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Article

Evaluation of Green Cities in the Drainage Area of China's Beijing–Hangzhou Canal

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Abstract: The phrase 'green cities' refers to an idealised and modernised urban development model that features harmonious development among the environment, ecology, society, culture, and the inhabitants of a city. Harmonious humanistic relations and green pathways have become predominant models in modern urban development. Green city construction has drawn considerable attention. However, the construction and development of green cities involves numerous problems. The various needs of different populations must be coordinated to foster the green development of a city. In this study, the analytic hierarchy process was used to classify factors related to green city construction into different levels. The scope of the empirical verification was eight cities alongshore the drainage area of the Jiangsu section of the Beijing–Hangzhou Canal. Data from 2009, 2014, and 2019 were selected for analysis. Both quantitative and qualitative analyses were performed using these data, and standards were established to serve as a reference for city administrators in the process of decision-making regarding green city construction.

Keywords: green city; sustainable development; evaluation indicators

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1. Introduction

As a physical environment inhabited by humans, the city is a complex ecological system. The livelihood and social systems connected to the natural environment and the mobilisation of its resources dictate the behaviour of cities' inhabitants. The construction of green cities requires that the production, lifestyle, and the environment comply with the principles of ecological environment construction to create compact and highly efficient production spaces, habitable environments, and adequate ecological spaces, thereby promoting harmonious humanistic relations. The construction of green cities has become a new mode of development in the modern world. Green development is closely related to sustainable development.

1.1. Background

In 1987, the World Commission on Environment and Development of the United Nations officially proposed the idea of sustainable development in the Report of the World Commission on Environment and Development: Our Common Future. The central idea of this concept was to urge the current generation to satisfy their needs without jeopardising the needs of future generations [1,2]. Hu Angang asserted that developing 'green roads' meant emphasising the integration and coordination of economic development and environmental protection, in other words, developing human-centric, sustainable development pathways in a more proactive manner. Green development not only demands improvement in the utilisation of energy resources but also demands the protection and restoration of the natural ecological system and ecological processes, as well as the harmonious coexistence and coevolution of humans and nature [3]. Green city development evaluation systems are complex. Such systems are mainly used to evaluate the level of green development of a city [4]. Because the evaluation systems reflect the levels of natural habitats and green environments in a city, they encourage cities to invest their efforts in green development, and this in turn paves the way to the sustainable social and economic development of a city. Therefore, green city development evaluation systems not only reflect the state of a city's development but also provide a scientific basis to governments for green city-related development, planning, and decision-making according to the actual situation of the city. Green development evaluation for Chinese cities is still in its infancy stage, and the statistics bureau is yet to consider green development evaluation indicators in a systematic manner.

1.2. *Significance of Research*

In the current era, water is a significant resource for socio-economic growth and the protection of healthy environments. Properly controlled water resources are considered a vital part of development, reducing poverty and equity [5]. Based on the results of the previously mentioned studies, the researchers of this study established a scientific green city evaluation indicator system [4,6]. By using the analytic hierarchy process (AHP) analysis method, the researchers performed analyses of cities alongshore the Jiangsu section of the Beijing–Hangzhou Canal's drainage area (the Beijing–Hangzhou Canal is included in the World Cultural Heritage List created by the United Nations Educational, Scientific and Cultural Organization), namely Suzhou, Wuxi, Changzhou, Zhenjiang, Yangzhou, Huai'an, Suqian, and Xuzhou (Figure 1). In terms of the time frame, the years 2009, 2014, and 2019 were selected as the time nodes for space–change evaluation. The researchers evaluated the development level and space layout of the eight chosen cities alongshore the Jiangsu section of the Beijing–Hangzhou Canal to determine the problems in the process of green city construction and the main elements limiting green city construction. The main purpose was to clearly identify the direction and focus of future development efforts such that the results could serve as a reference for green city construction in the eight cities. In addition, the results of the study have implications for green city construction in other cities.

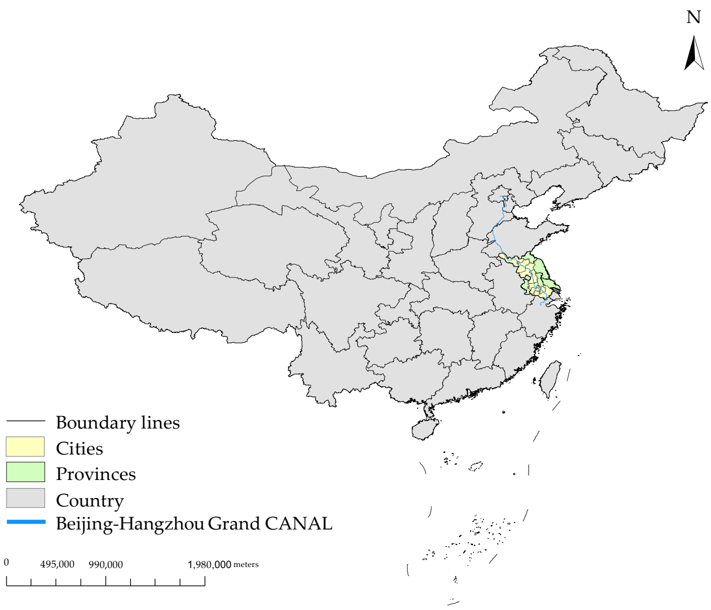


Figure 1. Drainage map of the Beijing–Hangzhou Canal.

2. Overview and Theoretical Basis

2.1. Analysis of Relevant Concepts

Research on habitable green cities originated from research on human living environments. Numerous concepts in the field overlap with those in the field of green cities, including garden cities, compact cities, low-carbon cities, landscape cities, landscape garden cities, ecological cities, healthy cities, and habitable cities [7]. To gain a deeper understanding of the details behind the concept of green cities, the researchers of this study analysed concepts closely related to green cities, including garden cities, ecological cities, and low-carbon cities.

2.1.1. Garden City

The industrial revolution of the 1860s promoted urbanisation, causing a huge influx from the rural population into cities. This resulted in problems such as land scarcity in cities, soaring land prices, pollution in cities, and a wealth gap. In 1898, British urban planner Ebenezer Howard proposed the idea of the garden city, which examines the city as a whole entity. Howard established a connection between urban and rural areas and proposed city planning problems emerging from the process of adaptation to modern industry. Howard proposed unique opinions regarding critical problems such as population density, city economy, and city afforestation [7].

2.1.2. Compact City

After World War II, Western cities returned to a period of expansion and flourished. Although the cities had not sustained any damage, problems resulting from the process of urbanisation began to rapidly emerge. This included housing preferences (more green spaces per person) or avoiding inner-city problems: poor air quality, noise, small apartments and lack of more open green space [8]. Urban sprawl has been mainly discussed with regard to its negative impacts. However, there is a variety of rural lands that benefit the suburbanisation process in social, environmental, economic and political terms [9]. Because these problems could not have been resolved effectively through the available measures, a new solution was desperately needed; the original garden city philosophy arose from such needs [10]. The idea of compact cities was first proposed by George Dantzig and Thomas Saaty in 1973 in 'Compact City: A Plan for a Liveable Urban Environment', the earliest work detailing the concept of compact cities. The city environment described in the work was a complex, highly dynamic city system with internal connections [11]. In 1990, the idea of the compact city was proposed in 'Green Paper on the Urban Environment', published by the Commission of the European Communities. Western academics engaged in intense discussion over the concept of compact cities as a means of resolving living and environmental problems [12]; the idea had both supporters and dissenters, and several scholars took the middle ground. With traditional life in European cities as the underlying model, the new model emphasised density, diversity, and social and cultural diversity [13]. Breheny was a major supporter of the concept of a compact city. He defined the compact city in a more comprehensive manner, as one that facilitated the rebuilding of cities, promoted the prosperity of central zones, protected farmlands, limited large-scale development in rural areas, increased the density of cities, laid lands for hybridised functions on the relevant nodes, prioritised the development of public transport, and centralised city development [14]. The concept of compact cities originated from Europe and gained extensive support from European scholars and decision-makers, becoming the fundamental principle behind the design and transformation of European cities [10]. The birth of land-use planning as we know it today was caused by the development of cities and the industrialisation of transport in the nineteenth century. The campaign for compact city transformation spread to many countries in Europe (including countries with a low population density), including the Netherlands, Switzerland, and Italy [15]. In addition, the campaign influenced the planning and development of American and Australian cities [15,16].

