Research on the evolution of port hinterland scope in Jiangsu Province based on accessibility

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Abstract: In this study, the accessibility value of ports is obtained by using GIS cost-weighted distance method through Arcgis10.8 software; Secondly, construct a scientific and objective port competitiveness evaluation system, and use the original research data of 2012, 2016 and 2020, through SPSS factor analysis, calculate the comprehensive influence of the main ports in Jiangsu province in different years; Then, the shortest transportation distance between port and city is obtained through GIS network analysis; Thirdly, on the basis of comprehensive consideration of the industrial output value and permanent population of the city where the port is located and the industrial output value and permanent population of the potential city, combined with the optimal transportation distance of the port to the potential city, the correlation degree between the port and the city is calculated; Then, based on the introduction of Gaussian Plume Model, a Gaussian Plume Model suitable for port range division in Jiangsu Province is constructed; Finally, the scope evolution of port cities in Jiangsu province is analyzed, and the corresponding improvement suggestions are put forward.

1. The introduction

Located in the important intersection of the belt and Road Initiative and the Yangtze River Economic Belt, Jiangsu province is located in the Yangtze River Delta region of China. It has both coastal and riverside location advantages and rich port resources. The overall size of the port cluster, cargo throughput, the number of productive berths and other indicators rank first in China.At the same time, Jiangsu province opened to the outside world earlier, the import and export volume has been in the forefront of the country, developed economy for the development of Jiangsu port freight provides a strong support.However, despite the favorable geographical location and economic foundation, there are still many bottleneck problems in the development process of jiangsu port group in recent years, such as overlapping port positioning, serious overcapacity, excessive expansion of scale and lack of perfect gathering and distributing system, which restrict the upgrading and development of Jiangsu port group.Therefore, in order to avoid the vicious competition between ports in hinterland resources, collection and distribution facilities and reduce the waste of social resources, it is urgent to divide the scope of port hinterland in Jiangsu province reasonably and scientifically.So far, scholars have used different methods to scientifically and rationally classify the scope of Port's hinterland.However, according to existing methods of Port's Hinterland division, most of the indicators used in the current Port's Hinterland division method were single and not comprehensive enough. In comparison, the Gaussian Plume Model selected a variety of quantifiable indicators, The scope of Port's Hinterland can be scientifically and reasonably divided.

2. Research Object and Research Method

(1)The Research Object

At the spatial scale, 13 cities in Jiangsu province are selected as the research scope. Lianyungang port, Suzhou port, Nantong port, Nanjing port, Taizhou port and Jiangyin port are selected as the research object.On the time scale, three time nodes, 2012, 2016 and 2020, were selected to analyze the scope evolution of Port's Hinterland in Jiangsu Province.The traffic network data of Jiangsu

province is obtained through the traffic atlas of Jiangsu Province and the national basic geographic data. The annual China Statistical Yearbook, China Port Yearbook and Jiangsu Statistical Yearbook were used to obtain the relevant index data of each region.

(2)The Research Methods

The improved Gaussian Plume Model was used as a method of Port's Hinterland scope in this study.

$$C_{ij}=(Q_iU_iF_{ij})/(4\pi X^2{}_{ij}) \quad (1)$$

Where, C_{ij} represents the influence intensity of port I on region J; Q_i represents the comprehensive competitiveness of port I; U_{ij} represents the accessibility of port I and region J; F_{ij}represents the correlation degree between port I and region J; X_{ij}represents the optimal transport distance between port I and region J.

3. The Research Process

(1)Port Accessibility Calculation

Port accessibility refers to the convenience of interaction between ports and hinterland.GIScost weighted distance analysis can be used to calculate port accessibility: First of all, according to the speed standards of different grades of railway, highway engineering technical standards and the actual situation of the region during the study period, the traffic speed of different types of road is set; Secondly, the rasterized vector layers are stacked sequentially, and the pixel size is set to 500 meters, so as to obtain the comprehensive time cost Grid map; Thirdly, Cost Distance instruction in ArcGIS is used to set the core port areas of six ports in Jiangsu province as target source points, and the shortest reachable time values of six ports are obtained respectively; Finally, formula (2) is used to obtain the port accessibility value.

$$D_i=\sum_{j=1}^{n}\frac{T_{ij}}{N} \quad (2)$$

Where D_i is port accessibility; T_{ij} is the shortest transportation time from port I to region J; N is the number of regions.

