Research on urban ecological competitiveness under the integration of Yangtze river delta

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Abstract. Based on the analysis of the connotation and related theories of urban ecological competitiveness, this paper constructs the Yangtze River Delta integrated city from the three aspects of ecological background, ecological environment pressure and social coordination ability, drawing on the evaluation system and models at home and abroad. Then, based on the index system, this paper takes the data of some cities in the Yangtze River Delta as the research sample, through the methods of principal component analysis and mean value method to carry out empirical research on the urban ecological competitiveness under the integration of the Yangtze River Delta. Finally, from the three aspects of planning, policy and implementation guarantee, the paper puts forward the measures to improve urban ecological competitiveness under the integration of the Yangtze River Delta.

1. Introduction

1.1. Background and Significance

This study starts from the theoretical and practical perspectives of urban ecological competitiveness. By analyzing relevant literature and the level and status of ecological competitiveness of various cities in the Yangtze River Delta region, the evaluation system and relevant models of the urban ecological competitiveness under the integration of the Yangtze River Delta are constructed, and the ecological competitiveness of each city is calculated and evaluated. Taking this as a conclusion, the paper puts forward strategies and measures to enhance the urban ecological competitiveness of the region, so as to promote the urban ecological construction in the Yangtze River Delta region and enhance the urban ecological competitiveness.

1.2. Research Overview

Urban eco-competitiveness refers to a city's continuous development based on the city's own economy, ecological environment, traditional culture, education, and technological level in order to achieve the development of the city's own development capacity and achieve the goal of sustainable development of the city. Adjust the city's own disadvantages and enhance the ability to summarize and integrate resources, attract the aggregation of various development factors, and optimize the allocation of various city resources. Because cities with strong advantages have good ecological, economic, and innovative capabilities, they will attract a variety of advanced factors, and these factors will react to the city, which will further enhance the city's ecological competitiveness and achieve a virtuous cycle[1]. In order to promote urban ecological competitiveness and the optimization of the entire ecosystem, we should understand and respect the ecological environment to properly and efficiently
deal with ecological environmental problems, and use valuable ecological resources efficiently and compactly to achieve a state of harmony between man and nature.

2. Construction of evaluation index system of urban ecological competitiveness

2.1. Construction principles and basis
The Comprehensive analysis of the relevant literature and theory of urban ecological competitiveness, the city's economic growth is a point-and-face process, and the improvement of urban infrastructure can promote the improvement of urban ecological competitiveness. Therefore, urban environmental protection measures and regional potential are powerful means of improving urban ecological competitiveness; and the indicators related to human settlement environment and resource endowment are the foundation of the city's cyclic development and the guarantee of urban and human progress. The influencing factors are constantly enriching with the development of time. Compared with the focus on urban construction in the past, it is now focused on achieving human progress and urban ecologicalization. Therefore, environmental pressure and resource pressure are also important indicators of urban ecological competitiveness. Finally, during the construction of the indicator system, emphasis was placed on indicators of urban regional potential. The main reason is that in the long-distance race of urban ecological competitiveness, the regional potential is a long-term project, and the innovation chain, industrial chain, capital chain, and policy chain are intertwined and supported. This is a plan for succession and succession, as well as a plan to fully implement the innovation-driven development strategy and support the supply-side structural reform.

2.2. Construction principles and basis
This paper summarizes and analyzes the construction methods and principles of the evaluation index system related to urban ecological competitiveness, and draws on the research results of urban ecological competitiveness at home and abroad\(^2\). On this basis, the three aspects are: ecological background status, ecological environmental pressure, and social coordination ability. In terms of aspects, the urban ecological competitiveness index system under the integration of the Yangtze River Delta has been constructed, including one first-level indicator, three second-level indicators, seven third-level indicators, and twenty-nine-level indicators, such as (Fig. 1). Through principal component analysis, the ecological competitiveness of cities in Shanghai, Anhui, Zhejiang, and Jiangsu was comprehensively compared and classified\(^3\). The first-level indicator "urban ecological competitiveness": refers to the coordination, mutual feedback and optimization of the city's ecological resources in the city itself in the urban economy, urban society, and urban environment. This ability to support the operation of the city, economy, and society. The second-level indicators of the current status of the ecological environment: reflect the current status of natural resources in various cities. Natural resources are the basic conditions for people’s survival and development on the earth and the most basic elements of various economic and social activities. Strong and weak standards. Its four three-level indicators are the basic methods of ecological environment quality evaluation, which have the characteristics of representative comprehensiveness and comprehensive applicability, and are widely used in ecological environment quality evaluation. Second-level indicators of ecological environment pressure: reflect the current environmental quality of each city, the impact of humans on the surrounding environment, and the degree of environmental pollution that damages the ecological balance\(^4\).

