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Study on Spatial–Temporal Patterns and Factors Influencing Human Settlement Quality in Beijing

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Abstract: Human settlements lay the basis for urban sustainable development and embody comprehensive urban competitiveness. Based on data from the period 2010–2019, the entropy value method, global spatial correlation, and local spatial correlation are adopted to systematically analyze the overall level and spatial–temporal pattern of human settlement quality in Beijing. In particular, this study sought to uncover the factors that influence human settlement quality in Beijing by using the panel data model. The results show that the quality of human settlements in Beijing has generally followed an upward trend, with slow growth and a slight decline since 2017. Despite significant spatial positive correlations and stable local spatial self-correlation, the spatial difference is still evident, and regional correlation needs further improvement. Medical resources, economic development, public services, governance investment, and infrastructure are significantly and positively correlated with human settlement quality, while population growth is significantly and negatively correlated with it. Based on this study, specific recommendations are proposed which can be used as a reference for Beijing and other cities' human settlement construction and its improvement.

Keywords: human settlement quality; spatial–temporal pattern; influencing factors; Beijing

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1. Introduction

Human settlements are not only surface spaces closely related to human survival activities but also important manifestations of economic and social development and residents' living standards [1]. With the development of China's economy and the rapid advancement of urbanization, "urban diseases" such as environmental pollution and traffic congestion have become prominent [2], posing severe challenges to ecological safety and environmental quality [3]. With a large economic aggregate and population, China plays an important role in the development of the world. The drastic changes in human settlements within China are bound to have an impact on the sustainable development of the world. With residents' growing pursuit of a higher quality of life, sustainable development has become the aspiration of all mankind [4], and the sustainable development of human settlements has increasingly become a common concern of governments and society [5]. The policy document adopted by world leaders at the UN Habitat III Conference, the New Urban Agenda, proposed a direction and goals for the development of world cities in the next 20 years. The Chinese government proposes that three elements are required to improve the living environment. One is to follow the path of sustainable development. The second is to take the road of new urbanization and promote the integrated development of urban and rural areas. The third is to strengthen international cooperation. Moreover, the improvement of human settlements is an important goal of China's urban development. In 2015, China's Central City Work Conference proposed that the creation of a good human settlement environment should be the central goal of urban work. The Chinese government regards the obvious improvement of the human settlement environment as an important development task during the "14th Five-Year Plan" period (2021–2025).

As the capital of China and an international metropolis, Beijing fulfills many political, economic, social, and most basic life functions. Its functional positioning and development play an exemplary role. The rapid economic development of Beijing, the rapid increase in the diversity of life and the rapid development of vitality, have also caused serious "urban disease." For example, frequent hazy weather [6], the relative lack of jobs and public service facilities in urban fringe areas [7], traffic congestion in built-up areas [8], and the lack of historical and cultural protection [9], have hindered the construction of human settlements. Beijing' s development plays an important guiding role in China's urban construction, the quality of its human settlements is the foundation of sustainable urban development [10]. The improvement of human settlements is an important goal of China's urban development. The 2015 China Urban Work Conference held in Beijing proposed that the creation of excellent human settlements should be the primary goal of urban work. China's 14th Five-Year Plan regards the significant improvement of human settlements as an important task for development in the next five years.

Research on human settlements usually uses the theories of geography, ecology, and economics [11] indexed to established systems and evaluation models to evaluate human settlements [12–16]. Although existing studies provide rich insights, there is a paucity of research focusing on the factors influencing and mechanisms affecting the evolution of human settlements. Analyzing the spatial–temporal patterns in the quality of urban human settlements and the factors that influence them and discussing the law of urban human settlement development will play a guiding role in accelerating the high-quality development of the city and comprehensively enhancing its competitiveness. Here we take Beijing as a research case and systematically analyze the overall level and spatial–temporal pattern of human settlement quality. In particular, this paper attempts to uncover the factors influencing human settlement quality in Beijing using the panel data model.

The remainder of this paper is organized as follows. The next section provides a review of the literature on human settlement. Section 3 sets out the study area and data resources. Section 4 describes the methods to be used in this research, including the construction of the index system, the calculation of the index weight, the comprehensive evaluation of human settlement quality, and the panel data model for influencing factors. Section 5 contains the results of the analysis. Section 6 presents the discussion and concludes the paper.

2. Literature Review

2.1. The Connotation and Research Perspective of Human Settlements

The study of human settlements originated from urban planning. In the 1950s, the urban planner Doxiadis put forward the theory of "human settlement," which applied the research results of geography, architecture, ecology, sociology, and other disciplines. In the study of human settlements, Doxiadis explored the law of the historical evolution of human settlements and laid a foundation for the theoretical study of human settlements [17]. The human settlement environment is an overall concept [18,19], which is a synthesis of the quality of life [20,21] and social welfare [22]. Human settlements are not only related to residential and ecological sustainability, but also the economic and social sustainability of a city [23]. The connotations of human settlements can be analyzed as follows: First, the core of human settlements is human [24], which means they must first meet the living needs of human beings. Second, human settlements are based on nature with regard to life and productive activities [25]. The suitability of the natural environment affects the health of human beings [26]. Thirdly, human beings interact and connect with nature. Although human beings have created human settlements, human behavior is also affected by human settlements [24]. The core goal of the construction of human settlements is to create a sustainable interactive relationship between people and the external environment [27] and to realize the suitability and sustainability of human settlements [28]. Human settlement quality is a qualitative or quantitative description of the suitability and sustainability of human settlements [29]. A high-quality human settlement can meet the needs of human production and life, and realize the coordinated development of humanity and nature.

Studies of human settlements mainly adopt such perspectives as livable cities [30–32], landscape cities [33], garden cities [34,35], and ecological cities [36,37], among which a large number of studies focus on the livability of human settlements. Livability is not an inherent environmental assessment [38], but an urban concept of the interaction between the environment and people [39]. Livability is the goal of the construction of human settlements [40]. A livable human settlement involves not only a beautiful, clean, and harmonious natural ecological environment but also a safe, convenient, and comfortable social and cultural environment [25]. The economic, natural, social, and cultural environment are not only the comprehensive elements of the livability of human settlements but also the elements to measure the quality of human settlements.

