Scientific and Social Research, 2025, Volume 7, Issue 7
https://ojs.bbwpublisher.com/index.php/SSR
Online ISSN: 2981-9946
Print ISSN: 2661-4332

Research on Spatial Optimization of Carbon Sources and Carbon Sinks in the Urban Agglomeration around Poyang Lake under the Guidance of Carbon Balance

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Abstract: In the context of the advancement of the "dual carbon" goals, research on the carbon source—carbon sink balance of the urban agglomeration around Poyang Lake has very important practical significance. However, due to socio-economic differences in industrial layout and uneven population distribution, there are significant spatial differences in carbon sources and sinks. Based on this, the author will conduct an in-depth analysis of the general situation of the urban agglomeration around Poyang Lake in this paper, and propose corresponding carbon source and carbon sink spatial optimization strategies for the urban agglomeration in combination with the influencing factors of the spatial distribution of carbon source and carbon sink in the urban agglomeration around Poyang Lake, hoping to provide some reference and assistance to readers.

Keywords: Carbon balance; Urban agglomeration; Carbon sources and sinks

Online publication: August 12, 2025

1. Introduction

In the face of the severe challenge of global climate change, the balance between carbon emissions and carbon absorption has become the focus of the international community. To address this global challenge, China has put forward the "dual carbon" goals of "carbon peak and carbon neutrality", aiming to achieve sustainable economic and social development through measures such as energy conservation, emission reduction, and increased carbon sinks. In this context, the study of carbon sources and sinks is particularly important, as it not only relates to the realization of China's "dual carbon" goals but also directly affects the coordinated development of the regional ecological economy. The Poyang Lake urban agglomeration, as an important demonstration area for the coordinated development of ecological civilization and economic and social development in China, has particular

research value in terms of the balance of carbon sources and carbon sinks [1].

2. Overview of the study area

2.1. Geographical location and scope of the urban agglomeration around Poyang Lake

The urban agglomeration around Poyang Lake is located within the Poyang Lake Ecological Economic Zone, which is centered around Poyang Lake and supported by the Poyang Lake Urban Circle. It is an important special economic zone in Jiangxi Province, aiming to achieve the coordinated unity of ecological protection and economic development. The geographical location specifically covers the three prefecture-level cities of Nanchang, Yingtan, and Jingdezhen, as well as some counties (cities, districts) of Jiujiang, Xinyu, Fuzhou, Yichun, Shangrao, and Ji'an, with a total area of 510,81.63 square kilometers. This area accounts for 30.7% of Jiangxi Province's area and also houses 44.3% of the province's population, and it generates 58.3% of the total economic output. The urban agglomeration around Poyang Lake, as an important part of the Poyang Lake Ecological Economic Zone, not only enjoys a superior geographical location and beautiful natural environment, but also has a solid economic foundation. It is an ecological economic demonstration area in China where ecological civilization and economic and social development are coordinated and harmonious, and where humans and nature coexist in harmony. It is also a pioneer area for low-carbon economic development [2].

2.2. Characteristics of the natural environment

The natural environment of the urban agglomeration around Poyang Lake is unique and diverse. With Poyang Lake, a large freshwater lake, at its core, it has abundant water resources and wetland ecosystems, which play a crucial role in maintaining regional ecological balance and biodiversity. The terrain of the region is complex and diverse, covering lakes, rivers, plains, and hills. This geographical diversity not only enriches the natural landscape of the region but also provides rich spatial heterogeneity for the study of carbon sources and carbon sinks [3].

2.3. The importance and status of the Poyang Lake Ecological Economic Zone

The Poyang Lake Ecological Economic Zone is an ecological economic demonstration area in China where ecological civilization and economic and social development are coordinated and unified, and where humans and nature coexist in harmony. In the course of its economic development, the region has always focused on ecological protection and is committed to achieving coordinated development of the economy, society, and environment. Meanwhile, the Poyang Lake Ecological Economic Zone is also a pioneer in China's low-carbon economic development, actively exploring and practicing a low-carbon development model, providing useful experience and reference for other regions [4].

