose the

appropriate way according to the actual situation of tree species and seedlings, and to determine the time of closing hillsides to facilitate afforestation through scientific calculation. In addition, artificial afforestation should be combined to help vegetation recover quickly. The vegetation area can be restored by returning farmland to forests and grasslands, so that the effect of afforestation can be seen in a short time (Chen, Luo, Ye, Zhao, Wang, & Han, 2013). Secondly, we should increase the scale and scope of afforestation and the types of trees, enhance their diversity, and give full play to the development of forestry to bring the ecological, economic and social benefits of afforestation into full play. Therefore, in the process of expanding afforestation area and strengthening forest land tending management, it is necessary to take the comprehensive benefits of forests as the core task of afforestation. Only by ensuring that afforestation can give full play to the ecological benefits of trees and enhance other benefits, can the sustainable development of forestry ecology be realized. Forestry departments need to strengthen their understanding of the forestry market, such as the development direction of the market and market demand, and then select suitable tree species for cultivation according to the development direction of forestry ecological protection, or by purchasing saplings for afforestation. In addition, we should strengthen the information construction of forestry ecological protection. In the process of forestry ecological construction, it is necessary to improve the utilization rate of natural resources, and adjust the development mode and progress of the whole forestry construction according to the environmental characteristics of the planting area, so as to effectively reduce the economic losses in the construction process.

3.2 Stabilize the Surface Water Area and Enhance the Aquatic Carbon Sink

It can be seen from Table 2 that surface waters have the advantages of short carbon sink cycle and high carbon density, and have strong potential for carbon sink development and utilization. It is also one of the ecosystems with high ecological service value on the earth, providing living space and habitat for plants, birds, fish and benthic animals, and is an important basis for biodiversity conservation. Therefore, the aquatic carbon sink capacity can be improved by stabilizing the surface water area. First of all, river banks and lakeshore should be protected and any form of water encroachment should be prohibited. Stop straightening and hardening the river channel. With the social construction, straightening and hardening of rivers and banks are often seen, even in rural areas. In addition to the central areas of central cities, the practice of straightening and hardening rivers should be abandoned, and efforts should be made to restore the natural rivers that have been transformed. Secondly, it is forbidden to dig sand in the river. Because many rivers have become seasonal waterways, and because of the increasing demand for sand and gravel for capital construction, many places take sand from rivers as building materials. The river bed is an organic part of the river, which has been formed naturally for thousands of years. Once the riverbed is damaged, it will lead to river diversion, soil erosion and other problems, and may even cause unpredictable floods. The sand and gravel shall be taken from a special sand and gravel plant, and shall not be excavated from the river at will. In addition, mining is prohibited under or near surface water systems (rivers, lakes, reservoirs, wetlands, etc.). Under normal circumstances, surface water will not

turn into groundwater, but if the underground is mined out, the surface water will easily seep into the underground and disappear permanently from the ground. Underground mining may also cause the change and decline of groundwater level. In recent years, the author has visited some mining areas, all of which have the problem of water loss without exception. What mining gets is nothing more than some minerals, but once the surface water system is destroyed, it may form an irreversible environmental disaster.

3.3 Establish a Long-term Monitoring System to Ensure Carbon Sink Contribution

At present, the development and utilization of terrestrial ecosystem carbon sinks in China is still in its infancy, which is not enough to match its due contribution and potential. In order to accelerate the development and utilization of carbon sinks in China, we should organize and carry out key technical research as soon as possible, establish technical specifications for carbon sink investigation, monitoring, measurement and evaluation, study technologies for improving carbon sequestration and storage capacity, design and establish carbon sink monitoring methodologies in the whole chain, and form a scientific and standardized carbon sink standard system as soon as possible (Shi, Cao, Zhang, Mao, & Chen, 2022).

Firstly, it is equally important to establish a scientific and systematic carbon sink investigation and monitoring system to improve the level of carbon sink development and utilization in terrestrial ecosystems. We will build a national key laboratory for carbon cycle research or a carbon sink monitoring engineering technology center, build a network of carbon sink observation stations with reasonable layout and smooth operation, and strengthen the effective connection between the carbon sink survey and monitoring system, the ecosystem carbon flux observation system and the hydrological and water resources monitoring system. Secondly, it is necessary to build a representative carbon sink monitoring system in different sub-regions, identify the carbon cycle process of terrestrial ecosystems and the control factors of carbon sinks, develop the technology of increasing carbon sink potential under artificial intervention, and guide the classification and grading of national carbon sink potential; In addition, regional characteristics, eco-geological conditions, regulation and control measures should be coordinated, and carbon sequestration potential zoning, artificial regulation and control measures and regional carbon neutralization zoning should be carried out at different levels. Finally, to carry out the pilot demonstration construction work, we can establish a “calculable, verifiable and controllable” quantitative assessment technology system of carbon sinks, and then carry out the pilot demonstration of carbon sink trading, which will be included after the restart of the national certified voluntary emission reduction (CCER) market.

4. Conclusion and Discussion Conclusion

Based on the remote sensing statistical data of the terrestrial ecosystem in Yuqing County, this paper calculated the amount of carbon sinks in the county according to the carbon density index of carbon sinks under different land use types reported by previous studies, and compared the amount of carbon sinks of different types, and analyzed their respective carbon sink potential. The results showed that the total

carbon sink of each terrestrial ecosystem subsystem in Yuqing County was 294. 479 million tons, and there were many types of ecological carbon sinks, among which the forest carbon sink was the largest, which was 219. 665 million tons, accounting for 74. 493% of the total carbon sink in the county, showing the great potential of forest vegetation to absorb CO_2 through photosynthesis; The second is the carbon sink produced by dry land (cultivated land), the amount of carbon sink reaches 394,310 tons, accounting for 13.372% of the total carbon sink in the county, which is similar to the forest carbon sink. Planting crops through cultivated land also uses the photosynthesis of plants to absorb and reduce atmospheric CO_2.

According to the above calculation results, in the process of ecological construction in the future, the goal of "carbon peak" and "carbon neutralization" in China can be achieved by promoting the type of large carbon sink potential. Among them, the forestry carbon sink is the largest type of carbon sink at present, and its contribution to the total carbon sink is also the largest, which can form more carbon sinks through continuous reforestation activities. However, forestry carbon sequestration takes a long time, takes effect slowly, and the management process is relatively complex. Relatively speaking, water areas (including rivers, lakes, reservoirs, paddy fields, wetlands, etc.) can continuously carry out carbon sequestration due to the photosynthesis of aquatic plants, and the benefits of carbon sequestration are better due to the fast growth and reproduction of aquatic plants and the short renewal cycle. On the basis of the above research and analysis, combined with the spirit of the national carbon peak and carbon neutral policy and the natural law of ecosystem development, it is proposed to (1) continue to carry out forestry planting and do a good job in forestry protection, (2) stabilize the surface water area and develop aquatic carbon sinks, (3)establish a long-term monitoring system to ensure the contribution of carbon sinks. It provides support for the protection of ecosystem and the development of carbon sink potential in Yuqing County from two aspects of science and management.

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