2.2. Factors Influencing Human Settlements

According to relevant research, the factors influencing human settlements can be roughly divided into three dimensions: human activities [41], climate change [42], and social economy [43]. First, large-scale human activity is the most important aspect. Urban population agglomeration leads to changes in land use and pollution problems caused by industrialization have a significant impact on human settlements [44]. Human activities can also alter regional climates, such as reduced precipitation due to urban sprawl and urban pollution [45]. In addition, land-use methods, such as deforestation and agricultural development, also lead to the acceleration of soil erosion, resulting in potential environmental risks to the human settlements in the surrounding area [44].

The impact of global climate change on human settlements is also the focus of current research, and includes severe weather and climate events such as rising temperatures [46], rising sea levels [47], urban flooding [48], and energy shortages [49]. Extreme weather events may also reduce water and air quality [50], threaten health conditions and public health, and enhance urban heat island effects [42].

The level of social and economic development is an important condition affecting human settlements. Financial support has improved human settlements [51], but the improvement of the economic level will also cause problems such as resource consumption and environmental pollution [43], which will cause damage to human settlements. In addition to the challenges of population urbanization [52], human settlements are also challenged by socio-spatial inequality. For example, social factors such as spatial isolation [53] and class differentiation [54] in cities have a significant impact on the demand for human settlements.

2.3. Research Methods of Human Settlements

The evaluation of human settlements is mainly a qualitative description or quantitative analysis of the development trend and characteristics of human settlements, which elevates the study of human settlements from theoretical analysis to practical application and operation. The existing human settlement evaluation systems can be mainly divided into two types. One is to evaluate residents' satisfaction based on the micro-scale [55]. This is mainly based on residents' needs and evaluated by residents' scores through questionnaires. The evaluation results focus on the actual feelings of residents. The other is to establish an index system to quantitatively evaluate the social, economic, and other urban entity elements [56]. The latter is currently the most used evaluation method. The construction of the evaluation index system is mainly based on the framework of the social-economic-natural system, taking ecological environment superiority, economic development vitality, and public service convenience as system layers [41]. With the continuous development of the economy and society, human settlements are constantly changing, and new indexes are constantly appearing [57], which means the evaluation index system of human settlements is in dynamic development.

The selection of evaluation methods is an important manifestation of the evaluation process. The development of evaluation methods and research data has promoted the diversification of themes and perspectives of human settlements research. According to the existing literature, the research methods of human settlements evaluation mainly include entropy method [58], analytic hierarchy process [59], cluster analysis [60], fuzzy comprehensive evaluation [61], and so on. In addition, more and more studies apply GIS [62] to the evaluation of human settlements. Combined with GIS, the spatial information is visualized, and the natural pattern and regional characteristics of the human settlements are revealed [63], so as to expand human settlement research to the spatial level. With the rapid development of technologies such as the internet and big data, research data tend to be diversified [64]. For example, POI data are widely used in the field of human settlement research [65], realizing the transformation to multivariate big data.

3. Study Area and Data Source

3.1. Study Area

Beijing is located in the north of China, with a total area of 1640 square kilometers. There are 16 administrative districts of Beijing (Figure 1). The 16 districts in Beijing can be divided into three types: central urban areas, plain areas, and ecological conservation areas. The central urban areas, located in the center of Beijing, consist of six districts: Dongcheng, Xicheng, Chaoyang, Haidian, Fengtai, and Shijingshan. The central urban area is a political, cultural, and business center, with a high level of economic activity. The plain areas are composed of five areas: Daxing, Fangshan, Tongzhou, Changping, and Shunyi. It is an important area for the evacuation of the population and industry in the center area. Ecological conservation areas, located in mountainous areas, comprise Miyun, Yanqing, Mentougou, Pinggu, and Huairou with good ecological environments.

Figure 1. Location of the study area.

At the end of 2018, the total population of Beijing was 21,536,000. As the capital of China, Beijing is the political and cultural center of the country, as well as a world-famous ancient capital and a modern international city. In recent years, aiming to relieve non-capital functions, Beijing has implemented in-depth special actions for remediation and improvement, which has resulted in a significant improvement in the urban human settlement environment. According to the 2020 ranking of the American economic magazine *Global Finance*, Beijing ranks 22nd among the world's livable cities. The *Beijing City Master Plan (2016–2035)* currently being implemented proposes to transform the urban development mode, effectively control the diseases of the big city, continuously improve the quality of the living environment, and build a world-class harmonious and livable city. As a large city, the contradiction between its population, resources, and environment is still prominent, and there is still a gap between citizens' yearning for a better life and the existing living environment. A systematic analysis of the spatial and temporal differences and influencing factors of the quality of Beijing's human settlements and exploration of the characteristics of the temporal and spatial evolution of Beijing's human settlements have important reference values for accelerating the creation of human settlements, and also provide a typical reference for the governance of other cities' human settlements.

3.2. Data Source

The data used in this study come from the Beijing Statistical Yearbook 2011–2020, Beijing Regional Statistical Yearbook 2011–2020, Beijing Government website, and related yearly statistical bulletins or government work reports. A small amount of missing data is measured by linear interpolation.

4. Methods

4.1. Establishment of Index SYSTEM

In this paper, an index system is established based on two related efforts: the Beijing city's overall planning index system for the top-class livable and harmonious capital proposed by the Beijing Municipal Government, and criteria used by the China Human Settlements Award [66]. Besides this, we also refer to relevant research [55–57] and combine the characteristics of Beijing. Based on the connotations and characteristics of human settlements, we divide human settlements into four aspects: the economic environment, residential environment, ecological environment, and infrastructure and public service environment (Table 1).

Table 1. Comprehensive Evaluation Index System and Weights.