3. Factors influencing the spatial distribution of carbon sources and carbon sinks in the urban agglomeration around Poyang Lake

3.1. Natural factors

The urban agglomeration around Poyang Lake is located on the south bank of the middle and lower reaches of the Yangtze River. Its unique natural conditions profoundly shape the spatial distribution pattern of carbon sources and carbon sinks. From the perspective of natural factors, the interlaced distribution of terrain such as mountains, hills, and plains within the urban agglomeration has a guiding effect on human activities and the layout of the

ecosystem. Mountainous areas have large undulations, inconvenient transportation, relatively low concentration of industry and population, energy consumption is mainly for residential use, and carbon source emissions are scattered and small in total [5]. But mountainous areas are rich in forest resources, with high vegetation coverage and strong soil carbon pool accumulation capacity, making them important carbon sink regions. Agricultural activities are frequent in hilly areas, and the application of chemical fertilizers and the operation of agricultural machinery in the agricultural production process will bring about certain carbon emissions. Meanwhile, the forest and grassland ecosystems in hilly areas also have certain carbon sink functions. The plain area is flat and open, which is conducive to industrial layout and urban expansion. The carbon source emissions from industrial production, transportation, and urban energy consumption are more concentrated. However, the favorable soil and water conditions in the plains are also conducive to the development of agricultural carbon sinks. If farmland ecology is rationally planned, its carbon sequestration capacity can be enhanced [6].

3.2. Socio-economic factors

Industrial layout is the core force in determining the spatial distribution of carbon sources. The cities in the Poyang Lake urban agglomeration have distinct industrial positioning and development directions, resulting in different industrial clusters. Nanchang, as the provincial capital, has seen rapid development of high-tech industries and modern service industries. Its software information and biomedicine industries have relatively low energy consumption, but the building carbon emissions from urban expansion and infrastructure construction cannot be ignored. Meanwhile, some traditional manufacturing industries, such as chemical and mechanical manufacturing, still have a certain scale, and the energy consumption and waste emissions in the industrial production process are important sources of carbon [7]. Thanks to its proximity to rivers and ports, Jiujiang has developed heavy industries such as chemicals and steel, which have high energy demand and high carbon emission intensity, making some areas of Jiujiang a concentrated carbon source area. Ganzhou, relying on its abundant mineral resources, has an important position in industries such as non-ferrous metal smelting and rare earth processing. Fossil fuel combustion and process emissions in the production process have led to a large amount of carbon source emissions in this area. The ceramic industry in Jingdezhen and the deep processing of non-ferrous metals in Yingtan also have an impact on the spatial distribution of carbon sources due to differences in energy utilization efficiency and technological levels. In contrast, regions with more green industries, such as eco-agriculture and eco-tourism, such as some rural areas around Poyang Lake, have relatively lower industrial carbon emissions and even achieve a certain degree of carbon balance through the carbon sink function of the ecosystem [8].

4. Spatial optimization strategies for carbon sources and carbon sinks in the urban agglomeration around Poyang Lake under the orientation of carbon balance

4.1. Industrial optimization strategy

At the industrial level, local authorities should actively promote the low-carbon transformation and coordinated emission reduction of industries. There are significant differences in industrial positioning among cities within urban agglomerations. Heavy industries such as chemicals and steel in places like Jiujiang, and characteristic industries such as non-ferrous metal smelting and rare earth processing in Ganzhou, generally have problems of low energy utilization efficiency and high carbon emission intensity [9]. To this end, it is necessary to vigorously introduce advanced energy-saving technologies and carry out technological transformation and upgrading of traditional high-energy-consuming industries, such as using high-efficiency energy-saving equipment and

optimizing production processes, to reduce energy consumption and carbon emissions per unit of product. At the same time, encourage the development of low-carbon industries such as high-tech industries and modern service industries. Nanchang can leverage its technological and talent advantages to further expand the scale of emerging industries such as software information and biomedicine, optimize the industrial structure, and reduce reliance on traditional high-energy-consuming industries [10].