2.1.3. Ecological City

The concept of the modern ecological city originated from the idea in Ebenezer Howard's garden city theory that a balance must be maintained between the city and nature [17]. In the late 1960s, environmental pollution and ecological damage were becoming increasingly severe, causing the insufficiencies inherent in the traditional model of urban development to be reconsidered. Wolman wanted to draw attention to the fact that mayors of American cities in the 1960s made no conscious attempt to manage these flows, even though it was within their ability to do so. As a result, they suffered from interruptions in the supply of resources, such as water, and from the accumulation of residuals, such as air pollutants [18]. Increased water-to-air carbon dioxide fluxes were a potentially important consequence of canal estate developments in estuaries surrounded by wetlands [19]. The amount of excess water that passed St. Louis during the 1993 flood would have covered little more than 13 million acres—half of the wetland acreage drained since 1780 in the upper Mississippi Basin [20]. By strategically placing at least 13 million acres of wetlands on hydric soils in the basin, in this case, solved the basin's flooding problems in an ecologically sound manner. The concept of ecological cities involves the harmonious development of a city's ecological, social, and economic aspects based on ecological theories to form a healthy and habitable environment. In the 1970s, the United Nations Educational, Scientific, and Cultural Organization conducted a comprehensive research program entitled 'Man and the Biosphere Programme', and the report proposed five principles for ecological city planning: strategies for ecological protection; ecological infrastructure, inhabitants' living standards; protection of culture and history; and the integration of nature into the city [17]. The analysis from this perspective indicated that the concept of ecological cities included both the maintenance of city landscape planning and design as well as the promotion of the utilisation of engineering technology in a city's construction of its ecological environment; it also included the philosophy of urban development and emphasised the harmonious development between city and nature and the health and vitality of the relationship between humans and nature [21]. China's urban explosion has resulted in a substantial loss of agricultural production on the fringes of many cities [22]. Farmland is not only converted into urban uses but also taken out of production because it has lost its value for those who can farm it. Strengthening the land market and removing the remaining barriers for farmers to transfer land to colleagues can further help to keep farmland in production.

2.1.4. Low-Carbon City

Since the term 'low-carbon economy' was coined in the 2003 British White Paper report entitled 'Our Energy Future: Creating a Low Carbon Economy', low-carbon practices have been implemented extensively, and international collaboration has been encouraged. In December 2009, the Copenhagen Accord was signed at the United Nations Climate Change conference held in Copenhagen. The objective of the accord was to limit the global temperature increase to 2 °C above the preindustrialisation level [23]. The proposition of the concept of low-carbon cities was related to climate change and the energy crisis. The greenhouse gas emissions resulting from the acceleration of urbanisation and the rapid development of industrial economy and private transportation would exacerbate climate change across the world. Climate change then constituted a severe threat for the sustainable development of human society. In short, the development model of cities urgently required alterations to control carbon emissions and complete the target low-carbon transformation.

2.1.5. Landscape City

The concept of landscape cities was first proposed by Chinese scholar Qian Xue Sen in the 1990s. The concept proposes a blueprint for a futuristic city based on China's traditional view of natural landscape and philosophical notion of 'tian-ren-he-yi' (the unification of nature and humans as one) [24]. The concept of landscape cities integrated elements from a city's ecology and historical culture with elements from modern technology and environmental aesthetics. A landscape city is a green city with uniquely Chinese features; a product of modern civilisation and traditional Chinese culture. The concept of landscape cities represents an objective for the future development and construction of cities in China [25]. Wu Liang Yong noted that the concept of landscape cities advocates for the coordination between artificial and natural development and that the ultimate goal is to create an environment for human settlement in which the artificial and natural environments are merged [26]. Bao Shi Xing noted that the concept of landscape cities contains profound elements from ecological philosophy [27].

After more than 10 years of experience in contemplating, creating, and implementing, Chinese architect Ma Yansong proposed his idea of the landscape city. He argued that architects should be able to create a new vision for future cities that combines the density of cities with the artistic concept of landscape and maintains the humanistic spirit and cultural values at their core. Such a city, known as a 'landscape city' should be shared by all inhabitants [28].

2.2. The Development of the Concept of Green Cities

The concept of green cities was originally used in city planning and emphasised the construction of ecological environments. In 1898, British scholar Ebenezer Howard proposed the idea of garden city, a novel social formation that would replace the old social formation of urban–rural separation, with urban–rural integration [7]. Inland uses with less human disturbance, urban green spaces (UGS) tend to be larger and more homogeneous in enhancing ecosystem services, and are closer to each other, with more green cover to enhance connectivity and facilitate the movement of organisms and people between proximal patches [29]. To address the aimless development and crowded, polluted environment of big cities, master French architect Le Corbusier, in 1930, proposed the idea of Ville Radieuse (the Radiant City) for Brussels. He claimed that the idea of Ville Radieuse portrayed the ideal form of the city [30,31]. Le Corbusier was the earliest proponent of the concept of green cities. He had an affinity with natural beauty and vehemently opposed the separation of city inhabitants from the natural environment. He argued that buildings could be fused with community environments to form an organic entity harmonious in form, continuous in function, and mutually complementary and integrated in terms of space. In short, the organic entity would be a dynamic, harmonious integration of buildings with community environments. In 1990, the book *Green Cities*, edited by David Gordon, explored ecotransformation paths for city spaces and proposed the concept, connotation, and strategies for the realisation of a green city. The book marked the official introduction of the concept of green cities to the international sphere [32]. In 2005, mayors of 50 cities from various countries signed the Urban Environment Agreement: Green Cities Declaration [33] in San Francisco and urged for the sustainable development of cities to improve inhabitants' quality of life. The concept of green cities has been expanded over the years from a simple environmental concept to a concept that relates to the human living environment.

The notion of ecology in the social production of green spaces continues to aid our understanding of an environment characterised by different stakeholders and actors, as well as technical, social, and discursive elements that operate across dynamic time and space constraints [34]. Cities are challenging environments for human life, because of multiple environmental issues driven by urbanisation. These can sometimes be mitigated through ecosystem services provided by different functions supported by biodiversity [4]. Cities are socio-ecological systems mostly dominated by the grey infrastructure (built-up areas, including buildings and roads) and the green and blue infrastructure, which includes all natural, semi-natural, and artificial (i.e., entirely human-made) habitats within a city, such as parks, rivers and green roofs [35].

The circular economy (CE) concept is trending both among scholars and practitioners. Notable concepts also supposed to operationalise sustainable development for businesses are the green economy and green growth concepts [36]. Lahane et al. examined the current status and trends in the circular economy (CE) research. The research in the domain of CE is in the beginning phase. It has numerous quantitative modelling opportunities, value creation, proposition aspects, and application in real-life case problems [37]. Concerns about water resources sustainability have increased worldwide due to population growth and urbanization problems [38,39]. The Sponge City concept is emerging as a new kind of integrated urban water system, which aims to address urban water problems. However, its implementation has encountered a variety of challenges [40].