System Layer	System Weigh	Index	Significance of Index	Index Weigh
Economic environment	0.3632	X_1: Per capita GDP (yuan/person)	Characterizing the level of economic development	0.0901
		X_2: Disposable income per capita (yuan/person)	Characterizing the income level of residents	0.0915
		X_3: Engel coefficient (%)	Characterizing the consumption structure of residents	0.0141
		X_4: Per capita investment in fixed assets (yuan/person)	Characterizing the level of construction investment	0.0220
		X_5: Total retail sales of consumer goods per capita (yuan/person)	Characterizing the level of social consumption	0.0537
		X_6: Public budget revenue per capita (yuan/person)	Characterizing the financial level of the region	0.0869
		X_7: Registered unemployment rate (%)	Characterizing the level of employment	0.0038
		X_8: The proportion of tertiary industry (%)	Characterizing the level of industrial structure	0.0012

Table 1. *Cont.*

System Layer	System Weigh	Index	Significance of Index	Index Weigh
Residential environment	0.1801	X_9: Living area per capita (m^2)	Characterizing the residential living environment	0.0030
		X_{10}: Urban population density (person/km^2)	Characterizing the pressure of the population on the environment	0.0020
		X_{11}: Natural population growth rate (‰)	Characterizing the level of population growth	0.0654
		X_{12}: Per capita electricity consumption (kW·h)	Indicating the level of electricity consumption in residents' lives	0.0504
		X_{13}: Number of criminal cases filed per 10,000 people	Representing the social security environment	0.0148
		X_{14}: Number of traffic accidents per 10,000 people	Characterizing the traffic safety environment	0.0290
		X_{15}: Harmless treatment rate of domestic garbage (%)	Characterizing domestic waste treatment capacity	0.0001
		X_{16}: Domestic sewage treatment rate (%)	Characterizing domestic sewage treatment capacity	0.0040
		X_{17}: Per capita real estate investment (yuan/person)	Characterizing the level of real estate investment	0.0115
Ecological environment	0.2746	X_{18}: Green coverage rate in the built-up area (%)	Characterizing the level of greening in the built-up area	0.0010
		X_{19}: Park green area per capita (m^2)	Characterizing the park green space environment	0.0011
		X_{20}: Forest greening rate (%)	Characterizing the level of forest greening	0.0036
		X_{21}: Energy consumption per 10,000-yuan GDP (tce)	Characterizing energy consumption efficiency	0.0633
		X_{22}: Annual daily average value of PM2.5 (ug /m^3)	Characterizing the degree of air pollution	0.0497
		X_{23}: Per capita sewage discharge (t/person)	Characterizing sewage discharge pressure	0.0153
		X_{24}: Proportion of energy-saving and environmental protection expenditure (%)	Characterizing the level of energy conservation and environmental protection investment	0.1406
Infrastructure and public service environment	0.1821	X_{25}: Number of beds per thousand medical and health institutions	Characterizing the medical service environment	0.0316
		X_{26}: Number of practicing physicians per thousand	Characterizing medical service capabilities	0.0337
		X_{27}: Number of kindergartens per 10,000 people	Representing the educational environment	0.0059
		X_{28}: Number of primary schools per 10,000 people	Representing the educational environment	0.0422
		X_{29}: Community health service station per 10,000 people	Characterizing the level of community health services	0.0034
		X_{30}: Public library collections per thousand people	Representing the public cultural environment	0.0146
		X_{31}: Proportion of public service expenditure (%)	Characterizing the level of public service investment	0.0315
		X_{32}: Road network density (km/km^2)	Characterizing the level of road construction	0.0005
		X_{33}: Infrastructure investment accounted for the proportion of fixed asset investment (%)	Characterizing the level of infrastructure investment	0.0188

The economic environment is the driving force for the development of human settlements and provides financial support. The index to measure the economic environment includes two aspects: regional economic level and residents' consumption capacity [11]. Therefore, we chose indexes such as per capita GDP, per capita investment in fixed assets, per capita disposable income, and Engel's coefficient to reflect the economic environment.

The living environment is the core content of the construction of human settlements [67]. In the selection of indexes, we considered that the quality of the living environment can be reflected by living area, residential living facilities, social security environment, and so on. Therefore, we chose indexes such as the per capita living area, the harmless disposal rate of domestic waste, and the number of criminal cases filed per 10,000 people to evaluate the living environment. There are many factors affecting the ecological environment, but the most fundamental factors include terrain, climate, hydrology, and land coverage [68]. Therefore, we used the green coverage rate in the built-up area, the annual daily average value of PM2.5, and so on, to express the ecological environment. Infrastructure and public service environment are the material guarantees of human settlements [69], and the most basic orientation for the construction of the living environment is to improve the convenience and quality of life of residents. Therefore, we comprehensively considered the level of public services such as medical care, culture, and education, and the convenience of infrastructure.

In the index layer, the Engel coefficient, registered unemployment rate, urban population density, number of criminal cases filed per 10,000 people, number of traffic accidents per 10,000 people, energy consumption per 10,000-yuan GDP, annual average PM2.5, and per capita sewage discharge are all negative.

4.2. Entropy Value Method

As an objective weighting method, the entropy method can overcome the subjectivity and arbitrariness brought about by the subjective weighting method in the comprehensive evaluation of multiple indicators [58], to reflect the effective information value of the indicators objectively and systematically. In this paper, the entropy method was used to calculate the index weight and quantitatively evaluate the environmental quality of Beijing's human settlements. The equations are as follows:

Assuming that the number of evaluation objects is m and the number of evaluation indicators is n, the original index data matrix is $X = \{x_{ij}\}_{mn}$, where x_{ij} is the original data value of the jth index of the ith evaluation object.

The linear scale transformation method is used to standardize the original data, to eliminate the influence dimension and number size on results. If the index value is larger, it is more beneficial to the development of the system; if it is a positive index, Formula (1) is used to standardize it. If a smaller value is more conducive to the development of the system, then the indicator is a negative index, and Formula (2) will be used to standardize it.

