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Research Article

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Spatial evolution of coastal environmental enterprises: An exploration of driving factors in Jiangsu Province

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Abstract: This article presents an in-depth analysis of the spatial and temporal evolutionary characteristics of the environmental protection industry in Jiangsu Province and analyzes the dynamics of changes in the spatial pattern of the environmental protection industry as a whole using spatial visualization methods. Attribute data of environmental protection enterprises in Jiangsu Province from 2000 to 2022 were selected for this article, with spatial analysis methods. From 2000 to 2005, the industry expanded to include Suzhou, Changzhou, and other areas, forming a multi-core pattern, supported by a Moran's *I* value of −0.049837. This clustering trend continued from 2006 to 2010, with Moran's *I* values of −0.115285 in 2011–2015 and −0.117398 in 2016–2022. By 2022, new clusters emerged in the coastal areas of Xuzhou, Yancheng, and Nantong, reflecting industry growth. By detecting with multiple factors, it is found that such pattern evolution is a result of a combination of factors, which is mainly influenced by environmental and employment factors in the early stages of development, while also significantly driven by market factors in the later stages of development as the dynamics of the spatial pattern continue to evolve with the economy.

Keywords: green total factor, environmental protection industry, spatial analysis, aggregation

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1 Introduction

In recent times, China has experienced an impressive upsurge in its economic growth [1]. However, the economic growth model that drove this expansion, characterized by excessive resource inputs, pollution, and energy consumption, poses a significant threat to the natural environment [2]. Consequently, concerns such as resource scarcity and environmental degradation have started to come to the forefront [3]. According to the *2020 Report on China's Ecological Environment*, an astonishing 40.1% of the 337 cities at the prefecture level or higher exceeded air quality standards. Acid rain impacts an area spanning approximately 466,000 km^2, and China's surface and groundwater sources show varying degrees of contamination. Responding to this, China introduced the concept of "green development" in October 2015 and raised the building of an ecological civilization to a national strategic priority in October 2017. This move has elevated the environmental protection sector to a pivotal position in tackling environmental pollution, implementing resource recycling, and garnering substantial acknowledgment from the government [4]. The scope of China's environmental protection industry continues to broaden, significantly aiding in alleviating environmental pressures and preventing pollution [5]. China classified the environmental protection industry as a strategic emerging sector in 2010, and in April 2011, the *Guidelines on Environmental Protection Systems* were launched to further invigorate its growth. This document formally introduced incentives for environmental protection industry clusters, the establishment of environmental protection industry parks in different regions, and the establishment of demonstration zones for environmental protection industry clusters, all aimed at steering the industry's advancement. In addressing the ongoing challenges confronting China's environmental protection industry, fostering industry agglomeration could emerge as a pivotal pathway for its sustainable expansion, aligned with the practical imperatives of its growth [6].

As industrial agglomeration in China continues to diversify, the concept of synergistic agglomeration within the environmental protection industry has gained significant attention among scholars. Li and Wang [7] conducted an analysis of the current state of the environmental protection industry, highlighting noteworthy issues such as the necessity for an optimized business environment, gaps in policy mechanisms, and limitations in terms of innovation and quality. They provided targeted suggestions to enhance the business environment, optimize policy mechanisms, and improve innovation capacity and quality standards. Their findings provide valuable insights for decision-makers aiming to foster the sustainable, robust, and high-quality development of China's environmental protection industry. Xin et al. [8] employed the Gini coefficient method and spatial autocorrelation analysis to assess the spatial imbalances in China's environmental protection industry. They qualitatively analyzed and formulated a multiple regression model to explore the factors driving agglomeration development within the environmental protection industry, utilizing the framework of the new economic geography theory. Their empirical analysis covered 30 provincial administrative regions in China. The measurements of the Gini coefficient and spatial autocorrelation revealed that although the input levels of China's environmental protection industry demonstrate a tendency toward balanced development, regional disparities in output levels and investment efficiency of the industry have significantly increased. Ren et al. [9] employed the R-index to gauge the overall level of agglomeration in China's energy-saving and environmental protection industry from 2008 to 2016. They proposed strategies for optimizing agglomeration structure in energy-saving and environmental protection industries in each region. Their results indicated a relatively uniform distribution of China's energy-saving and environmental protection industries, with the level of agglomeration steadily increasing. Despite the extensive research on industrial agglomeration from the perspective of the environmental industry, there is an urgent need for a more comprehensive analysis of the impact and mechanisms of synergistic agglomeration within the coastal environmental industry and the green economy as a whole.