Eric Martinot asserted that green cities emphasise energy saving and carbon reduction and that a green city should produce zero carbon emissions [41]. Scholars such as Evelyn Waugh and Douglas Loh have argued that the construction of green areas in cities plays a crucial role in the construction of green cities [42]. Several scholars have integrated the concept of sustainable development into the construction of green cities and have argued that when constructing a green city, the relationship among city construction, the environment, economic development, and social development must also be considered. Urban green spaces, such as parks, forests, green roofs, streams, and community gardens, all provide critical ecosystem services. Green spaces also promote physical activity, psychological wellbeing, and the general public health of urban residents [43]. As the field of research on green cities expands, researchers of green city construction should investigate the stable development of cities under a four-in-one ecological system, which combines aspects related to humans, nature, the economy, and society [44]. Table 1 presents fundamental concepts in the global discourse on the development of green cities. The relevant indicators data of the empirical scope of this research are shown in Appendix A.

Table 1. Development of the concept of green cities in various countries.

Definition of Green Cities in Countries Other Than China	Agency/Author
A green city is an environmentally friendly city.	UNEP [45]
Promoting economic and urban development through events in cities that could reduce the negative influence of negative external environmental factors on natural resources and services related to ecological systems.	OECD [46]
Their purpose is to live in cities that are within ecological boundaries, reduce humans' ecological footprint from the foundation, and gain a deeper understanding of the effect of interaction with other cities, communities, or the global community.	Beatley [47]
Green cities should have three priorities:the quality of the ecological environment, public health, and the economy.	Kahn [48]
The green smart city project should be launched. Various information and communication technology have emerged from advancements in computer technology, the Internet, cloud computing, and mobile communication. Green technology should focus on providing clean technology for energy consumers, reducing carbon emissions, and increasing energy efficiency.	Stanford Programon Regions of Innovationand Entrepreneurship, (SPRIE) [49]
A green city is a city that utilises energy, transportation, and building infrastructure as cleanly and efficiently as possible.	Earth Day Network [50]
The term 'green cities' refers to the practice of creating communities that are mutually beneficial to humans and nature.	Global Green USA [51]
A green urban economy involves a process of economic transition and the transformation of existing and emerging cities to make the economy of the city more environmentally friendly and socially beneficial.	Simpson and Zimmermann [52]

Emerging from these concepts, research on green cities on an international scale has prioritized the establishment of healthy urban environments and the management of environmental pollution.

According to the concepts in the discourse presented in Table 2, Chinese scholars have argued that developing green cities can reduce the risk posed to environmental resources, improve living environments, increase economic prosperity and employment opportunities, resulting in societal advancement, which can provide solutions to the severe resource and environmental problems that Chinese cities face.

Table 2. Development of the concept of green cities in China.

Definition of Green Cities in China	Agency/Author
The green city is a model emphasising the stable development of cities under a four-in-one ecological system, which combines aspects related to humans, nature, the economy, and society.	Zhao [44]
Green cities represent a healthy model for urban development for two reasons: a prosperous green economy and green human living environments.	Chang and Li et al. [53]
The goal of constructing a green city is to satisfy humans' needs for health and nature. The function of a city is comprehensively optimised to achieve clean and highly efficient utilisation of resources and energy, a safe and comfortable environment, high-functioning and comfortable infrastructure, and a harmonious and civil social environment.	Ouyang et al. [54]
Green cities utilise a series of innovative technology, especially low-carbon technology, for green development to increase the efficiency of resource and energy utilisation, improve city governance, and reduce the consumption of resources and discharge of waste. In addition, urbanisation and economic and social advancements are accelerated and habitable cities are constructed to avoid the environmental crisis caused by high levels of carbon, increase the quality of urban development, and realise the goal of sustainable development.	Li and Li [55]
Green city development requires the harmonious development of the economy, society, and environmental resources. To ensure the stable development of a city's economy, the negative influence of economic activity on environmental resources must be minimised, thereby increasing inhabitants' quality of life.	Shi and Liu [56]

2.3. Confirmation of the Indicator Evaluation System

According to the research of foreign scholars in the field of green city evaluation, a green city indicator evaluation system should provide description, explanation, evaluation, warning, and decision-making assistance to create computable indicators, collectable data, comparable methods, and explainable results [4,43,57].

The authors of this study examined the temporal and spatial conditions of the development of cities in the Jiangsu and combined their findings with the characteristics and concept of green cities to create an indicator evaluation system based on the principles of comprehensiveness, scientificity, data availability, manoeuvrability, and typicality [4,58,59]. The drainage area of the Beijing–Hangzhou Canal was selected as the scope of the empirical verification. The drainage area has a flat topography and is rich in water resources. Therefore, the area is suitable for green city development [60]. We integrated the results from different research perspectives with other research results. In this study, the analytic hierarchy process was used to classify factors related to the construction of green cities into different levels. Table 3 describes each of the eight indicators. Figure 2 clearly shows the hierarchical distribution of the research questions. The researchers created an evaluation system consisting of eight evaluation indicators in three evaluation dimensions and used this system to evaluate the level of green city development in eight cities alongshore the Jiangsu section of the Beijing–Hangzhou Canal's drainage area, namely Suzhou, Wuxi, Changzhou, Zhenjiang, Yangzhou, Huai'an, Suqian, and Xuzhou.

As shown in Figure 2, the first layer of the system is the target layer, and the second and the third layers are the dimension layer and indicator layer, respectively.

Table 3. Evaluation indicators for the level of sustainable development of a green city.

Evaluation Dimension	Evaluation Indicator	Description of the Evaluation Indicators
D_1 Green production	C_1 Resource utilisation	Energy consumption per unit of GDP; reuse rate of industrial water; C_{11}: comprehensive utilisation rate of solid industrial waste.
	C_2 Pollution control	C_{21}: carbon dioxide emissions per unit of GDP; C_{22}: volume of soot emissions; C_{23}: amount of industrial waste water in compliance with discharge standards.
D_2 Green life	C_3 Green municipal administration	C_{31}: centralised treatment rate for domestic sewage; coverage rate of domestic waste classification equipment; domestic waste collection rate.
	C_4 Green transportation	C_{41}: number of rail transit vehicles; C_{42}: total passenger volume of rail transit transportation; C_{43}: number of public transportation vehicles per 10,000 inhabitants.
	C_5 Green consumption	C_{51}; residential electricity consumption; C_{52}: water consumption per capita; waste generation per capita.
D_3 Environmental quality	C_6 Ecological environment	C_{61}: green coverage area of completed construction area; C_{62}: public recreational green space per capita; C_{63}: green coverage rate of completed construction area.
	C_7 Atmospheric environment	Number of hazy days; C_{71}: ratio of number of days with excellent environmental air quality; C_{72}: annual average concentration of inhalable particles.
	C_8 Water environment	C_{81}: water quality compliance rate of centralised drinking water sources; C_{82}: ratio of surficial water cross-sections with water quality of level III or above.

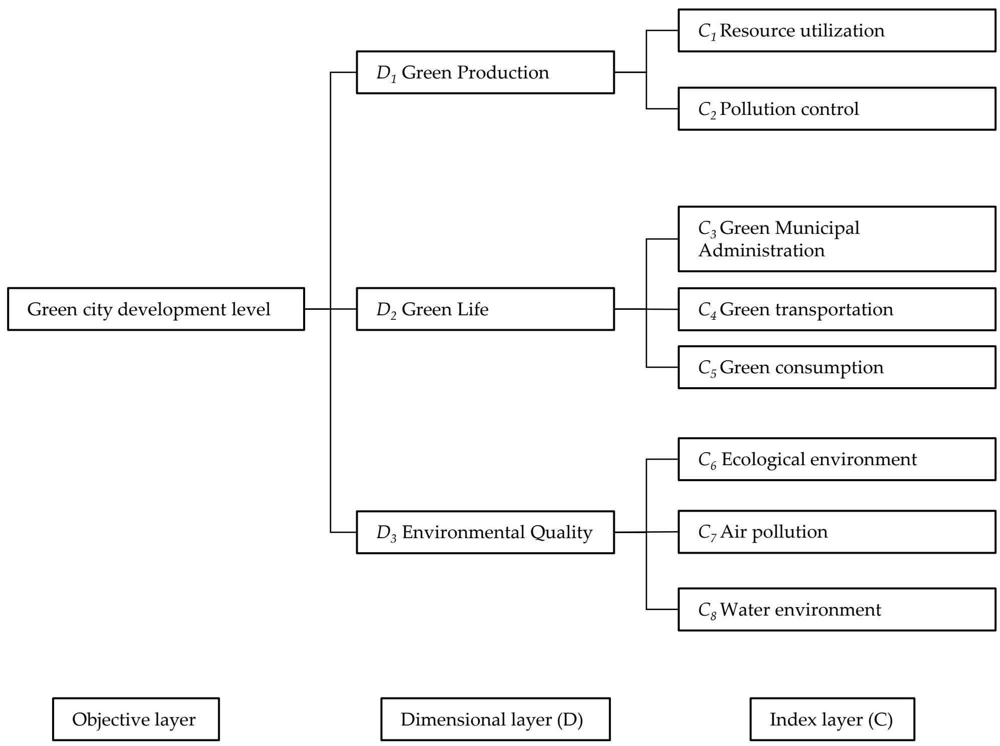


Figure 2. Framework for the indicator evaluation system for the level of sustainable development of green cities.