In terms of land use, strict control should be exercised over the expansion of construction land, and the carbon sink capacity of the land should be enhanced. With the acceleration of urbanization, the problem of disorderly expansion of construction land is prominent, and the encroachment on natural ecological land occurs from time to time, which not only undermines the carbon sink function of the ecosystem but also increases carbon emissions. Therefore, in light of the reasonable demands of urban development, the scale, structure and timing of the development and utilization of incremental land should be scientifically determined, the boundaries of urban growth should be demarcated, the dividing line between urban and rural areas should be clearly defined, and legal urban development rights should be restricted within this boundary to prevent the disorderly growth of urban spatial scale [11].

4.2. Strategies for optimizing transportation

Traffic structure adjustment is the key to traffic optimization. At present, road transportation is the main mode of transportation in the urban agglomeration around Poyang Lake, and the potential of low-carbon transportation modes such as railways and waterways has not been fully unleashed. The proportion of rail transportation should be increased. On the one hand, the railway network layout should be improved, and intercity and suburban railways between regions should be built at a faster pace to increase the coverage and accessibility of rail transportation and make more medium and short-distance travelers choose rail. On the other hand, we will improve the organization of railway transportation, increase the speed and punctuality of trains, and increase the number of train services to meet the travel needs of different time periods [12].

4.3. Strategies for ecological restoration and protection

Strengthening the protection and restoration of wetland ecosystems is of paramount importance. Poyang Lake, as an internationally important wetland, is of great significance to the regional carbon cycle. The red line for wetland protection should be strictly demarcated, and illegal reclamation, landfill, and other destructive activities should be prohibited through legislation and policy measures [13]. The government will carry out the project of returning farmland to lakes and aquaculture to beaches, gradually restore the natural form and area of wetlands, and increase the space for wetland vegetation growth. Establish ecological water replenishment mechanisms for wetlands, scientifically allocate water resources based on seasonal and climatic conditions to ensure ecological water demand for wetlands, maintain stable water levels in wetlands, promote the growth of submerged and emergent plants, and enhance the carbon sink capacity of wetlands [14].

5. Conclusion

To sum up, under the guidance of the “dual carbon” goals, the research on the carbon source-carbon sink balance of the urban agglomeration around Poyang Lake is not only a key proposition for the coordinated development of regional ecological economy, but also an important practical sample for China to achieve green transformation.

To this end, the local government should, on the one hand, strengthen cross-regional collaborative governance, improve the carbon emission monitoring and assessment mechanism, and ensure the orderly advancement of industrial transformation and ecological protection; On the other hand, deepen the research and application of low-carbon technologies, empower carbon sink resource management with digitalization, stimulate the vitality of market entities to reduce emissions, provide a replicable and scalable Poyang Lake model for the national "dual carbon" strategy, and jointly paint a new green picture of harmonious coexistence between humans and nature [15].

Funding

Science and technology project of Jiangxi Provincial Education Department: Space and temporal evolution mechanism of carbon source/carbon sink in Poyang Lake ecological economic zone, grant number (GJJ2202918); Jiangxi Provincial Social Science Fund: Research on carbon emission difference and coordinated emission reduction countermeasures in Poyang Lake urban agglomeration under the dual-carbon target, grant number (22JL15D); Jiangxi Provincial University Humanities and Social Sciences Project: Space and temporal evolution mechanism of carbon source/carbon sink and carbon balance prediction in Poyang Lake ecological economic zone, grant number (JJ22111); Nanchang Institute of Science & Technology University-level Teaching Reform Project: Research on the construction and practice of high-quality skilled talent training course clusters under the "dual carbon" background (NGJG-2022-63)

Disclosure statement

The author declares no conflict of interest.

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