The environmental protection industry in Jiangsu Province has been a pivotal driver of development for over three decades, establishing a prominent position within China [10]. This study aims to conduct a comprehensive assessment and analysis of the degree of industry clustering within Jiangsu Province's environmental sector. This analysis is carried out using spatial examination, with the overarching goal of scrutinizing the evolutionary patterns that have transpired during the study period. Through this approach, we seek to gain a deeper comprehension of the present state of eco-friendly progress in Jiangsu Province. This encompasses an exploration of the factors that exert influence on this progress, as well as the potential courses of action available to enhance the overall performance of the province's green economy. Additionally, our study endeavors to facilitate an extensive exploration of the cooperative industry clustering layout within Jiangsu Province. This exploration, in turn, aims to aid governmental bodies across all tiers in evaluating their individual developmental circumstances, economic statuses, and resource endowments. By doing so, our research intends to offer guidance for strategically arranging the environmental protection industry. Ultimately, these efforts aspire to propel integrated development within Jiangsu Province in harmony with its distinct local conditions.

2 Methods

2.1 Research data

The data collection process undertaken for this study adhered to rigorous standards and employed a comprehensive approach. The primary sources of data utilized encompassed attribute data of environmental protection enterprises in Jiangsu Province. These data were meticulously curated from the authoritative official filing enterprise credit agency, Tianyancha System (https://www.tianyancha.com/), which is affiliated with the National SME Development Fund [11]. This database furnished crucial information regarding enterprises (organizations), encompassing details such as registered names, registered capital, registration dates, business scopes, registered addresses, and current operational statuses. Furthermore, data pertaining to green total factor indicators were acquired through a meticulous process. These indicators were sourced from reputable government publications, research reports, and academic journals within the field of environmental economics. Great care was taken to ensure the reliability and precision of the selected indicators. Importantly, it should be emphasized that all data employed in this study were gathered as of the year 2022, thus guaranteeing the integration of the most current and accurate information within our research framework.

2.2 Weighted kernel density

Kernel density estimation is a powerful non-parametric method employed in this study to estimate the probability density of a random variable. This method, based on the principles of kernel density estimation, incorporates weights that reflect the importance or significance of each data point in the analysis. The utilization of weighted kernel density estimation in our research offers several distinct advantages. First, it allows for the incorporation of relevant weights, enabling a more accurate representation of the underlying distribution by giving greater emphasis to data points that are deemed more influential or informative [12]. This is particularly valuable when dealing with imbalanced datasets or when certain observations carry more weight due to their significance in the research context. Second, weighted kernel density estimation provides a flexible and adaptable framework for modeling data, accommodating varying levels of importance and producing more nuanced density estimates [13]. Additionally, this method effectively handles outliers or irregularities, ensuring robust and reliable results even in the presence of influential observations. The incorporation of weighted kernel density estimation, building upon the original principles [14], enhances the precision and reliability of our probability density function estimates, facilitating deeper insights into the distribution characteristics essential for our research objectives. Let X_1, X_2, …, X_n be independent identically distributed samples of the unit variable, then the kernel density estimation of the probability density function obeyed by X is

$$f(x) = \frac{1}{nh_n}\sum_{i=1}^{n} k\left(\frac{x - X_i}{h_n}\right), \tag{1}$$

where n is the number of samples, h is the bandwidth, X_i is the independent identically distributed observations, $\bar{X}$ is the mean, and $K(\cdot)$ is the kernel function.

2.3 Global spatial autocorrelation

In the realm of spatial statistical analysis, Moran's index stands as a widely recognized metric for gauging global spatial autocorrelation. It functions as an assessment of the collective tendency of akin attributes to cluster within the confines of the study area. This index holds particular efficacy in scrutinizing spatially uniform processes. In our present study, we enlist the global Moran's I statistic to thoroughly explore the existence of spatial clustering attributes within the urban environmental industries. This employment further aids in characterizing the comprehensive spatial distribution pattern that envelops the entire study region [15]. The range of Moran's I values spans from −1 to +1. Values that gravitate toward 1 serve as indicators of pronounced spatial clustering. Meanwhile, a value of 0 signals a lack of spatial autocorrelation, and values that take on a negative aspect ($-1 < I < 0$) imply a discernible negative spatial autocorrelation along with a significant negative correlation. The proximity of the value to −1 denotes an elevated dissimilarity between individual cells or a less concentrated distribution. The methodology for calculating Moran's I is delineated as follows:

$$I = \frac{N}{\sum_{i=1}^{N}\sum_{j=1}^{N} w_{ij}} \times \frac{\sum_{i=1}^{N}\sum_{j=1}^{N} w_{ij}(y_i - \bar{y})(y_j - \bar{y})}{\sum_{i=1}^{N}(y_i - \bar{y})^2}, \tag{2}$$

where n represents the number of observations; y_i and y_j denote the attribute values of the i-th and j-th observations, respectively; $\bar{y}$ is the mean value of all observations; and w_{ij} represents the spatial weights between observations. The numerator of the formula calculates the sum of the cross-products of attribute value deviations from the mean, weighted by the spatial weights. This measures the spatial similarity of attribute values. The denominator normalizes this similarity measure by summing the squared deviations of attribute values from the mean.

2.4 Standard deviational ellipse (SDE)

The SDE is widely used to analyze the distribution of geographical elements in two-dimensional space [16,17]. In this study, we use the SDE to examine the distribution pattern and spatial evolution of the environmental protection industry in Jiangsu Province. By considering parameters such as the SDE's center, azimuth, long axis, and short axis, we gain a comprehensive understanding of the distribution characteristics [18–22]. This helps us identify concentration areas, dispersion tendencies, and directional changes in the industry's distribution. Utilizing the SDE allows us to uncover spatial patterns and trends in the environmental protection industry, aiding in formulating effective policies and strategies for sustainable development. The SDE is calculated using a formula that incorporates the variance of the ellipse

$$\mathrm{SDE}_x = \sqrt{\frac{\sum_{K-1}^{N}(x_i - \bar{X})^2}{n}},\ \mathrm{SDE}_y = \sqrt{\frac{\sum_{K-1}^{N}(y_i - \bar{Y})^2}{n}}, \tag{3}$$

where x_i and y_i are the spatial coordinates of each point feature, $\bar{X}$ and $\bar{Y}$ are the arithmetic mean centers, n is the total number of features, and SDE_x and SDE_y are the calculated variances of the ellipse.

The formula for calculating the angle of the ellipse is

$$\tan\theta = \frac{A + B}{C}, \tag{4}$$

$$A = \left(\sum_{i=1}^{n}\tilde{x}_i^2 - \sum_{i=1}^{n}\tilde{y}_i^2\right), \tag{5}$$

$$B = \sqrt{\left(\sum_{i=1}^{n}\tilde{x}_i^2 - \sum_{i=1}^{n}\tilde{y}_i^2\right)^2 + 4\left(\sum_{i=1}^{n}\tilde{x}_i\tilde{y}_i\right)}, \quad (6)$$

$$C = 2\sum_{i=1}^{n}\tilde{x}_i\tilde{y}_i. \quad (7)$$

In the equation, $\tilde{x}_i$ and $\tilde{y}_i$ represent the differences between the mean center and the x and y coordinates. The formula for determining the standard deviation of the XY axes is

$$\sigma_x = \sqrt{2}\sqrt{\frac{\sum_{i=1}^{n}(\tilde{x}_i\cos\theta - \tilde{y}_i\sin\theta)^2}{n}}, \quad (8)$$

$$\sigma_y = \sqrt{2}\sqrt{\frac{\sum_{i=1}^{n}(\tilde{x}_i\sin\theta + \tilde{y}_i\cos\theta)^2}{n}}. \quad (9)$$

The standard equation expression of the ellipse can be obtained using the standard deviation:

$$\left(\frac{x}{\sigma}\right)^2 + \left(\frac{y}{\sigma}\right)^2 = s, \quad (10)$$

where s represents the confidence level.

3 Results

3.1 Spatial distribution evolution of the environmental industry in Jiangsu Province

3.1.1 Transition from single-zone to multi-zone distribution

The spatial pattern of the environmental protection industry in Jiangsu Province has been examined using kernel density calculations, revealing an evolving distribution over time. Initially, the industry was concentrated in Wuxi and Nanjing, benefitting from their abundant natural resources, transportation infrastructure, and industrial base. From 2000 to 2005, the industry expanded its presence to include Suzhou, Changzhou, and other areas, forming a multi-core pattern. This trend continued from 2006 to 2010, with a circular development centered around Nanjing, Wuxi, Changzhou, and Suzhou. By 2022, new clusters emerged in the coastal areas of Xuzhou, Yancheng, and Nantong, reflecting industry growth. The 13th Five-Year Plan for Economic and Social Development of China set ambitious targets to increase the proportion of the environmental protection industry's added value to GDP from 2% in 2015 to 3% in 2020 and to establish 20 industry clusters. This policy has facilitated the concentration of environmental protection industries in Jiangsu Province, with strong interconnectivity between Wuxi's industry and small and medium-sized enterprises in central and northern Jiangsu. This collaboration and integration among different regions indicate the potential for further growth and development of the environmental protection industry in Jiangsu Province. Overall, these findings highlight the positive influence of government policies and interregional collaboration on the industry's expansion and advancement in Jiangsu Province (Figure 1).