3. Methods

The above brief overview of the literature has shown that very different approaches have been developed in relation to green city issues, especially regardingwhich methods and measures should be applied to cities. In this study, the evaluation indicators were qualitatively analyzed using the literature review and in-depth interviews with experts. Quantitative analysis was used for the calculation of indicator weights and empirical data.

3.1. Literature Review

The researchers analysed and organised relevant literature reviews to comprehensively and accurately examine the problems. The researchers reviewed periodical literature, dissertations, research reports, conference papers, monographs, yearbooks, and news reports related to human living environments, habitable cities, green cities, and ecological cities. Next, the researchers organised, analysed, classified, and summarised the data from the materials. Through the examination and comparison of foreign and Chinese literature, the researchers compiled data related to habitable cities, the state of the research, and future research directions. These data were the theoretical basis for the study. In addition, there were still many gaps found in this research that needed to be studied [61], such as the lack of a definition of a green city rooted in a simple green city conceptual framework; the development of index methods containing a short number of indicators to measure environmental performance rooted in a conceptual framework; and simple methods to track the evolution and progress of cities' environmental performances over time.

3.2. Analytic Hierarchy Process

3.2.1. The Concept of Analytic Hierarchy Process (AHP)

AHP is a concept proposed by the American operational research expert Thomas Saaty, who was a professor at Pittsburgh University. It is a layered, weighted decision analysis method adapted from network system theory and a multiobjective comprehensive evaluation method that Saaty developed in the 1970s while conducting research for the United States Department of National Defense on the distribution of electricity to industrial departments on the basis of their contributions to the country's welfare. Based on the in-depth analysis of complex problems regarding decision-making, their influencing factors, and internal relationships, this method mathematises the decision-making process by using a small amount of quantitative information. This method can facilitate the resolution of complex multiobjective, multicriteria, or unstructured decision-making problems. In short, AHP is a model and method of decision-making regarding complex systems that are not completely quantitative [62]. There are many concepts and methods trying to accommodate the growth of cities without impairing sustainability. Brilhante and Klaas used Green City Concept (GCC) as one of the latest of these concepts. They introduced a Green City Conceptual Framework (IHS-GCCF) and a harmonized method to measure Global Green City Performance over time (GGCPI) [61]. Many methods stemming from applied mathematics and operations research have proven useful to help decision-makers make informed decisions, and among these methods, there are also those requiring, as inputs, subjective judgments from a decision-maker or an expert. It is in this context that the AHP became a useful tool for analyzing decisions [63].

3.2.2. AHP Computation

A. Establishing the pairwise comparison matrix.

As already mentioned, in the framework, the AHP can be applied to a multitude of decision-making problems involving a finite number of alternatives. The seven pillars of the AHP are (1) ratio scales, proportionality, and normalized ratio scales; (2) reciprocal paired comparisons; (3) sensitivity of the principal right; (4) homogeneity and clustering; (5) synthesis that can be extended to dependence and feedback; (6) rank preservation and reversal, and (7) group judgments [64]. In addition to factors at the target level, factors at other levels must be compared on the basis of the estimation of the top-level factors. When the questionnaire for the comparison of each pair was designed, experts were asked to evaluate the scale for the pairwise comparison of each item, the content of the scale, and the descriptions on a scale from 1 to 9. For n factors in a matrix, a total of $n(n-1)/2$ pairwise comparisons must be conducted. The results of the pairwise comparison of the n

number of elements are placed on the top of the pairwise comparison matrix A. Because n number of scales on the diagonal lines are used to compare the factors with themselves, the values on the diagonal lines are constant, measuring1. The value at the bottom of the matrix is the inverse of the corresponding value at the top of the matrix. Because of the reciprocal property of paired comparisons, if the ratio between elements i and j is a_{ij} then the ratio between elements j and i is $1/a_{ij}$. Similarly, the lower triangular matrix of the paired comparison matrix A is the reciprocal of the upper triangular matrix, as shown in Equation (1):

$$A = \left[a_{ij}\right] = \begin{bmatrix} 1 & a_{12} & \ldots & a_{1n} \\ 1/a_{12} & 1 & \ldots & a_{2n} \\ \ldots & \ldots & \ldots & \ldots \\ 1/a_{1n} & 1/a_{2n} & \ldots & 1 \end{bmatrix} \quad (1)$$

where $1/a_{ij}$ represents the element.

When the weight value of an element is known, it is expressed as follows:

$$A = \left[a_{ij}\right] = \begin{bmatrix} 1 & a_{12} & \ldots & a_{1n} \\ 1/a_{12} & 1 & \ldots & a_{2n} \\ \ldots & \ldots & \ldots & \ldots \\ 1/a_{1n} & 1/a_{2n} & \ldots & 1 \end{bmatrix} = \begin{bmatrix} W_1/W_1 & W_1/W_2 & \ldots & W_1/W_n \\ W_2/W_1 & W_2/W_2 & \ldots & W_2/W_n \\ \ldots & \ldots & \ldots & \ldots \\ W_n/W_1 & W_n/W_2 & \ldots & W_n/W_n \end{bmatrix} \quad (2)$$

where W_i represents the element weight of i; i = 1, 2, . . . , n.

In which:

$$a_{ij} = W_i/W_j, a_{ij} = 1/a_{ji}, W = [W_1, W_2, \ldots, W_n]^T = \begin{bmatrix} W_1 \\ W_2 \\ \ldots \\ W_n \end{bmatrix} \quad (3)$$

W_{ij} is the weight of element i, and a_{ij} is the ratio of the relative importance of a pair of elements (i = 1, 2, . . . , n; j = 1, 2, . . . , n).

B. Calculation of the eigenvalue and eigenvector.

After the pairwise comparison matrix is created, the matrix eigenvalue and eigenvector are calculated. After the matrix eigenvalue and eigenvector are obtained, the weight of the elements in each level can be derived.