For a positive index:

$$x'_{ij} = \frac{x_{ij}}{M_j} \tag{1}$$

For a negative index

$$x'_{ij} = \frac{x_{ij}}{M_j} \tag{2}$$

In this formula, x_{ij} is the original data, M_j is the maximum value of the jth index, and m_j is the minimum value of the jth index.

Entropy calculation. The formula for calculating the entropy value of the index is as follows:

$$e_j = -\frac{1}{lnm} \times \sum_{i=1}^{n} P_{ij} \ln(P_{ij}) \tag{3}$$

In this formula, P_{ij} is the characteristic proportion of the jth index in the ith evaluation object. P_{ij} is calculated as follows:

$$P_{ij} = x'_{ij} / \sum_{i=1}^{n} x'_{ij} \tag{4}$$

Calculate the weight of the index:

$$w_j = \frac{1 - e_j}{\sum_{j=1}^{m}(1 - e_j)} \tag{5}$$

Establishment of comprehensive evaluation model for the quality of human settlements. Calculate the evaluation value of each indicator based on the weight of each indicator: $f_{ij} = w_j \times x'_{ij}$. The comprehensive evaluation index model of Beijing's human settlement quality is as follows:

$$u = \sum f_{ij} \tag{6}$$

4.3. Spatial Correlation Analysis

4.3.1. Global Spatial Autocorrelation

The global spatial autocorrelation analysis can reflect the spatial distribution characteristics of the attribute value of the research object in the entire area, to measure the correlation degree of the attribute in the overall space. In this paper, the spatial correlation of Beijing's human settlement quality in the overall area is described in the global Moran's *I* index. The Moran's *I* index is calculated as follows:

$$I = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}|x_i - \overline{x}|\;|\;x_i - \overline{x}\;|}{\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}\sum_{i=1}^{n}(x_i - \overline{x})^2} u = \sum f_{ij} \tag{7}$$

where n represents the total number of research samples, x_i and x_j are the comprehensive evaluation value of the human settlement environment quality in the ith and jth research sample, $\overline{x}$ is the average of the comprehensive evaluation value of the human settlement environment quality in each research sample. W_{ij} represents the binary-adjacent space weight matrix. In this paper, mutual adjacency between spatial objects is defined by Queen adjacency.

The value of the global Moran's *I* index varies from −1 to 1. When $I > 0$, it means that there is a positive correlation between the quality of human settlements in each area and the surrounding area. When $I < 0$, it means there is a negative correlation between the quality of the human settlement environment and the surrounding area; when $I = 0$, it means that the quality of the human settlements in each area has no spatial autocorrelation with the surrounding area. Moreover, when the spatial correlation exists, the larger the absolute value of Moran's *I*, the more obvious the characteristics of the spatial correlation. At the same time, the standardized statistic *Z*-score is used to test whether Moran's *I* index passes the significance test. The *Z*-score calculation formula is:

$$Z = \frac{I - E(I)}{\sqrt{VAR(I)}} \tag{8}$$

4.3.2. Local Spatial Autocorrelation

The local spatial correlation index is a local form of Moran's *I* index, which is used to describe the correlation between each regional unit and its adjacent regions. In this study, the local Moran's *I* index is used to reflect the local spatial agglomeration characteristics of the quality of Beijing's human settlement environment. The local Moran's *I* index is calculated as:

$$I_i = \frac{n(x_i - \overline{x})\sum_j W_{ij}(x_i - \overline{x})}{\sum_i (x_i - \overline{x})^2} \tag{9}$$

The meaning of each parameter in this formula is the same as Formula (7). The significance test of I_i uses the Z test, and the calculation is the same as Formula (8). When $I_i > 0$, it means that the area around the area exhibits similar spatial agglomeration (high-high or low-low). When $I_i < 0$, it indicates that there is dissimilar spatial agglomeration (high-low or low-high) around the area.

The Moran scatter diagram is used to represent the local Moran's I index. The abscissa of the Moran scatter diagram represents the attribute value after normalization, and the ordinate is the average value of the attribute values of adjacent units determined by the spatial adjacency matrix [63]. The four quadrants of the Moran scatter chart represent the four types of spatial relationships: the first quadrant is of the high-high type, which means that the quality of human settlements in a certain area and surrounding areas is high; the second quadrant is of the low-high type, which means that the quality of human settlement in a certain area is low and the level of its adjacent areas is high; the third quadrant is of the low-low type, which means that the quality of human settlement in a certain area and surrounding areas is low; the fourth quadrant is of the high-low type, which means that the quality of human settlements in a certain area is high while the level of its adjacent areas is low.

4.4. Panel Data Model

The panel data model was used to analyze the factors influencing Beijing's human settlements, and the degree of influence of each factor has been quantitatively analyzed. Panel data models fall into three types: mixed models, variable intercept models, and variable coefficient models. The general form of the model is as follows:

$$y_{it} = \alpha + \sum_j x_{j,it}\beta_{j,it} + \delta_i + \gamma_t + \varepsilon_{it},\ i = 1, 2, \ldots, N,\ t = 1, 2, \ldots, T, \tag{10}$$

In this formula, y_{it} is the observed value of sample i in period t, α is the constant term of the model, δ_i represents the fixed or random cross-sectional effect, γ_t represents the fixed or random time effect, x_{it} is the observed value of the explanatory variable, β_j represents the coefficient of the explanatory variable. According to conditions, β falls into three forms: one is the same for all sections and periods, the other is different for different sections, and the third is different in different periods.

5. Results

5.1. The Spatial–Temporal Pattern of Human Settlement Quality in Beijing

5.1.1. Analysis of the Temporal Pattern of Human Settlement Quality in Beijing

During the period 2010–2019, the comprehensive evaluation index of human settlement quality in Beijing showed an overall upward trend (see Figure 2), rising from 0.593 in 2010 to 0.862 in 2019, with an average annual growth rate of 5.04%, reaching its peak in 2017. From 2017 to 2019, there was a slight decrease in growth. The comprehensive evaluation index dropped from 0.866 to 0.862, which was mainly related to the decline in the ecological environment and residential environment. In the field of the ecological environment, the proportion of energy conservation and environmental protection expenditure in public budget expenditure has been on a downward trend since 2017. In the field of residential environment, the per capita living area has declined. In addition, since 2017, the annual per capita investment in fixed assets and the proportion of public service expenditures in public budget expenditures have also shown a downward trend, which has led to an overall decline in the comprehensive evaluation index for the quality of human settlements.