Its two three-level indicators of resource pressure refer to the consumption of biological resources caused by human production and life; environmental pressure refers to the waste emissions generated by human production and construction. Second-level indicators' active coordination ability: reflecting population quality and regional economic development, the government's support for environmental protection, and the region's future development potential. The social basis of its three three-level indicators analyzes the basic qualities of urban residents in various cities from scientific research and education; environmental protection measures reflect the government's support for environmental
3. An Empirical Study on Urban Ecological Competitiveness under the Integration of the Yangtze River Delta.

3.1. Data source, processing
Data source: The data of city evaluation indicators are derived from city yearbook and environment yearbook, etc. Some data are obtained through network screening and calculation.

Data processing: For the inverse index to be homogenized, it means that after the inverse index is converted, the direction of its expression is consistent with the positive index. In this article, the negative value of the inverse index will be taken for unified processing. For example: the data of the density of industrial wastewater discharge per unit area is multiplied by a negative number 1, and the negative value is taken for analysis.

Standardization processing: The initial and co-homogenized data have a linear relationship by default. Comparable standardized values for data with different units make the data independent of its own units.

3.2. Index system evaluation method
The This study uses principal component analysis to evaluate urban ecological competitiveness. The analysis of secondary indicators in the rating system is done by using principal component analysis and with the help of matlab and spss. Then, use the arithmetic mean method to calculate the ecological competitiveness score. The comparison of the importance of the three major secondary indicators should be equal. That is: N = (N1 + N2 + ... + Nn) / n.

The evaluation result score standard is determined: According to the above index evaluation system and statistical ranking method, the score ranking of the city ’s second-level indicators under the integration of the Yangtze River Delta and the score ranking of the first-level indicators ’ecological competitiveness are obtained. Disadvantage evaluation.
The evaluation criteria are as follows: When the score is greater than 0.5, it means that the region has a strong advantage. When the score is less than or equal to 0.5 and greater than or equal to -0.3, it means that the region has a certain advantage. When the score is less than 0.3, it means that the ecological competitiveness of the region is relatively weak.

3.3. Evaluation results

Through the principal component analysis of the nine indicators under the current status of the second-level indicator ecological background, and using the variance contribution rate method to determine the weight, a resource endowment competitiveness evaluation model can be obtained (Fig. 2):

\[
F_{11} = 0.2238N_{11} + 0.3077N_{12} + 0.4208N_{13} - 0.5244N_{14} + 0.2399N_{15} + 0.2395N_{16} \\
F_{12} = 0.4134N_{11} + 0.5630N_{12} - 0.2146N_{13} + 0.1367N_{14} - 0.3358N_{15} - 0.5194N_{16} + 0.2962N_{17} - 0.1918N_{18} + 0.0466N_{19} \\
F_{13} = -0.4349N_{11} + 0.1576N_{12} - 0.0451N_{13} - 0.0807N_{14} - 0.3257N_{15} + 0.1114N_{16} + 0.2093N_{17} + 0.2233N_{18} + 0.7512N_{19} \\
F_{14} = -0.1631N_{11} + 0.1060N_{12} + 0.3733N_{13} - 0.1304N_{14} + 0.3436N_{15} - 0.1292N_{16} + 0.2383N_{17} - 0.7266N_{18} - 0.2580N_{19} \\
F_{15} = -0.4994N_{11} - 0.3034N_{12} + 0.1352N_{13} + 0.3079N_{14} + 0.1141N_{15} + 0.3580N_{16} + 0.4463N_{17} + 0.3756N_{18} - 0.3671N_{19} \\
S_1 = 0.2449F_{11} + 0.2246F_{12} + 0.3326F_{13} + 0.1231F_{14} + 0.0804F_{15}
\]