(2)Port Comprehensive Influence Calculation

Based on the research of other scholars and considering the accessibility and scientificity of evaluation indexes, this paper formulated a second-level port comprehensive influence evaluation index system composed of 12 indexes.Among them, the first-level indicators are Port's Hinterland economic aggregate, Port's Hinterland economic quality, Port size and Port accessibility.Secondary indicators include gross regional product, total import and export trade, fiscal budget revenue, per capita disposable income, energy consumption per unit GDP, per capita GDP, output value ratio of secondary and tertiary industries, port cargo throughput, port container throughput, port berths of 10,000-ton class, port foreign trade throughput and port accessibility.Then, SPSS was used to calculate the comprehensive influence index X_i by quadratic factor analysis, and X_i was treated with non-negative standardization to obtain the standardized index X_j.Among the rest, $X_j=100/(1+e^{-Xi})$.

(3)Port and City Correlation Degree Calculation

The development of the port cannot leave the city.Therefore, when calculating the correlation degree between them, representative indexes should be selected.Formula is as follows:

$$F_{ij}=\frac{\sqrt{P_iV_iP_jV_j}}{X^2{}_{ij}} \quad (3)$$

Where, $P_i$represents the permanent population of the city where port I resides at the end of the year; P_j represents the permanent population of region J at the end of the year; V_i represents the industrial output value of the city where port I is located; V_j represents the industrial output value of region J; X_{ij} represents the optimal transport distance between port I and region J.

(4)Calculation of Optimal Transport Distance for Ports and Cities

In this study, with the help of Arcgis software and GIS network analysis method, the OD cost matrix between port location and city location is established by constructing network data set after superimposed vector layers after Grid Map, so as to obtain the optimal transportation distance between port and city.

4. The Results of the Study

In this paper, an improved Gaussian Plume Model based on the construction of comprehensive impact indicators of ports and the minimum time cost to measure Port accessibility was selected to make Port's Hinterland classification.Put each indicator into formula (1) to get the final result of hinterland scope division.

Table.1. Division Results of Hinterland Scope

Port	2012 the Port 's Hinterland	2016 the Port 's Hinterland	2020 the Port 's Hinterland
Nanjing port	Nanjing, Yangzhou, Zhenjiang, Huaian	Nanjing, Yangzhou, Zhenjiang	Nanjing, Huaian, Suqian, Xuzhou, Yangzhou, Zhenjiang
Suzhou port	Suzhou, Wuxi, Xuzhou, Yancheng	Suzhou, Changzhou, Wuxi	Changzhou, Suzhou, Wuxi, Yancheng
Lianyungang port	Lianyungang , Suqian	Lianyungang , Huaian, Suqian, Xuzhou, Yancheng	Lianyungang
Nantong port	Nantong	Nantong	Nantong
Taizhou port	Taizhou	Taizhou	Taizhou
Jiangyin port	Changzhou	/	/

It can be seen from Table 1 that in three different periods, compared with other ports, The comprehensive competitiveness of Nanjing port, Suzhou port and Lianyungang Port is stronger.The number of Port's Hinterland has more and a wider range of Hinterland.According to the evolution trend of the scope of the Port's Hinterland, In recent years, Nanjing Port had the largest number of cities, followed by Suzhou Port, and lianyungang Port, Nantong Port and Taizhou Port only radiated the Hinterland of the cities in which the ports were located. Jiangyin does not have a radiant Port's Hinterland range.

5. Research Conclusions and Prospects

Based on the evolution of the scope of Port's Hinterland, it can be seen that the division of the scope of Port's Hinterland has broken through the restrictions of administrative regions. There are many ports in Jiangsu Province, and for some cities, they may be the Port's Hinterland of other cities. It didn't become a Port's Hinterland to a Port in the same city.In this paper, the Gaussian Plume Model was used to comprehensively consider the accessibility between ports and regions, the strength of the comprehensive impact of ports and their correlation, and the scope of the Port's Hinterland of each Port in the province was not only conducive to the intensive utilization of resources and the avoidance of repetitive Port construction. Moreover, it can better coordinate the development of the whole region and has certain practical significance.Looking to the future, Port operators should carry out multi-form cooperation in strategic coordination, layout optimization of Port's Hinterland and resource sharing, so as to make intensive use of resources, reduce cost and increase efficiency, and promote complementary advantages of ports and navigation resources, so as to enhance

comprehensive competitiveness of ports and promote sustainable and healthy development of regional economy.

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