The calculation of the eigenvector involves multiplying the row elements by each other, resulting in the geometrical mean of the product, and performing the normalised calculation. The process is as follows:

$$W_i = \frac{\left(\prod_{j=1}^{n} a_{ij}\right)^{\frac{1}{n}}}{\sum_{i=1}^{n}\left(\prod_{j=1}^{n} a_{ij}\right)^{\frac{1}{n}}}, i, j = 1, 2, \ldots, n \quad (4)$$

When pairwise comparison matrix A is multiplied by the obtained eigenvalue Wi, a new eigenvector $W_i{}'$ is created. By dividing each eigenvalue of $W_i{}'$ by the corresponding eigenvalue of original vector W_i, the arithmetic mean of each value can be calculated accordingly. Finally, its maximum eigenvalue is λ_{max} that can be calculated as follows:

$$A \times W = \lambda_{max} \quad (5)$$

$$A = \begin{bmatrix} W_1/W_1 & W_1/W_2 & \dots & W_1/W_n \\ W_2/W_1 & W_2/W_2 & \dots & W_2/W_n \\ \dots & \dots & \dots & \dots \\ W_n/W_1 & W_n/W_2 & \dots & W_n/W_n \end{bmatrix} \begin{bmatrix} W_1 \\ W_2 \\ \dots \\ W_n \end{bmatrix} = \begin{bmatrix} W_1' \\ W_2' \\ \dots \\ W_n' \end{bmatrix} \tag{6}$$

in which

$$\lambda_{max} = \frac{1}{n}\left(\frac{W_1'}{W_1} + \frac{W_2'}{W_2} + \dots + \frac{W_n'}{W_n'}\right) \tag{7}$$

C. Consistency test.

Because the values in the pairwise comparison matrix are generated based on the subjective opinions of experts, establishing consistency between the values is difficult. Therefore, consistency tests must be conducted on these values to obtain the consistency index (*C.I.*). The *C.I.* can then be used to examine whether the pairwise comparison generated from the experts' answers is a consistent matrix.

The *C.I.* is as derived as follows:

$$C.I. = \frac{\lambda_{max} - n}{n - 1} \tag{8}$$

The maximum eigenvalue of matrix A is λmax, and n is the number of evaluation elements.

When the value of $C.I.$ is equal to 0, this indicates that, under certain criteria, the importance levels of the nth number of elements are completely identical.

A $C.I.$ value larger than 0 indicates a divergence in the experts' judgments: the smaller the $C.I.$ values, the more similar the experts' answers. The optimal $C.I.$ value, as suggested by Saaty, is less than 0.1, and the maximum tolerable deviation is 0.2.

The positive reciprocal matrix generated from the 1 to 9 scale has different random index values $R.I.$ under different levels. Table 4 presents the random index value for each level of AHP.

Table 4. Random index value for each level of AHP.

Level	1	2	3	4	5	6	7	8	9
R.I.	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

As shown in (9), for matrices with the same number of levels, the ratio of their *C.I.* and *R.I.* is the consistency ratio (*C.R.*)

$$C.R. = \frac{C.I.}{R.I.} \tag{9}$$

When $C.R. < 0.1$, the consistency level of the matrix is relatively high.

3.2.3. Weight Analysis of the Evaluation Indicators

By reviewing the literature, the researchers constructed an indicator evaluation system to evaluate the level of green city development. The researchers interviewed experts and scholars from the fields of urban and rural planning, architecture, environmental ecology, landscape architecture, and regional planning. The experts were asked to conduct pairwise comparisons of the evaluation indicators and complete questionnaires using their experience and expertise. After the comprehensive tests, the questionnaires fulfilled the consistency requirement (*C.R.* < 0.1).

Table 5 presents an example of data from a questionnaire completed by one of the experts:

Table 5. Data from expert's answers to questionnaire.

Evaluation Element	D_1-D_2	D_1-D_3	D_2-D_3
Importance level	1:3	1:5	1:1

The following comparison matrix can then be obtained (Table 6):

Table 6. Sum of rows.

Influencing Factor	D_1	D_2	D_3
D_1	1	0.333	0.2
D_2	3	1	1
D_3	5	1	1
Sum of rows	9	2.333	2.200

Then, standardised values can be obtained by diving each value in the matrix by the sum of each row. Table 7 presents the results of the calculation.

Table 7. Standardised values.

Influencing Factor	D_1	D_2	D_3
D_1	0.111	0.142	0.090
D_2	0.333	0.429	0.455
D_3	0.556	0.429	0.455

Next, the mean value can be obtained based on the column vector, and the weight of each factor can be obtained accordingly. Table 8 presents the results.

Table 8. Weight.

Influencing Factor	Weight
D_1	(0.111 + 0.142 + 0.090)/3 = 0.114
D_2	(0.333 + 0.429 + 0.455)/3 = 0.406
D_3	(0.556 + 0.429 + 0.455)/3 = 0.480

The maximum eigenvalue, λ_{max} = 3.029, can be calculated by using the equation. The $C.I.$ value can be calculated as follows:

$$C.I. = \frac{\lambda_{max} - n}{n - 1} = 0.014. \quad (10)$$

After the $C.I.$ value is obtained, the R.I value corresponding to n is selected from the random index table, and the $C.R.$ value can be calculated as follows:

$$C.R. = \frac{C.I.}{R.I.} = 0.024 < 0.1. \quad (11)$$

Convergence was detected in the consistency level of the matrix. Therefore, the results of the survey satisfied the requirement. The consistency test on the other factors yielded the same results. After the results of the consistency test on the experts' responses to the questionnaire were combined, the weight analysis of the evaluation factors for the level of sustainable development in green cities was performed. Table 9 presents the results.

Table 9. Results of weight analysis of evaluation factors for the level of sustainable development in green cities.

Dimension	Dimension Weight	Evaluation Indicator	Indicator Weight	Comprehensive Weight
D_1 Green production	0.114	C_1 Resource utilisation	0.750	0.085
		C_2 Pollution control	0.250	0.029
D_2 Green life	0.406	C_3 Green municipal administration	0.634	0.257
		C_4 Green transportation	0.260	0.106
		C_5 Green consumption	0.106	0.043
D_3 Environmental quality	0.480	C_6 Ecological environment	0.634	0.304
		C_7 Atmospheric environment	0.260	0.125
		C_8 Water environment	0.106	0.051

The data revealed that among the three dimensions, element D_3, 'environmental quality', had the largest weight (0.480), followed by D_2, 'green life' (0.406), and D_1, 'green production' (0.114). As for the eight indicators, in the D1 dimension, element C_1, 'resource utilisation', had the largest weight (0.750), followed by C_2, 'pollution control'. In the D_2 dimension, C_3, 'green municipal administration', had the largest weight (0.634), followed by 'green transportation' and 'green consumption'. In the D_3 dimension, C_6, 'ecological environment', had the largest weight (0.634), followed by 'atmospheric environment' and 'water environment'. However, in terms of the comprehensive weight of all the dimensions and indicators, the order of importance level of each element was as follows: C6: 'ecological environment' (0.304); C_3: 'green municipal administration' (0.257); C_7: 'atmospheric environment' (0.125); C_4: 'green transportation' (0.106); C_1: 'resource utilisation' (0.085); C_8: 'water environment' (0.051); C_5: 'green consumption' (0.043); and C_2: 'pollution control' (0.029). These results indicated that the environmental quality, especially of ecological and atmospheric environments, had the strongest influence on the sustainable development of green cities.

4. Empirical Case Study

The researchers performed consistency tests on the data extracted from the experts' answers. After each evaluation indicator and the corresponding weight were confirmed to satisfy the requirement, the evaluation indicators and their weight were used to calculate the priority index (*PI*) of each plan proposed at the target layer. The *PI* value was derived from the simple weighted addition of an individual indicator score X_{ij} with weight Wi for plan i as follows:

$$PI_i = \sum_{j=1}^{n} W_j \times X_{ij} \tag{12}$$

The researchers used the PI value to evaluate the level of green sustainable development in cities. The case studies were cities alongshore the Beijing–Hangzhou Canal within Jiangsu, namely Suzhou, Wuxi, Changzhou, Zhenjiang, Yangzhou, Huai'an, Suqian, and Xuzhou.

4.1. The Beijing–Hangzhou Canal

The Beijing–Hangzhou Canal is the longest artificial canal in the world. It is a large waterway system on the eastern plain of China. At the northern end, it originates in Beijing and extends south to Hangzhou. With a total length of 1794 km, it is one of the largest water resource engineering projects in human history, connecting five major rivers in China [65,66]. It was built after AD 500 and first envisioned as a means of communication to unite the country in the seventh century. Now a pillar of China's economy, it provided social stability and played a role in governmental administration in ancient China. It was added to the World Cultural Heritage List of the United Nations Educational, Scientific, and Cultural Organization on 22 June 2014 [67].