3.1.2 Moran's I and SDE

The spatial distribution of the environmental protection industry in Jiangsu Province was assessed using Moran's I, and the results are presented in Table 1. Moran's I is a widely used statistic that measures spatial autocorrelation, indicating the degree of clustering or dispersion of attributes across a study area. In our analysis, Moran's I was employed to examine the spatial clustering pattern of the environmental protection industry at different time periods.

From the data, it can be observed that the spatial distribution of environmental protection enterprises exhibits different patterns during different time periods. In the early stages (prior to 2000 and from 2000 to 2005), the distribution of environmental protection enterprises shows a scattered or random pattern, with corresponding Moran's I values of −0.033735 and −0.057348, respectively. Additionally, the Z-score values for these periods are −0.369216 and −0.544102, indicating a relatively stable spatial distribution close to the average level. This suggests that during this period, the spatial distribution of environmental protection enterprises in Jiangsu Province was relatively balanced, without significant spatial agglomeration or dispersion.

However, as time progresses, starting from 2006, the spatial distribution of environmental protection enterprises begins to exhibit clustering, with a corresponding Moran's I value of −0.049837. This indicates that during this phase, environmental protection enterprises gradually aggregate in specific regions, forming industrial agglomeration effects. Furthermore, it is observed that the agglomeration effect strengthens over time. In both the 2000–2005 and 2006–2010 periods, the Z-score values for environmental protection enterprises are −0.436255 and −0.544102, respectively, indicating a certain degree of spatial clustering. This may be related to the spatial agglomeration phenomenon caused by the development of the environmental protection industry in specific areas during those time periods.