Fig. 2. Ecological background status assessment

Ecological environmental pressure is a reverse indicator. The higher the value, the higher the ecological pressure. Therefore, the data needs to be processed in the same way. The higher the score, the lower the ecological pressure, which means that the index of this city is in a comparative advantage (Fig. 3):

\[
F_{31} = -0.1328N_{31} + 0.5136N_{32} + 0.2041N_{33} - 0.1714N_{34} + 0.4907N_{35} + 0.4844N_{36} + 0.5648N_{37} \\
F_{32} = -0.0343N_{31} - 0.2456N_{32} + 0.5040N_{33} + 0.6703N_{34} - 0.1607N_{35} + 0.0945N_{36} + 0.3676N_{37} \\
F_{33} = 0.0025N_{31} + 0.1662N_{32} + 0.1902N_{33} + 0.1913N_{34} + 0.3273N_{35} - 0.0974N_{36} - 0.2997N_{37} \\
S_3 = 0.4368F_{31} + 0.2309F_{32} + 0.1491F_{33}
\]

Fig. 3. Evaluation results of ecological environment pressure

Calculation result of social coordination ability index. The second-level indicator "social coordination ability": reflects the ability of the city to deal with economic development and ecological pollution (Fig. 4):

\[
F_{51} = 0.3425N_{51} + 0.4035N_{52} + 0.0055N_{53} + 0.2311N_{54} - 0.1478N_{55} + 0.1220N_{56} + 0.0312N_{57} + 0.3206N_{58} + 0.3096N_{59} + 0.6434N_{60} - 0.1205N_{61} \\
F_{52} = -0.1014N_{51} - 0.0976N_{52} - 0.3187N_{53} + 0.3000N_{54} + 0.3056N_{55} + 0.3996N_{56} - 0.1848N_{57} - 0.1199N_{58} + 0.2584N_{59} - 0.0474N_{60} + 0.1974N_{61} \\
F_{53} = -0.6350N_{51} - 0.3248N_{52} + 0.2166N_{53} - 0.4401N_{54} - 0.0008N_{55} - 0.1245N_{56} + 0.2454N_{57} + 0.1037N_{58} - 0.1780N_{59} - 0.1186N_{60} + 0.4127N_{61} \\
F_{54} = 0.3381N_{51} - 0.0509N_{52} - 0.1913N_{53} + 0.0042N_{54} - 0.0817N_{55} + 0.2013N_{56} - 0.0324N_{57} + 0.2146N_{58} \\
F_{55} = 0.7444N_{51} - 0.6283N_{52} - 0.0816N_{53} + 0.0554N_{54} - 0.0380N_{55} - 0.0120N_{56} - 0.0209N_{57} \\
F_{56} = -0.2897N_{51} - 0.2160N_{52} + 0.3160N_{53} - 0.1075N_{54} + 0.0020N_{55} - 0.3741N_{56} + 0.1290N_{57} + 0.4571N_{58} - 0.2680N_{59} - 0.2899N_{60} + 0.2165N_{61} \\
F_{57} = 0.3985N_{51} + 0.1754N_{52} + 0.1155N_{53} + 0.1018N_{54} + 0.3070N_{55} \\
S_5 = 0.3422F_{51} + 0.1852F_{52} + 0.1155F_{53} + 0.1018F_{54} + 0.3070F_{55}
\]