4.2. Cities along the Canal

The Beijing–Hangzhou Canal runs through 20 cities: Beijing and Tianjin; Langfang, Cangzhou, Hengshui, and Xingtai of the Hebei Province; Dezhou, Xintai, Liaocheng, Jining, and Zaozhuang of the Shandong Province; Xuzhou, Suqian, Huai'an, Yangzhou, Zhenjiang, Changzhou, Wuxi, and Suzhou of the Jiangsu; and Jiaxing, Huzhou, and Hangzhou of the Zhejiang Province.

4.3. Drainage Area of Beijing–Hangzhou Canal

The length of the Beijing–Hangzhou Canal in the Jiangsu is 628 km. The repair and expansion of the canal was conducted in Subei and Sunan. The canal was expanded by the addition of two second-line ship locks in Jianbi and Xietai and three third-line ship locks in Huaiyin, Huai'an, and Suqian. The limitations in the Jiangsu section of the Beijing–Hangzhou Canal that impeded access between southern and northern Jiangsu were removed and therefore the canal has become a key north–south water transportation artery for Jiangsu and the eastern region of China region. The researchers selected eight cities in the Jiangsu, namely Xuzhou, Suqian, Huai'an, Yangzhou, Zhenjiang, Changzhou, Wuxi, and Suzhou for this study. Figure 3 presents this scope.

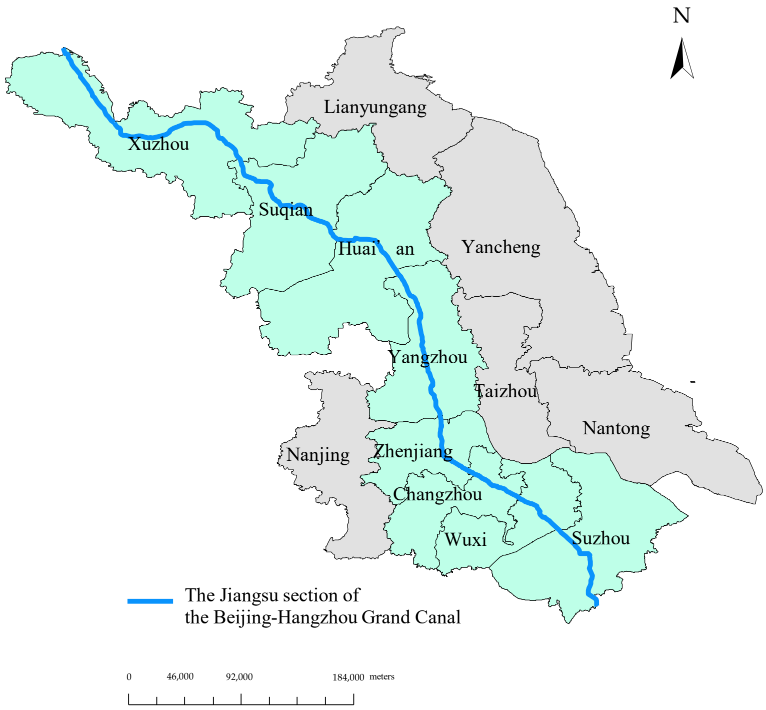


Figure 3. Drainage map of Beijing–Hangzhou Canal.

4.4. Data Source

The data used for the evaluation were collected from two sources. One source was the 2009, 2014, and 2019 statistical yearbooks of the Jiangsu and the 2009, 2014, and 2019 prefecture-level statistical yearbooks of the cities in the selected region. The other source was the 2009, 2014, and 2019 prefecture-level environment statements of the cities in the selected region [68].

4.5. Standardised Processing of Indicators

The evaluation of the level of the sustainable development of green cities involves a large number of design indicators. Because the unit differences between each indicator are also large, the indicators cannot be compared and analysed. A mathematical method must be used to eliminate the influence of different dimensions. The numerous methods for the standardisation of data, each with various advantages and disadvantages, can produce different results.

The researchers processed the raw data by using the maximum value standardisation method because of its characteristics. For this method, the positive and negative tendency of each indicator first needed to be identified.

The results indicated that the following variables exhibited a positive correlation with the level of sustainable development of green cities: the comprehensive utilisation rate of solid industrial waste, the centralised treatment rate for domestic sewage, the number of rail transit vehicles, the total passenger volume of bus transportation, the number of public transportation vehicles per 10,000 inhabitants, the area of green coverage in acompleted construction area, public recreational green space per capita, the green coverage rate of the completed construction area, the proportion of the number of days with excellent environmental air quality, the water quality compliance rate of centralised drinking water sources, and the ratio of surficial water cross-sections with a water quality of level III or above. The following variables exhibited a negative correlation: carbon dioxide emission volume, soot emission volume, waste water emission volume, the domestic electricity consumption of urban and rural inhabitants, the domestic water consumption per person per day, and the average annual concentration of inhalable particles.

Positive tendency indicators are calculated as follows:

$$N_i = \frac{M_i}{M_{max}} \tag{13}$$

Negative tendency indicators are calculated as follows:

$$N_i = \frac{Mmin}{M_i} \tag{14}$$

In (Equation (13)), Ni represents the new indicator value after standardisation; Mi (Equation (14)) represents the raw indicator value before standardisation; $Mmax$ represents the maximum value among the same type of indicator; and $Mmin$ represents the minimum value among the same type of indicator.

Through the maximum value standardisation method, the quantitative indicator data published in the 2019 statistical yearbook were processed to obtain standardised indicator data. Table 10 displays the results.

Table 10. Results of standardised processing of 2019 indicator data.

City	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
Suzhou	0.963	0.079	0.960	1.000	0.361	0.884	1.000	1.000
Wuxi	0.959	0.122	0.970	0.410	0.557	0.738	0.907	0.965
Changzhou	1.000	0.817	0.974	0.215	0.575	0.659	0.893	0.925
Zhenjiang	0.970	0.616	0.941	0.293	0.813	0.685	0.872	1.000
Yangzhou	0.995	0.212	0.938	0.323	0.700	0.788	0.878	0.861
Huai'an	0.997	0.619	0.950	0.215	1.000	0.637	0.891	0.858
Suqian	0.810	0.702	0.951	0.202	0.859	0.656	0.797	0.990
Xuzhou	1.000	0.422	1.000	0.230	0.713	0.693	0.792	0.865

4.6. Results and Discussion

Because judging evaluation indicator values is a complicated process, pairwise comparisons were conducted for the scores of each indicator, and the final scores were obtained through the competitive weight method. Pairwise comparisons of the case study cities were conducted for each evaluation indicator; the calculation steps were the same as those used in the calculation of the pairwise comparison matrix. Table 11 presents the results of the evaluation for the cities in 2019. According to the results, in 2019, Suzhou had the highest comprehensive indicator score for the level of sustainable development of green cities (0.897), followed by Wuxi (0.789) and Yangzhou (0.789). The city with the lowest score in 2019 was Suqian (0.742). The overall level in 2019 was moderate, and the speed of development was relatively consistent.

Table 11. Results of evaluation for 2019.

Dimension	Evaluation Indicator	Suzhou	Wuxi	Changzhou	Zhenjiang	Yangzhou	Huai'an	Suqian	Xuzhou
D_1 Green production	C_1 Resource utilisation	0.082	0.082	0.085	0.082	0.085	0.085	0.069	0.085
	C_2 Pollution control	0.002	0.004	0.024	0.018	0.006	0.018	0.020	0.012
D_2 Green life	C_3 Green municipal administration	0.247	0.249	0.250	0.242	0.241	0.244	0.245	0.257
	C_4 Green transportation	0.106	0.043	0.023	0.031	0.034	0.023	0.021	0.024
	C_5 Green consumption	0.016	0.024	0.025	0.035	0.030	0.043	0.037	0.031
D_3 Environmental quality	C_6 Ecological environment	0.269	0.224	0.200	0.208	0.240	0.193	0.199	0.211
	C_7 Atmospheric environment	0.125	0.113	0.122	0.109	0.110	0.111	0.100	0.099
	C_8 Water environment	0.051	0.049	0.047	0.051	0.044	0.044	0.050	0.044
PI		0.897	0.789	0.766	0.777	0.789	0.761	0.742	0.763

Regarding the comprehensive indicator score for the level of sustainable development of green cities, according to the results in Table 12, in 2014, Suzhou had the highest score (0.915), followed by Wuxi (0.791). The city with the lowest score was Suqian (0.729). The overall level in 2014 was moderate, and the speed of development was relatively consistent.