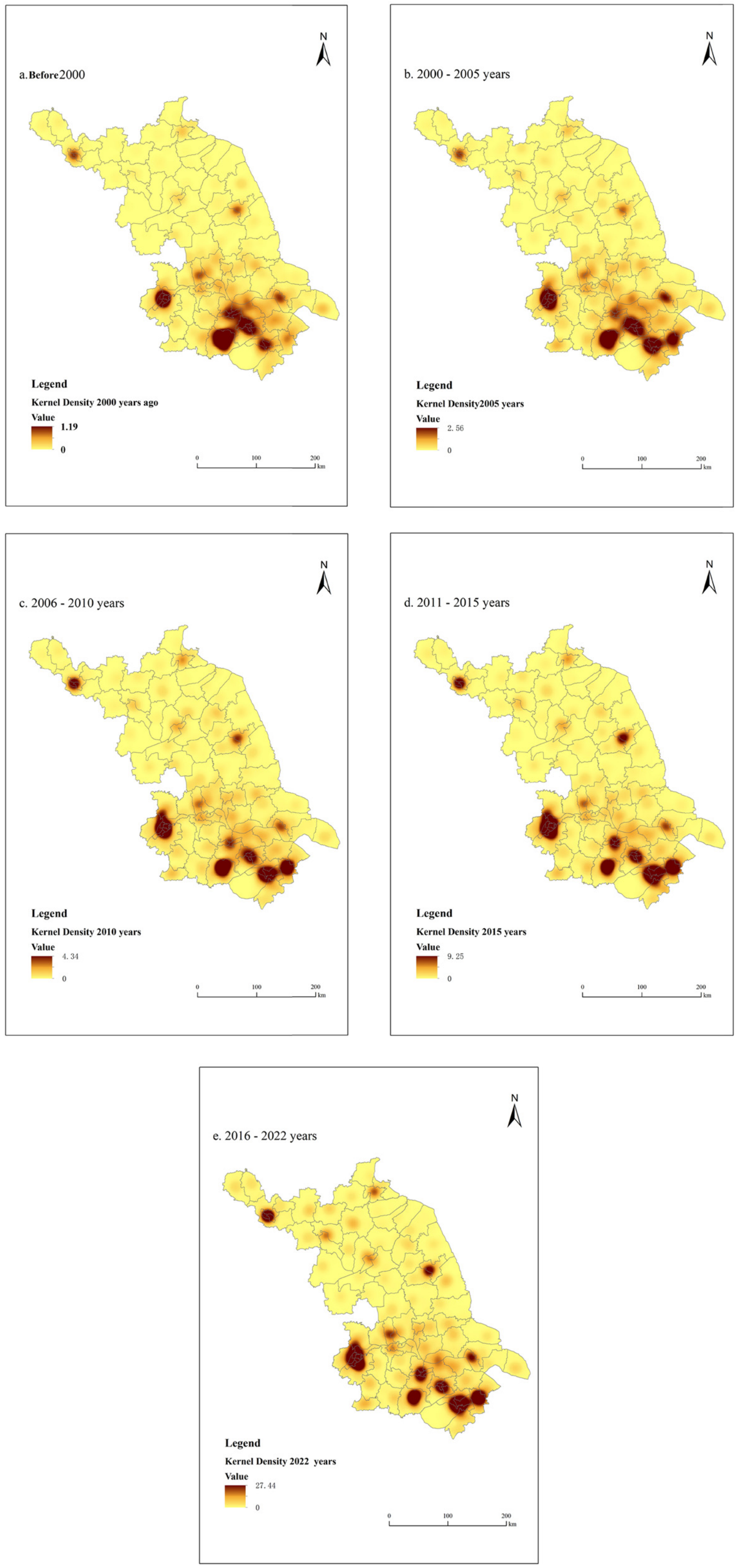

Figure 1: Weighted kernel density.

Table 1: Moran's *I* for the environmental protection industry in Jiangsu Province

Year	Moran *I*	*Z*-score	*P*-value
Before 2000	−0.033735	−0.369216	0.711967
2000–2005	−0.057348	−0.544102	0.586371
2006–2010	−0.049837	−0.436255	0.662651
2011–2015	−0.115285	−1.040054	0.298315
2016–2022	−0.117398	−1.062244	0.288125

In the period from 2011 to 2015, the corresponding Moran's *I* value is −0.115285, while in the period from 2016 to 2022, the Moran's *I* value is −0.117398. This indicates a stronger clustering pattern in the spatial distribution of environmental protection enterprises in Jiangsu Province. The *Z*-score values also suggest a more pronounced agglomeration feature in the spatial distribution of environmental protection enterprises during these two periods. This may reflect a more significant concentration of the environmental protection industry in specific regions of Jiangsu Province, indicating a concentrated development of environmental protection enterprises in certain areas.

By observing 2022, the southern part of Jiangsu Province emerged as a clear cluster core, representing the initial formation of five major environmental protection industry clusters: Nanjing, Suzhou, Wuxi, Changzhou, and Yancheng. These clusters followed a point-axis development pattern, with Suzhou, Wuxi, and Changzhou serving as axes of growth and Nanjing, Yancheng, and Taizhou acting as focal points for industry concentration. The presence of distinct clusters indicates the spatial organization and specialization of environmental protection activities within the province.

Based on our understanding, the collaboration among provinces and municipalities in Jiangsu Province has played a crucial role in promoting the growth and development of the environmental protection industry. By leveraging shared resources, knowledge exchange, and technological collaboration, the province has fostered an environment conducive to innovation and industry integration. This interregional collaboration has facilitated the formation of industry clusters and the realization of economies of scale. The clustering of environmental protection enterprises in Jiangsu Province, particularly the close linkages between the industry in Wuxi and small to medium-sized enterprises in central and northern Jiangsu, highlights the high level of collaboration and integration among different regions (Figure 2).

3.2 Impact of green total factors on the environmental protection industry in Jiangsu Province

This study utilized a comprehensive set of eight indicators to construct three distinct factors, as outlined in Table 2. To capture the spatially divergent characteristics of these factors over time, we organized the temporal attribute information into time series and hierarchically visualized the data. By integrating these patterns with the results of kernel density analysis (Figure 3), we gained valuable insights into how these indicators collectively influenced the spatial distribution of the environmental protection industry. The findings are summarized in Table 3, which presents a matrix of factors that influenced the evolution of the industry's spatial pattern in Jiangsu Province from 2000 to 2022.