Figure 3 shows the results of the development trends of the four areas of Beijing's human settlements. The fastest growth rate is that of the economic environment, followed by the ecological environment; the living environment, ecological environment, infrastructure, and public service environment all show a fluctuating development trend, in contrast to the steady growth of the economic environment.

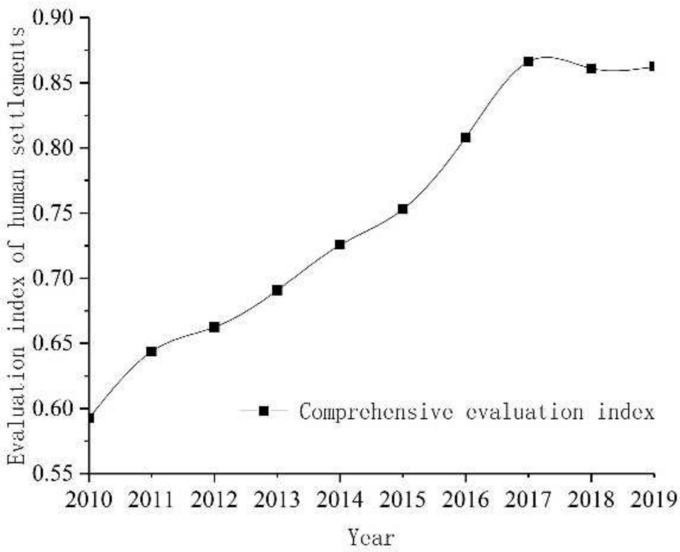

Figure 2. 2010–2019 Comprehensive Evaluation Index of Human Settlement Quality in Beijing.

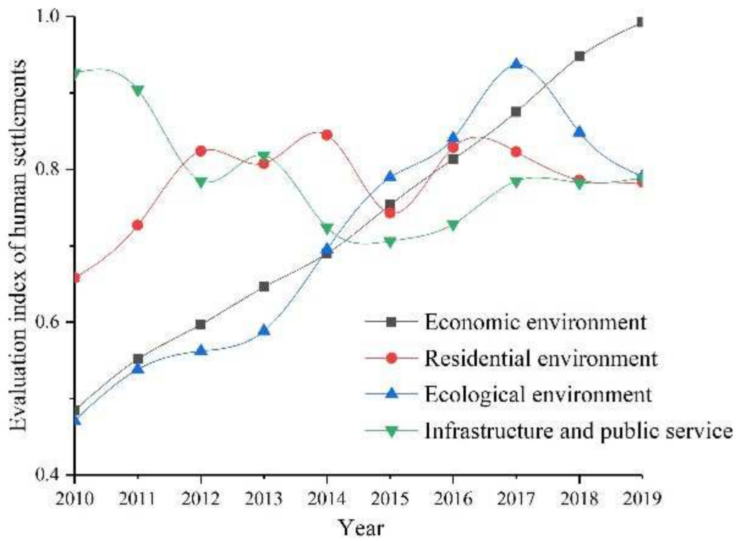

Figure 3. 2010–2019 Beijing Municipal Human Settlement Quality Evaluation Index.

Specifically, from 2010 to 2019, the comprehensive evaluation value of the economic environment has risen steadily from 0.485 to 0.992, with an average annual growth rate of 10.45%, becoming the primary factor in the significant improvement of the quality of the human settlements. In terms of specific indicators, from 2010 to 2019, per capita GDP and capita disposable income have increased by 1.22 and 1.32 times, respectively. At the same time, with the implementation of the policy to relieve non-capital functions, the industrial structure continues to be optimized, and the proportion of the tertiary industry rose from 75.70% to 83.50% during the period 2010–2019. The living environment has shown a significant fluctuating upward trend from 2010 to 2019, and its development process can be roughly divided into three stages. Among them, 2016–2019 is the decline stage, the evaluation index fell from 0.829 to 0.783, which was mainly affected by real estate control policies, and the per capita real estate investment continued to fall. The ecological environment evaluation index rose first and then declined. During 2017–2019, the evaluation index fell from 0.937 to 0.791, mainly due to the decrease in subsidies for new energy vehicles and the decline in the proportion of energy conservation and environmental protection expenditures in public budget expenditures. The evaluation index of infrastructure and public service environment dropped from 0.926 in 2010 to 0.706

in 2015, and then rose back to 0.789 in 2019, showing a "U"-shaped trend. The decline of the evaluation index was mainly due to the rapid growth of the permanent population and the relative lagging in the construction of roads, medical care, education, and other facilities; the later rebound was mainly due to the decommissioning of non-capital functions and population control, the decline in the growth of the permanent population, and the negative growth.

5.1.2. Analysis of the Spatial Pattern of Human Settlement Quality in Beijing

In this study, we calculated the comprehensive evaluation index of human settlement quality in 16 districts of Beijing from 2010 to 2019 and selected 2010, 2013, 2016, and 2019 for analysis. The calculation results are shown in Table 2.

Table 2. Comprehensive evaluation index and ranking of human settlement quality in districts of Beijing.