Table 12. Results of evaluation for 2014.

Dimension	Evaluation Indicator	Suzhou	Wuxi	Changzhou	Zhenjiang	Yangzhou	Huai'an	Suqian	Xuzhou
D_1 Green production	C_1 Resource utilisation	0.083	0.078	0.084	0.084	0.079	0.085	0.080	0.084
	C_2 Pollution control	0.004	0.007	0.015	0.015	0.019	0.017	0.024	0.009
D_2 Green life	C_3 Green municipal administration	0.252	0.254	0.206	0.206	0.224	0.241	0.220	0.257
	C_4 Green transportation	0.097	0.050	0.026	0.026	0.023	0.014	0.022	0.025
	C_5 Green consumption	0.015	0.022	0.036	0.036	0.028	0.037	0.041	0.038
D_3 Environmental quality	C_6 Ecological environment	0.295	0.224	0.213	0.213	0.223	0.195	0.182	0.215
	C_7 Atmospheric environment	0.125	0.111	0.117	0.117	0.108	0.104	0.111	0.102
	C_8 Water environment	0.044	0.045	0.048	0.048	0.044	0.051	0.049	0.049
PI		0.915	0.791	0.758	0.747	0.747	0.744	0.729	0.780

According to the results in Table 13, in 2009, Suzhou had the highest comprehensive indicator score for the level of sustainable development of green cities (0.929), followed by Wuxi (0.839). The city with the lowest score was Huai'an (0.693). The overall level in 2009 was moderate and the speed of development was relatively consistent.

Table 13. Results of evaluation for 2009.

Dimension	Evaluation Indicator	Suzhou	Wuxi	Changzhou	Zhenjiang	Yangzhou	Huai'an	Suqian	Xuzhou
D_1 Green production	C_1 Resource utilisation	0.084	0.084	0.081	0.080	0.083	0.085	0.085	0.085
	C_2 Pollution control	0.003	0.005	0.008	0.011	0.016	0.015	0.029	0.006
D_2 Green life	C_3 Green municipal administration	0.254	0.257	0.240	0.223	0.200	0.207	0.173	0.219
	C_4 Green transportation	0.105	0.090	0.104	0.078	0.091	0.050	0.052	0.106
	C_5 Green consumption	0.008	0.012	0.015	0.025	0.036	0.021	0.033	0.021
D_3 Environ-mental quality	C_6 Ecological environment	0.303	0.221	0.182	0.195	0.222	0.160	0.158	0.196
	C_7 Atmospheric environment	0.122	0.123	0.118	0.113	0.112	0.106	0.122	0.077
	C_8 Water environment	0.050	0.047	0.049	0.049	0.048	0.049	0.051	0.045
PI		0.929	0.839	0.798	0.774	0.809	0.693	0.704	0.755

The results in Figure 4 indicate that Suzhou had the highest score among the chosen cities. However, the score of Suzhou decreased from 0.929 in 2009 to 0.897 in 2019. The scores of only two cities, Huai'an and Suqian, increased; the score of Huai'an increased from 0.693 in 2009 to 0.761 in 2019, and the score of Suqian increased from 0.704 in 2009 to 0.742 in 2019. However, Huai'an exhibited a higher growth than Suqian. Although each city's level of sustainable development fluctuated over the course of a decade, the figures indicate that the gap between cities narrowed.

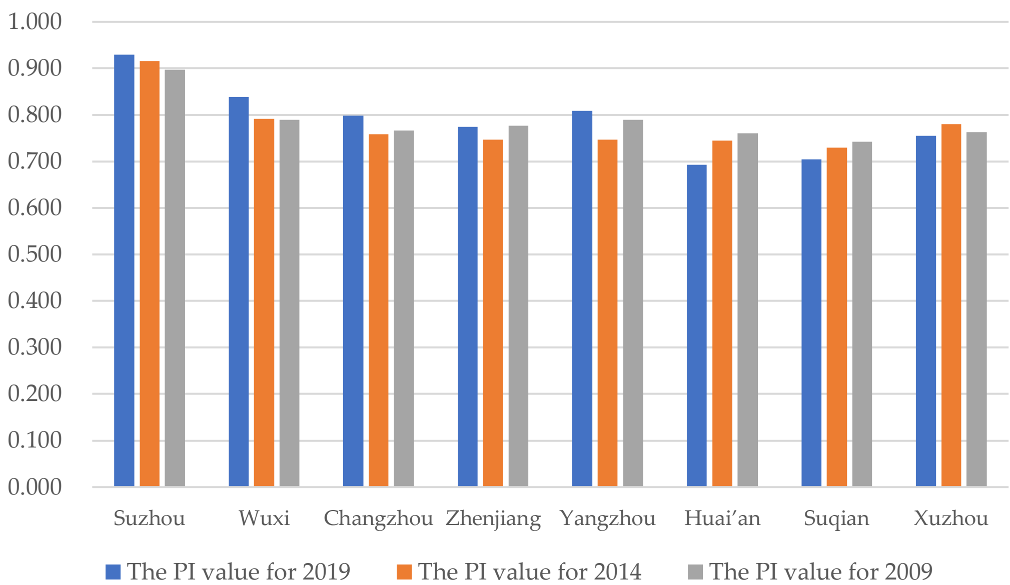
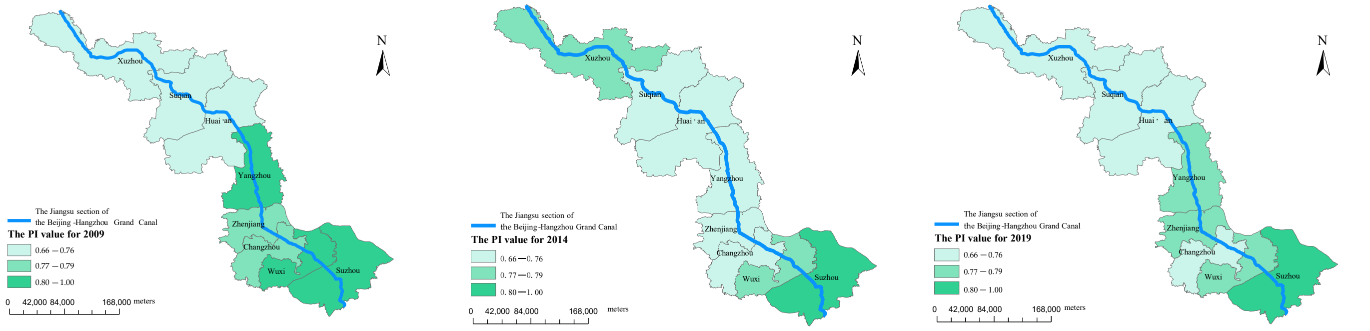


Figure 4. Comparative diagram for 2009–2019.

By using the natural breaks classification in ArcGIS10.2, the level of sustainable development in the green cities was divided into three categories, namely high (0.80–1.00), moderate (0.77–0.79), and low (0.66–0.76). Space visualisation was also performed (Figure 4).

In Figure 5, the zones of moderate and high development were concentrated around southern and central Jiangsu, whereas the zones of low development were concentrated around northern and central Jiangsu. The results revealed a distinct north–south gap in the level of sustainable development among the green cities alongside the Beijing–Hangzhou Canal in Jiangsu.



(**a**) 2009 (**b**) 2014 (**c**) 2019

Figure 5. Analysis of green city evaluation results.