The evolution of the environmental protection industry's spatial pattern in Jiangsu Province is a multifaceted process influenced by various factors. Our statistical analysis reveals that the spatial distribution of the industry has been shaped by different environmental, economic, and market factors over time. During the period from 2000 to 2005, the industry's distribution was predominantly driven by industrial dust and wastewater emissions, as well as the number of people employed in the industry. These factors played a pivotal role in determining the location of industry clusters, as they were closely linked to the region's industrial production and employment patterns. From 2006 to 2010, the establishment of a second major environmental protection industry-related park in Jiangsu Province and the increase in sulfur dioxide emissions significantly influenced the industry's spatial distribution. This marked a transition period in the industry's development, with greater emphasis on specialized environmental protection parks and the adoption of cleaner production methods. Between 2011 and 2022, as the national economy continued to grow, Jiangsu Province maintained its investment in the environmental protection industry, allocating between 1.07 and 1.61% of GDP to environmental protection initiatives. Market factors (M1, M2) emerged as prominent drivers during this period, driven by the rising demand for environmental protection products and services. This led to the emergence of new industry clusters and the expansion of existing ones.

In conclusion, the spatial pattern of the environmental protection industry in Jiangsu Province is influenced by a combination of factors that evolve over time. The specific

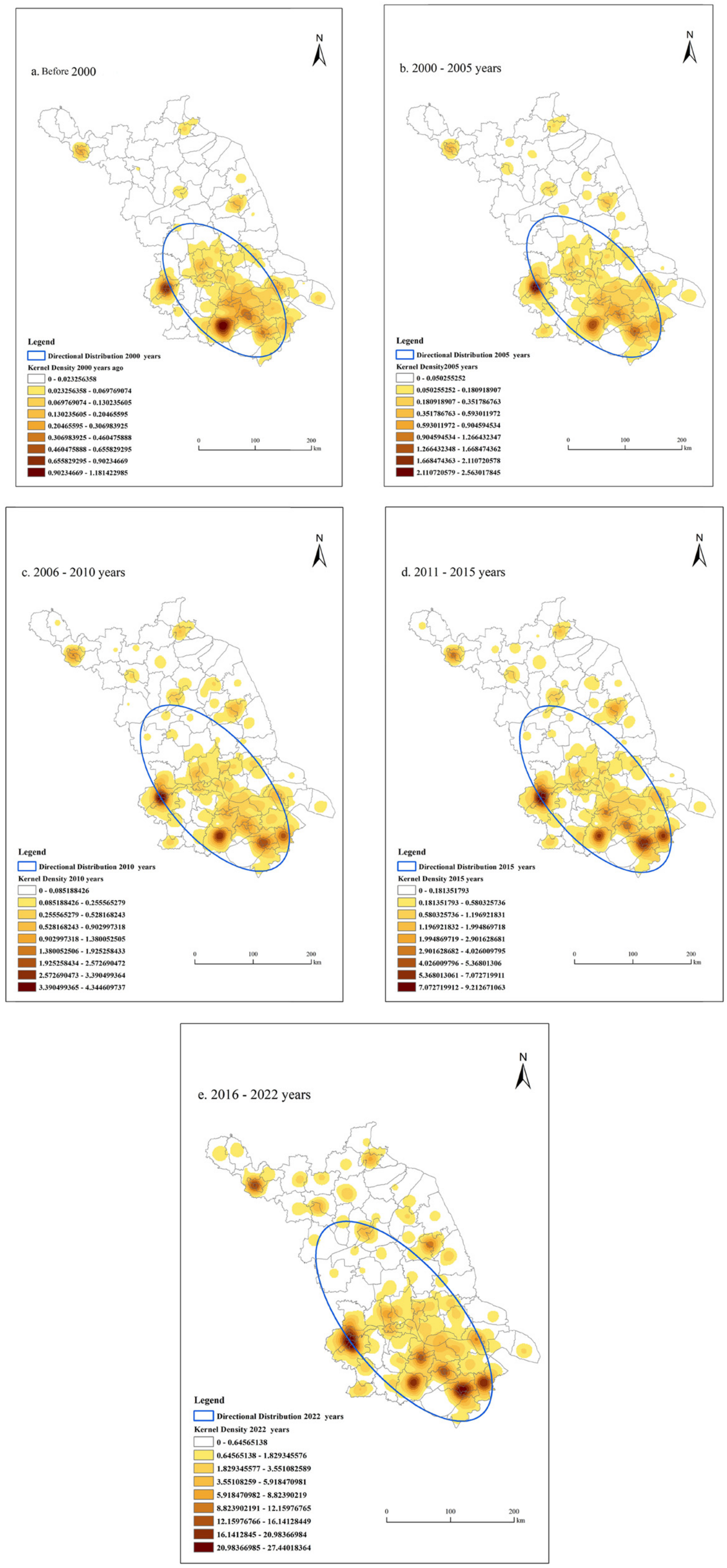

Figure 2: SDE for the environmental protection industry in Jiangsu Province.