District	2010		2013		2016		2019	
	Evaluation Index	Rank	Evaluation Index	Rank	Evaluation Index	Rank	Evaluation Index	Rank
Dongcheng	0.677	1	0.701	1	0.614	2	0.582	2
Xicheng	0.666	2	0.677	2	0.665	1	0.658	1
Chaoyang	0.547	4	0.620	3	0.537	4	0.527	5
Fengtai	0.455	8	0.399	15	0.530	5	0.403	16
Shijingshan	0.412	14	0.434	8	0.467	10	0.480	6
Haidian	0.557	3	0.505	4	0.546	3	0.574	3
Mentougou	0.537	5	0.452	6	0.491	7	0.423	12
Fangshan	0.477	6	0.444	7	0.511	6	0.452	9
Tongzhou	0.400	16	0.400	14	0.437	12	0.429	11
Shunyi	0.475	7	0.482	5	0.479	9	0.441	10
Changping	0.446	11	0.426	9	0.428	13	0.420	14
Daxing	0.411	15	0.410	13	0.415	16	0.417	15
Huairou	0.454	9	0.421	11	0.479	8	0.463	7
Pinggu	0.444	12	0.411	12	0.456	11	0.420	13
Miyun	0.446	10	0.423	10	0.426	14	0.547	4
Yanqing	0.419	13	0.367	16	0.415	15	0.463	8

As can be seen from Table 2, from 2010 to 2019, the gap between the highest value and the lowest value of the comprehensive evaluation index of all districts reduced from 0.277 to 0.253, indicating that the regional balance of the quality of the human settlement environment has increased. From the perspective of ranking changes, the districts at the two ends of the rankings showed little change, while the districts which ranked in the middle changed a lot. The rankings of Dongcheng, Xicheng, Chaoyang, and Haidian have always been in the top five. Among them, Dongcheng and Xicheng have always been in the top two, which have obvious advantages over other districts. As central areas of Beijing, these four districts, despite shortcomings in the ecological environment, are ahead of other districts in economic development, in that in these districts the infrastructure and public service facilities are relatively complete, and the overall level of the human settlements is relatively high. The quality of human settlements in Daxing, Pinggu District, and Tongzhou is relatively low—always in the bottom five. Among these, Daxing lingers in second place, and Tongzhou's ranking is slowly rising due to the construction of the city's sub-center. Among the above three districts, Daxing and Tongzhou have relatively large populations but fall behind relatively in public services and economic development in Pinggu, resulting in a relatively low overall level of human settlement. The ranking of other districts has changed significantly. Affected by the decrease in the proportion of energy conservation and environmental protection expenditures, Mentougou's ranking dropped from no. 5 in 2010 to no. 12 in 2019. Due to significant advantages in the ecological environment and increased investment in infrastructure and public services in recent years, the ranking of the Miyun district jumped from 10th in 2010 to 4th in 2019, and Yanqing district rose from 13th in 2010 to 8th in 2019.

ArcGIS software was used to further analyze the characteristics of the spatial pattern of Beijing's human settlement environment quality. The result is shown in Figure 4. In general, the regional spatial distribution was significantly different, showing a pattern with Xicheng and Dongcheng as the core, decreasing as one moves towards the surroundings. The overall level of the six central districts (Dongcheng, Xicheng, Haidian, Chaoyang, Fengtai, and Mentougou) is relatively high. Among them, Fengtai has a relatively low level due to relatively insufficient infrastructure and public services. The urban fringe areas are quite different, and the overall level of Yanqing and Daxing is relatively weak. The quality of human settlements in Miyun, Huairou, and other districts has increased significantly, mainly due to the significant advantages of the ecological environment and the continuous increase in infrastructure and public service investment in recent years.

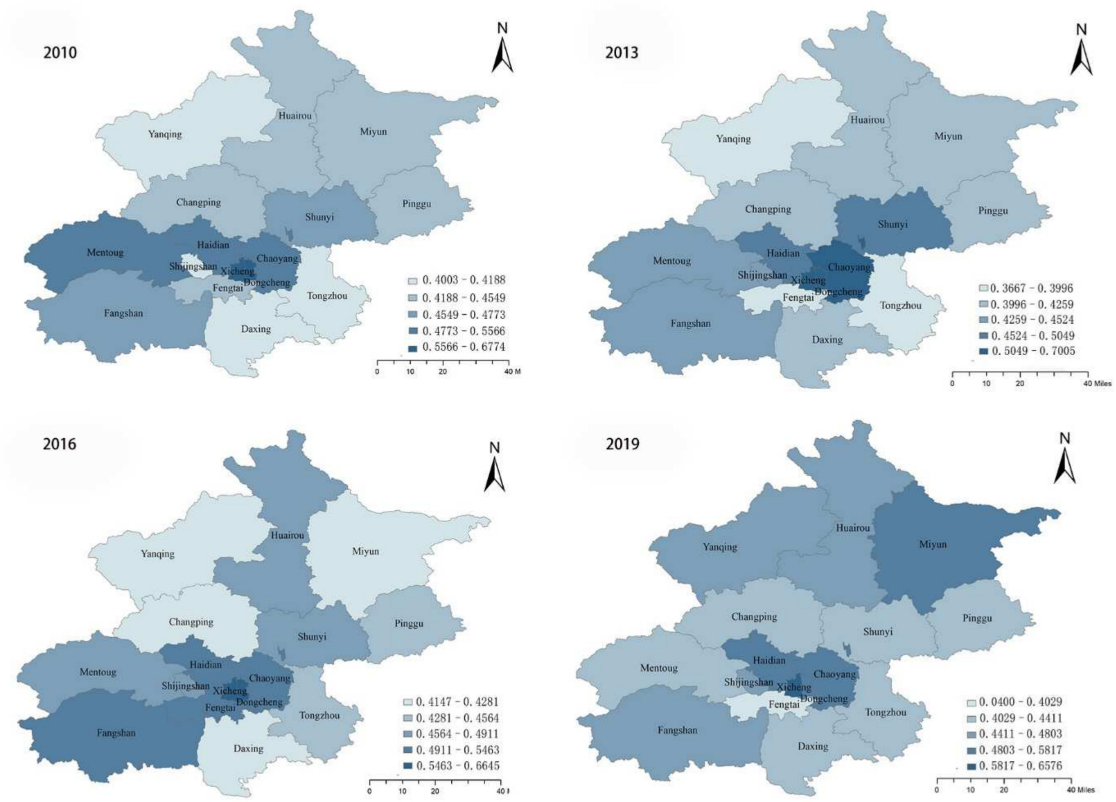

Figure 4. Spatial pattern of Beijing's human settlement quality in 2010, 2013, 2016, and 2019.