5. Conclusions

The researchers created and evaluated eight indicators and three dimensions (i.e., green production, green life, and environmental quality) based on the status of the natural resources and environmental conditions in cities in the Jiangsu, located along the Beijing–Hangzhou Canal, and obtained comprehensive results by performing calculations based on AHP and the eigenvector solution for weights and consistency. The results reflected the levels of sustainable development in the green cities, in economic, social, and environmental terms. The results revealed that cities in southern Jiangsu had higher levels of development than did those in northern Jiangsu and that the overall increase was affected by economic, social, and environmental factors. Therefore, these factors must be considered in the construction of green cities to enhance the cities' levels of sustainable development. The construction of green cities involved numerous problems. The researchers proposed the following actions to increase development:

A. Supporting governmental policies should be improved.

A mechanism combining elements from the market, industry, research, and development should be created to motivate the government, enterprises, and city inhabitants. This mechanism could be used to continually improve the overall green power of a city. Standardised laws, legislations, and a political support system should be established. Green city carrier construction policies should be drafted. Environmental development should be optimized and construction behaviour should be regulated.

B. An energy-saving and highly efficient green industry should be developed.

This industry should actively promote saving energy, reducingcarbon footprint, and aiding the development of a green economy. Energy-saving practices, high energy efficiency, pollution prevention, and the strengthening of environmental construction should be promoted by starting with key fields. The development of energy-saving and environmental industries should be accelerated, new forms of energy should be promoted, and a circular economy should be developed. Existing industries should be equipped with energy-saving and environmentally friendly technology. The application of innovatative technology, products, and services should promoted.

C. City renewal and restructuring should be promoted.

The reusing of old housing should be facilitated, living conditions should be improved, and employment and entrepreneurship opportunities should be increased. Quality of life in cities and the utilisation of city land should be improved. Sustainable development and centralised resettlement should be implemented. Sponge cities should be constructed in new areas, and sponge city infrastructure in old areas of cities should be restructured. The control of rain runoff should be strengthened, and cities' water environments should be restored. Flood prevention, water drainage, and comprehensive disaster control systems should be strengthened. Green areas should be standardised and popularised.

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Appendix A

Table A1. Quantitative data on evaluation indicators for 2019.

Indicator		Suzhou	Wuxi	Changzhou	Zhenjiang	Yangzhou	Huai'an	Suqian	Xuzhou
C_1 Resource utilisation	C_{11}	96.3	95.9	100	97	99.5	99.7	81	100
C_2 Pollution control	C_{21}	5.04	2.59	0.47	0.61	1.61	0.61	0.35	2
	C_{22}	3.51	3.62	0.31	0.44	1.02	0.44	0.46	3.39
	C_{23}	3.66	1.99	0.41	0.51	2.55	0.5	0.67	0.29
C_3 Green municipal administration	C_{31}	96	97	97.4	94.1	93.8	95	95.14	100
C_4 Green transportation	C_{41}	1111	306	36	0	0	0	0	43
	C_{42}	36,644	10,966	2222	0	0	0	0	531.1
	C_{43}	26.7	17.5	14.7	23.5	25.9	17.2	16.2	17
C_5 Green consumption	C_{51}	1,366,896	738,348	508,231	313,429	410,540	280,476	346,837	488,600
	C_{52}	276.37	195	239.43	195.72	199.4	143.1	157.35	168
C_6 Ecological environment	C_{61}	42,105	19,538	13,176	6231	15,351	8399	10,675	12,328
	C_{62}	13.25	14.93	13.28	18.08	19.6	14.5	14.15	15.4
	C_{63}	42.7	43.24	43.1	43.08	43.7	42.4	43.39	43.7
C_7 Atmospheric environment	C_{71}	78.8	72.1	69.9	69.6	69.6	72.6	63	74
	C_{72}	62	69	69	72	71	72	78	96
C_8 Water environment	C_{81}	100	100	100	100	90	87.5	100	100
	C_{82}	87.5	81.4	74.4	87.5	71.9	73.6	85.7	63.8

Note: for details on the code of the subindicators, refer to Table 3.

Table A2. Quantitative data on evaluation indicators for 2014.

Indicator		Suzhou	Wuxi	Changzhou	Zhenjiang	Yangzhou	Huai'an	Suqian	Xuzhou
C_1 Resource utilisation	C_{11}	96.7	91.1	98.2	98.6	92.3	99.5	94	98.74
C_2 Pollution control	C_{21}	16.84	7.88	3.53	5.46	4.75	4.31	2.14	9.85
	C_{22}	8.1	10	11.67	2.96	1.88	3.13	4.23	7.48
	C_{23}	6.14	2.16	1.19	0.91	0.88	0.8	0.49	1.08
C_3 Green municipal administration	C_{31}	95.03	95.97	95	77.9	84.4	91	82.97	97
C_4 Green transportation	C_{41}	226	106	0	0	0	0	0	0
	C_{42}	11,559	1770.25	0	0	0	0	0	0
	C_{43}	17	17.9	22.7	16.6	14.5	9.1	14.4	16.2
C_5 Green consumption	C_{51}	873,279	489,448	324,278	201,462	280,296	236,802	217,345	266,087
	C_{52}	272.62	205.1	217.2	189.38	230.8	146.1	131.6	130
C_6 Ecological environment	C_{61}	42,193	18,543	11,101	5692	9905	10,466	8801	11,039
	C_{62}	17.32	14.81	12.8	18.69	18	13.8	11.88	16.2
	C_{63}	42.93	42.88	42.3	42.28	43.6	40.9	41.47	43.3
C_7 Atmospheric environment	C_{71}	71.8	60.9	63.8	65.9	65.5	60.8	63.8	65.6
	C_{72}	86	93.4	104	90	106	105	97	119
C_8 Water environment	C_{81}	100	100	100	100	100	100	100	100
	C_{82}	67.1	73	81.9	85	70.4	94.7	87.5	87.98

Note: for details on the code of the subindicators, refer to Table 3.

Table A3. Quantitative data on evaluation indicators for 2009.

Indicator		Suzhou	Wuxi	Changzhou	Zhenjiang	Yangzhou	Huai'an	Suqian	Xuzhou
C_1 Resource utilisation	C_{11}	98.74	98.6	95.5	93.52	97.5	99.7	99.8	99.3
C_2 Pollution control	C_{21}	14.73	9.37	6.23	5.9	8.3	3.96	1.83	8.78
	C_{22}	6.86	4.19	2.5	1.23	1.06	1.68	0.98	5.57
	C_{23}	5.74	4.17	3.6	8.78	0.9	1.05	0.5	2.14
C_3 Green municipal administration	C_{31}	94.46	95.51	89.2	82.8	74.4	76.9	64.19	81.5
C_4 Green transportation	C_{41}	0	0	0	0	0	0	0	0
	C_{42}	0	0	0	0	0	0	0	0
	C_{43}	17.7	15.2	17.6	13.2	15.4	8.4	8.8	17.9
C_5 Green consumption	C_{51}	601,400	363,767	229,934	116,147	154,367	170,703	106,952	171,657
	C_{52}	279.32	208	233.4	212	53.1	143.4	98.28	155.8
C_6 Ecological environment	C_{61}	36,651	16,557	6773	4386	8133	7717	6471	9409
	C_{62}	18.58	13.56	12.2	15.6	18.7	10.6	8.43	13.9
	C_{63}	43.01	43.18	41.5	42.1	41.8	34.5	40.4	40.5
C_7 Atmospheric environment	C_{71}	90.14	93.4	89.7	90	92.9	91.2	89.6	63.4
	C_{72}	69	70	73	81	85	94	68	124
C_8 Water environment	C_{81}	100	100	100	100	100	99.7	100	100
	C_{82}	83.5	74.6	81.9	79.4	77.2	81.6	87.5	67.3

Note: for details on the code of the subindicators, refer to Table 3.

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