Table 2: Selected indicators of detecting the evolution drivers

Influencing factors	Indicators	Symbols
Environmental factors	Industrial dust emissions	E1
	Wastewater emissions	E2
	Sulfur dioxide emissions	E3
	PM2.5	E4
Employment factors	Number of persons employed	W1
	Total electricity consumption	W2
Market factors	Capital stock	M1
	In real terms GDP	M2

Table 3: Statistical results of selected factors

Year	Essential factor
2000–2005	E1, E2, W1
2006–2010	E1, E2, E3, W1
2011–2015	E1, E2, E3, W1, M1
2016–2022	E1, E2, E3, E4, W1, M1, M2

factors affecting the industry's spatial distribution vary across different time periods, with environmental policies, economic growth, and market dynamics all playing significant roles in shaping the industry's trajectory. These findings highlight the dynamic nature of the environmental protection industry and emphasize the importance of aligning policies, investments, and market strategies to foster its continued growth and sustainable development in Jiangsu Province.

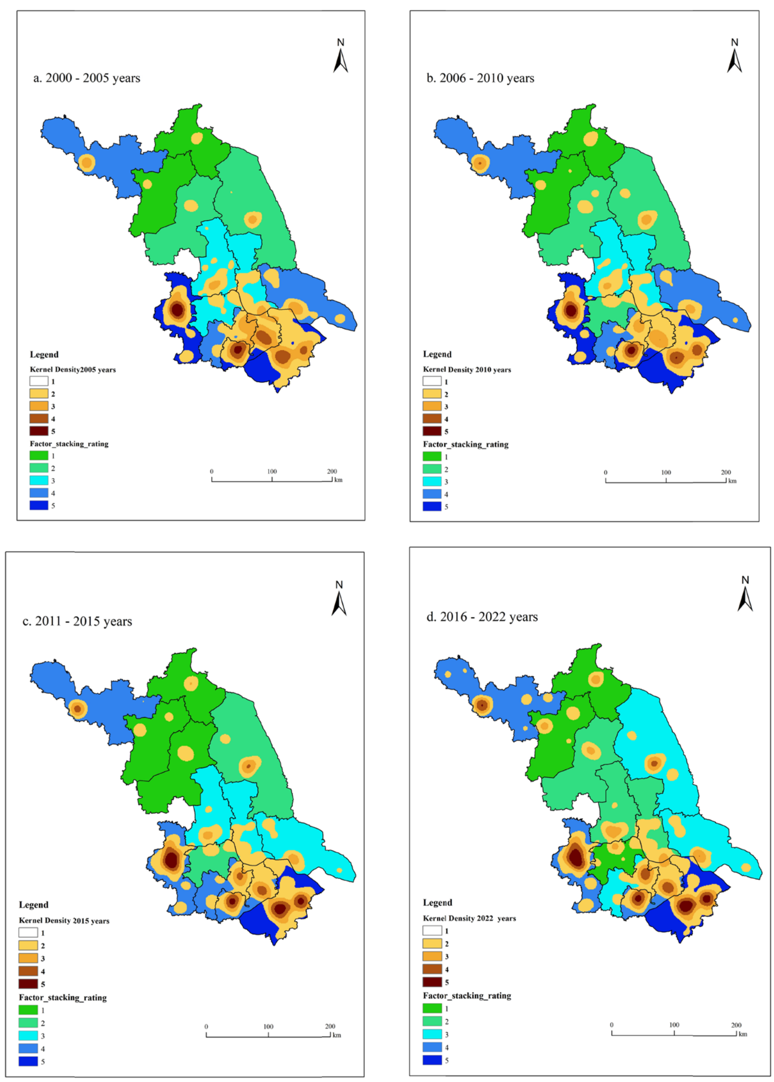

Figure 3: Phased impact of factors on the environmental protection industry in Jiangsu Province.