In order to more intuitively summarize the spatial pattern characteristics of Beijing's human settlement environment, the "geostatistical analyst" tool of ArcGIS software was used to conduct a spatial trend analysis of the comprehensive evaluation value of Beijing's human settlement environment in 2010, 2013, 2016, and 2019. The results are shown in Figure 5.

As can be seen from Figure 4, the quality of the human settlement environment in Beijing presents an inverted U-shaped distribution characteristic of "high in the middle and low on both sides," and the overall spatial pattern shows a pattern that might be described as "strong in the west and weak in the east" and "high in the south and low in the north." In 2010, the comprehensive evaluation value of the human settlement environment changed in the north–south direction more than that in the east—west direction, and the gap in the range of changes narrowed over time. It shows that the gap in the quality of Beijing's human settlements in all directions is narrowing.

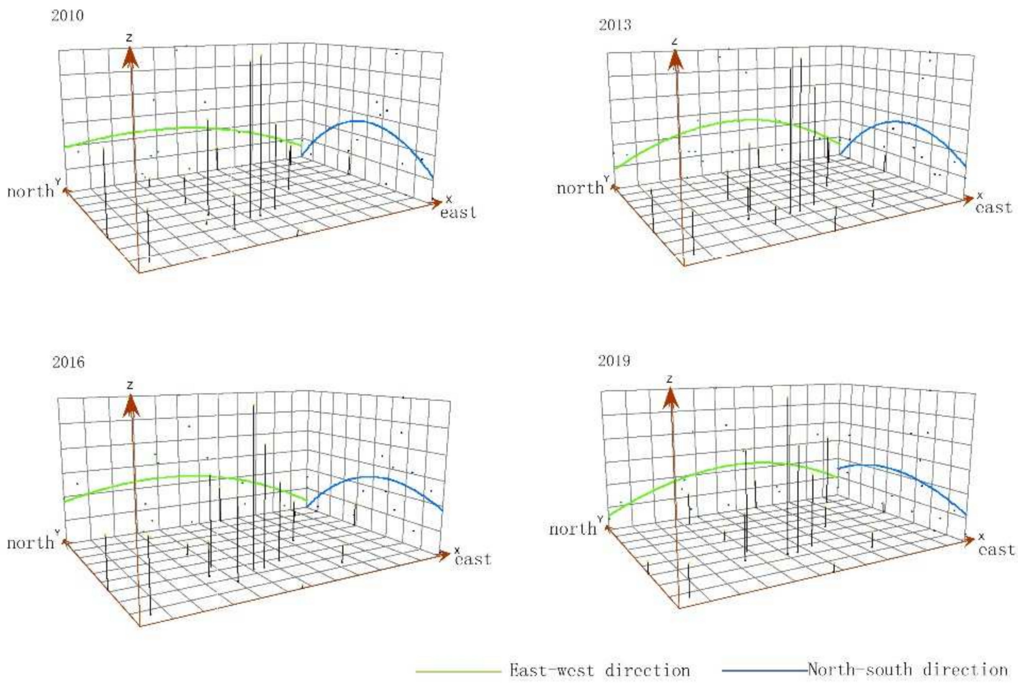

Figure 5. Spatial trend analysis of the comprehensive evaluation value of Beijing's human settlement environment.

To analyze the global spatial correlation of the quality of human settlements, we used GeoDa software to perform global spatial autocorrelation analysis to obtain the global Moran's *I* index and test statistics related to human settlement quality in Beijing. The results are shown in Table 3. As can be seen from Table 3, from 2010 to 2018, the global Moran's *I* index passed the significance test with a *p*-value less than 0.05, and the test statistic *Z*-score was greater than 1.96, indicating that the quality of Beijing's human settlements has a significant positive spatial correlation. Specifically, the overall Moran's *I* index increased from 0.2963 in 2010 to 0.3864 in 2018, indicating that the overall spatial agglomeration is increasing. However, from the perspective of different periods, the global Moran's *I* index has volatility, indicating that spatial correlation is not stable, and the coordinated development of regional human settlements needs to be further strengthened.

Table 3. 2010–2019 The Overall Moran's I index of Human Settlement Quality in Beijing.

Year	Moran's *I*	*Z*-Score	*p*-Value
2010	0.2963	2.4039	0.0170
2011	0.2369	2.1263	0.0320
2012	0.2392	2.2879	0.0230
2013	0.3227	2.6987	0.0110
2014	0.3033	2.6435	0.0100
2015	0.2001	2.0362	0.0340
2016	0.4068	3.1947	0.0010
2017	0.4068	3.3579	0.0020
2018	0.3864	3.1918	0.0040
2019	0.1669	1.7378	0.0510

Using a Moran scatter plot and local Moran's *I* index statistics to analyze the local spatial correlation of Beijing's human settlement quality in 2010, 2013, 2016, and 2019. The Moran scatter plot is shown in Figure 6. It can be seen from Figure 4 that in the four-time sections, there are 12 areas in the first and third quadrants, accounting for 75%. It shows that since 2010, the spatial agglomeration effect of Beijing's human settlement environment has been stable, and the local spatial autocorrelation has changed little, which indicates that most regions have a positive spatial correlation. According to the Moran scatter diagram comparing the changes in the areas in each quadrant, it can be seen that:

1. Located in the first quadrant, Dongcheng, Xicheng, Haidian, Chaoyang, and other areas have a high quality of human settlements, as well as its surrounding areas;
2. The areas located in the second quadrant are mainly Fengtai and Shijingshan. Although these districts belong to the center areas of Beijing, the quality of their human settlements is low, while the surrounding areas are relatively high;
3. Huairou, Yanqing, Pinggu, and other suburban areas are located in the third quadrant, and the quality of human settlements in themselves and surrounding areas are both relatively low;
4. The number of regions in the fourth quadrant is only one per year, but the specific regions change greatly. In 2010, 2013, 2016, and 2019, they were Mentougou, Shunyi, Fangshan, and Miyun. These areas are located in ecological conservation areas, whose natural ecological environment provides an obvious advantage, but the quality of human settlements in their surrounding areas is low.