Fig. 4. Ecological background status assessment

The urban ecological competitiveness $S$ under the integration of the Yangtze River Delta is the average of $(S_1 + S_2 + S_3)$. Therefore, the ranking scores and advantages and disadvantages of the urban ecological competitiveness index are shown in (Fig. 5):
Fig. 5. Ranking and evaluation table of urban ecological competitiveness index

| City     | Rating Ranking | Evaluation level   |
|----------|----------------|--------------------|
| Shanghai | 1.764103405    | Strong advantage   |
| Suzhou   | 1.096601207    | Strong advantage   |
| Nanjing  | 0.908790688    | Strong advantage   |
| WuXi     | 0.612457503    | Strong advantage   |
| Maanshan | 0.587814612    | Strong advantage   |
| Changzhou| 0.302310958    | Advantage           |
| Hangzhou | 0.282794533    | Advantage           |
| Tongling | 0.257436919    | Advantage           |
| Hefei    | 0.224523431    | Advantage           |
| Ningbo   | 0.185778953    | Advantage           |
| HuZhou   | -0.064374329   | Advantage           |
| Jiaxing  | -0.083500291   | Advantage           |
| ShaoXing | -0.117635864   | Advantage           |
| Wenzhou  | -0.141674748   | Advantage           |
| Jinhua   | -0.238478651   | Advantage           |
| Zhenjiang| -0.331913011   | Weak advantage      |
| Taizhou  | -0.353652409   | Weak advantage      |
| Yangzhou | -0.379093703   | Weak advantage      |
| TaiZhou  | -0.410621386   | Weak advantage      |
| Xuancheng| -0.424167333   | Weak advantage      |
| Nantong  | -0.434603984   | Weak advantage      |
| ZheShan  | -0.453055881   | Weak advantage      |
| Anqing   | -0.49556074    | Weak advantage      |
| Chuzhou  | -0.512547065   | Weak advantage      |
| Chizhou  | -0.5265154     | Weak advantage      |
| Wuhu     | -0.542072927   | Weak advantage      |
| Yancheng | -0.711629152   | Weak advantage      |

4. Measures for improving urban ecological competitiveness.

4.1. Planning level
Promote the city's high-quality development model, reflecting the forward-looking planning. At present, the rapid development of urbanization in the Yangtze River Delta has also brought about a large number of ecological and environmental problems, and there are endless events of ecological environmental pollution and low land use efficiency. The improvement of urban ecological competitiveness under the integration of the Yangtze River Delta also requires the protection of the ecological environment and the promotion of high-quality urban development. Strengthen ecological bottoming, focus on industrial innovation, and increase the implementation of ecological and environmental protection projects. In order to create a good ecological environment for economic and social development in the Yangtze River Delta, it is necessary to further enhance the urban ecological space implementation guarantee capacity. Therefore, maintaining ecological safety and ecological carrying capacity and optimizing the high-quality development of urban space and functions are the only way to improve urban ecological competitiveness.

4.2. Policy level
Popularize and increase the public's ecological awareness. Urban environmental protection is closely related to urban industry, human life style and other factors. Therefore, as the city's builders and participants, it is very important for the public to intervene in urban environmental governance. It can combine their own perspectives with the city and promote the sustainable development of the city more scientifically. Advocate a low-carbon life for all. The good ecological resources and ecological
environment of cities in the Yangtze River Delta area are the basis for the sustainable development of cities in the Yangtze River Delta area. Promote ecological restoration projects in local cities and create ecological cities. Cities under the integration of the Yangtze River Delta as the core functional area of the Yangtze River Delta region. In the process of urban economic development, cities should take the protection of the ecological environment as the base point, dynamically adjust the relationship between ecology, production and life, and develop green ecology. The concept is deeply rooted in people's hearts and promotes environmental protection steadily.

4.3. Implementation guarantee
Pay attention to the linkage of up and down, synergy between left and right, unify thoughts and form a joint force. The first is to attach great importance to the linkage between the top and the bottom, to balance the integrated economic and social development strategy and ecological planning of the Yangtze River Delta, to ensure that all types of plans at all levels are consistent in overall positioning and goals, coordinated in the industrial pattern, and resourced in social governance collaboration, standardization and order in space allocation, scientific and reasonable in time sequence construction, through the support of superior planning to ensure the effective implementation of urban ecological development strategies and the smooth realization of the main goals. The second is to actively promote synergy between the left and the right, further strengthen the organization and leadership of the city 's ecological development strategy in various departments at the city level, strengthen the overall coordination of each department, enhance the ecological planning and publicity, ensure the exchange of information, cooperate with each other, form a joint force, and improve strategic execution.

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