4 Discussion

The analysis suggests that the environmental protection industry in Jiangsu Province has undergone an evolution from a continuum sheet shape to a single kernel and multiple kernel dispersion. The initial concentration of the industry was in Wuxi and Nanjing, which provided a favorable foundation for its development due to its abundant natural resources, transportation infrastructure, and industrial base. From 2000 to 2005, the industry's distribution expanded to include Suzhou, Changzhou, and other areas, forming a multi-core pattern. This trend continued between 2006 and 2010, with a circle-like development centered on Nanjing, Wuxi, Changzhou, and Suzhou. By 2022, new clusters had formed in the coastal areas of Xuzhou, Yancheng, and Nantong, reflecting the growth of the industry. The agglomeration of environmental protection industries in Jiangsu Province has been facilitated by government policies and interregional collaboration, with Wuxi's industry closely linked to small and medium-sized enterprises in central and northern Jiangsu. This interdependence reflects a high level of collaboration and integration among different regions, indicating the potential for further growth and development of the environmental protection industry in Jiangsu Province.

The study utilized eight indicators to construct three specific factors, and the results revealed that the industry's spatial distribution has been shaped by various environmental, economic, and market factors over time. The environmental protection industry's spatial distribution in Jiangsu Province was primarily influenced by industrial dust and wastewater emissions and the number of people employed in the industry. These factors played a crucial role in determining the location of the industry clusters in the province, as they are closely related to the industrial production and employment patterns in the region. The establishment of the second key environmental factor in 2006–2010, the investment in environmental protection, further drove the industry's growth and expansion, resulting in the formation of linear clusters in the northwest of Jiangsu Province.

It is worth noting that by collaborating on a high platform, provinces and municipalities in Jiangsu Province can exchange and integrate their resource advantages, which strengthens the exchange and integration of environmental technology innovation, improves the environmental protection industry's industrial chain, and realizes the clustering, scale, and characteristics of the environmental protection industry system. With the increasing clustering of the environmental protection industry in Jiangsu Province, it is expected that there will be more opportunities for resource sharing, technological collaboration, and innovation in the industry, leading to more sustainable development and growth.

Based on the findings, the government should continue to support the development of the environmental protection industry in Jiangsu Province through policies that promote collaboration and integration among different regions, with a focus on encouraging investment in environmental protection and reducing industrial dust and wastewater emissions. The government should also encourage the development of small and medium-sized enterprises in central and northern Jiangsu, strengthening their linkages to the environmental protection industry in Wuxi. Additionally, more efforts should be made to encourage the development of the industry in coastal areas, particularly Xuzhou, Yancheng, and Nantong, where new clusters have formed, reflecting the growth potential of the industry in these regions. Overall, the government should focus on creating a supportive policy environment that promotes innovation, collaboration, and sustainable development in the environmental protection industry in Jiangsu Province.

5 Conclusions

In this article, an in-depth analysis of the spatial and temporal evolution characteristics of the environmental protection industry in Jiangsu Province is carried out using spatial analysis methods, and the following conclusions are drawn from the spatial visualization methods on the dynamics of the overall spatial pattern changes in the environmental protection industry.

(1) The evolution of the environmental protection industry in Jiangsu Province is characterized by different locations and forms of agglomeration at different times, and the industry was distributed along the cities of Wuxi and Nanjing in the early years, but later it developed in a circle pattern centered on Changzhou and Suzhou, forming a "multi-core" distribution.

(2) Generally speaking, industries in Jiangsu Province show a trend of increasing volume, gradually expanding distribution, increasing intensity of agglomeration per unit area, and spreading of agglomeration core. By 2022, the environmental protection industry in the southern part of Jiangsu Province has developed a clear cluster core, marking the initial formation of five major environmental protection industry clusters in Jiangsu Province, including Nanjing, Suzhou, Wuxi, Changzhou, and Yancheng, with Suzhou, Wuxi, and Changzhou as the axis and Nanjing, Yancheng, and Taizhou as the points to form a point-axis development pattern.

(3) The evolution of the spatial pattern of the environmental protection industry in Jiangsu province occurred after a combination of factors, mainly influenced by environmental and employment factors in the early stages of development, while factors of the market also significantly drive the dynamic changes in the spatial pattern in the later stages of development as the national economy continues to develop.

From a green economy perspective, this article examines the spatial pattern of the environmental protection industry in Jiangsu Province and its evaluation characteristics as well as its influencing factors, broadening the perspective of environmental protection industry research, refining the spatio-temporal perspective of the study, and providing important value to the optimal layout of the development of the urban environmental protection industry. However, it is important to acknowledge the limitations of this study. Data availability at the micro and medium scales is limited, leading to relatively homogeneous indicator selection that may not fully capture the spatial and temporal dynamics of the industry's development. The analysis of green indicators in this article relies on previous scholars' summarized data and is incomplete. Further research is needed to explore qualitative approaches that can provide a more comprehensive understanding of the findings by referring to similar works [23–25].

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