Spatio-Temporal Evolution Characteristics of Carbon Source and Carbon Sink in Jiangsu Province

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Abstract. Since the proposal of China's carbon neutrality goal, the government has focused on the problems surrounding low carbon. This essay took Jiangsu Province, a province with large carbon emission, as the research topic. County-level carbon source, carbon sink and administrative land area data were used to calculate the average amount of carbon source and sink. Combined with GIS, analyzed the spatio-temporal evolution characteristics of carbon source and carbon sink in Jiangsu Province. This research aims to formulate development policies based on actual conditions for each region in Jiangsu Province, and put forward suggestions for carbon neutrality.

1. Introduction
Jiangsu Province is an important leading area for the Chinese social economy. With the process of urbanization and industrialization, resources have been being consumed in large quantities [1]. Carbon source in the province showed a growing trend during 2000-2017. The total amount of carbon source was at a high level nationwide, and carbon sink was at a rather low level [2].

Up to now, the existing research have mainly focused on the national and other macro levels, only few studies focused on the county level. However, due to the differences in development among provinces, making research on the more micro level should be paid much attention to [3]. Zhao Rongqin [4, 5] studied the carbon budget of the Central Plains Economic Zone and Henan Province based on the county level. However, these studies cover a wide geographic range but lack in-depth research on specific provinces. Clarifying the counties’ characteristics of carbon source and carbon sink is essential for understanding the status of carbon neutrality in each region and formulating regional development strategies based on differentiation.

County-level data in 2000 to 2017 from Carbon Emission Accounts and Datasets, and administrative land area data from the Statistical Yearbook of Jiangsu and cities in Jiangsu, were used to calculate each county’s carbon source and carbon sink data per area. The study of spatio-temporal evolution characteristics of carbon source and carbon sink in Jiangsu Province was accomplished by virtue of the GIS technology.
2. Spatio-temporal evolution characteristics of carbon source-carbon sink

2.1. Carbon Source

2.1.1. Characteristics of temporal evolution. In 2017, Jiangsu Province’s carbon source totalled 685.44 kilo tons, with an increase of 489.84 kilo tons compared to the base period of 2000 (195.59 kilo tons). The average annual increase is 7.65%. In general, the amount of carbon sources in Jiangsu Province from 2000 to 2017 showed two stages: rapid rise-smooth change. In the first 2000-2011 period, carbon source increased rapidly, with an average annual growth rate of 11.99%. After 2011, the growth rate of carbon source slowed down, and there was a significant decline between 2014 and 2015. Generally speaking, it had a fluctuated growth in a small number from 2011 to 2017, and the average annual volatility was small at 0.12%. Although the amount of carbon source had been effectively controlled to a certain extent, it was still at a high level overall. The total emissions fluctuated in the high range of 6.68 million tons to 7 million tons. The emission reduction situation is worthy of attention. From the perspective of county level, the average carbon source amount in each county of Jiangsu Province as a whole took 2011 as the node: before 2011, the rate of increase was rapid, and the annual change was large; after 2011, the rate of increase slowed down significantly.

2.1.2. Characteristics of spatial evolution. Taking the horizontal comparability into account, data of carbon source of per unit area was used. In terms of the spatial distribution of carbon source pattern, the county-level carbon sources in Jiangsu Province had obvious regional differences from 2000 to 2017 (Figure 1). The high-amount areas of carbon sources mainly gathered in southern Jiangsu, while the amount in northern Jiangsu was rather low, showing the pattern of "Southern Jiangsu > Central Jiangsu > Northern Jiangsu". In terms of temporal periods, the carbon source pattern changed from 2000 to 2011. From 2011 to 2017, carbon sources in Nantong declined, and carbon sources in the northwest of Suqian, the carbon source in western Yancheng increased.

![2000](image1.png) ![2011](image2.png)
2.2. Carbon Sink

2.2.1. Characteristics of temporal evolution. In 2000, Jiangsu Province’s carbon sink totalled 172.31 kilo tons. In 2017, Jiangsu Province’s carbon sink amounted to 182.52 kilo tons, with an increase of 10.22 kilo tons in 17 years. The average annual growth rate was about 0.34%. In general, Jiangsu's carbon sink fluctuated slightly from 2000 to 2017, with a coefficient of variation of only 0.04, which is a weak variation. The amount of carbon sink was generally stable, but the aggregate amount of carbon sink was still relatively low compared to the amount of carbon source. From the perspective of county level, the average carbon sink of each county in Jiangsu Province fluctuated.

2.2.2. Characteristics of spatial evolution. In order to make the data horizontally comparable, the average carbon sink of the land was used for discussion. From the perspective of the spatial distribution of carbon sink pattern in the province, there existed differences among carbon sink in counties from 2000 to 2017 (Figure 2). The high-amount carbon sink and low-amount carbon sink regions were alternately distributed. The pattern of carbon sink changed: the overall carbon sink in northern Jiangsu rose, while in some counties of central and southern Jiangsu it declined.
Figure 2. (a) (b) Spatial patterns of carbon sink in Jiangsu Province in 2000-2017.

3. Conclusions and discussion
In terms of spatio-temporal changes, the carbon sources in Jiangsu Province increased first, grew with small fluctuations, and then remained at a high level overall, but the carbon sink amount was still at a low level. The county carbon source presented a spatial pattern of high in the south and low in the north, while the county carbon sinks showed the characteristics of alternate distribution.

Differences between carbon source and carbon sink experienced a “rapid increase-smooth change” period, and had a decline trend in recent years. From the perspective of spatial change, the general trend change is Southern Jiangsu> Central Jiangsu >Northern Jiangsu.

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