Generally speaking, the number of areas belonging to the "low-low" type is greater than that of the "high-high" type, and the "high-high" types are mainly central urban areas such as Dongcheng, Xicheng, Haidian, and Chaoyang, while the "low-low" type areas are mainly Yanqing, Huairou, Shunyi, Fangshan, Daxing, and other outer suburban areas.

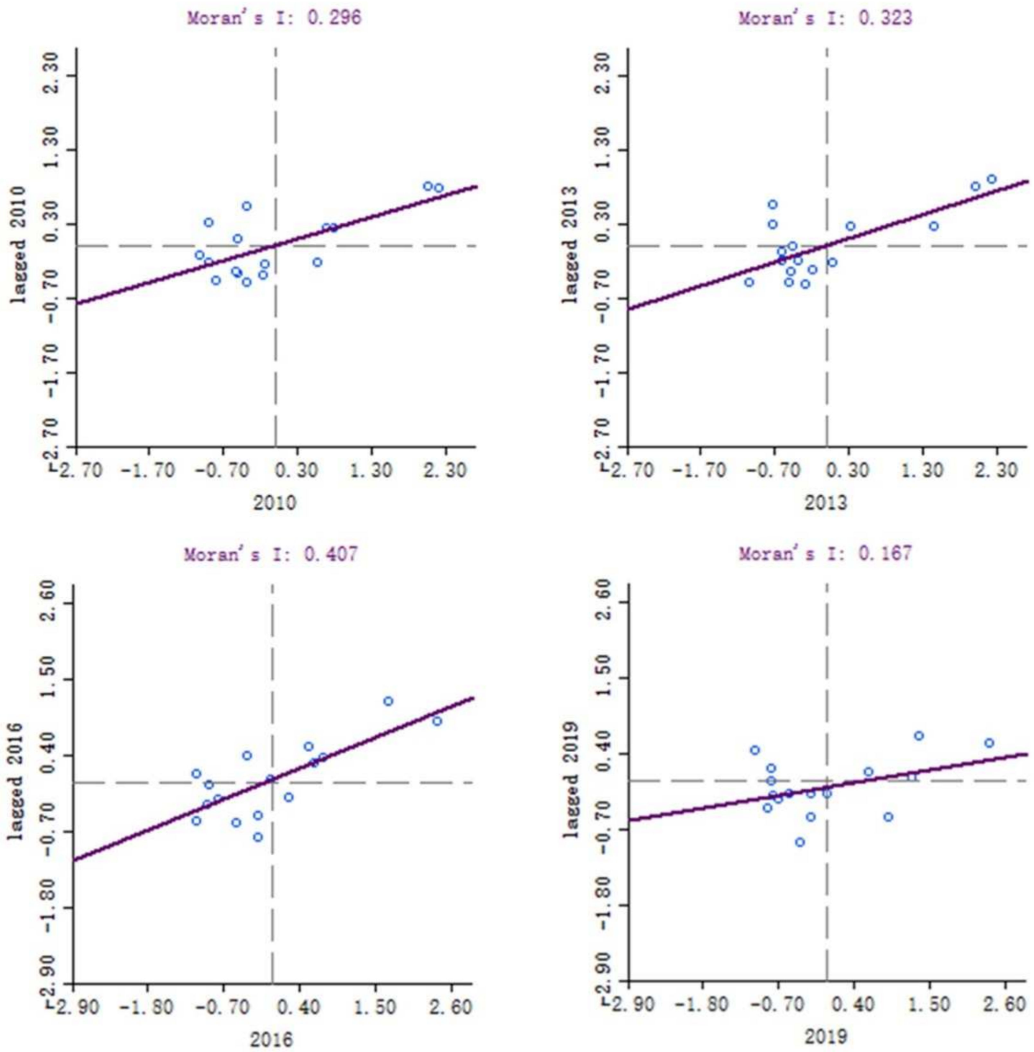

Figure 6. Moran scatter plot of Beijing's human settlement quality in 2010, 2013, 2016 and 2019.

Furthermore, using Formula (8), we perform a significance test on the local Moran's *I* index of Beijing's human settlements from 2010 to 2019 at the level of p-value < 0.05, to analyze the degree of local spatial autocorrelation of human settlement quality in Beijing. The results show:

1. From 2010 to 2019, Xicheng was always located in the "high and high" type area, with strong spatial autocorrelation. Dongcheng has been in the "high and high" type area for 6 years; Chaoyang only showed a significant spatial correlation in 2018;
2. Fengtai has fallen into the "low-high" type area for 6 years, and fell into the "high-high" type area in 2016 and 2017, indicating that the surrounding high-level areas have a positive effect on the quality of the human settlements in Fengtai, but the effect is relatively unstable;
3. Huairou fell into the "low-low" area for three consecutive years from 2016 to 2018, while Daxing and Fangshan fell into the "low-low" area in 2012 and 2014, and 2019, respectively. Except for the above areas, there is no significant spatial correlation in other areas. It can be seen that the relevance of Beijing's various regions needs to be further improved, and the high-level areas have little effect on the surrounding areas.

5.2. Analysis of Factors Influencing the Human Settlement Quality in Beijing

5.2.1. Impact Factor Extraction

We used SPSS software to perform principal component analysis on the data. From the results of the KMO test and Bartlett sphere test, it can be seen that the KMO value is 0.833, and the p-value < 0.001, indicating that the principal component analysis results have a high level of significance. Based on the feature "value greater than 1," the principal components were extracted from 33 indicators, and nine principal components were obtained. The cumulative contribution rate of these nine principal components is 76.52%, which can reflect most of the information of the original data, so these nine principal components were selected instead of the original 33 indicators. The results are shown in Table 4.

According to the results in Table 4, factor 1 has a higher load on the number of beds in medical and health institutions with 1000 people and the number of practicing doctors per 1000 people. Therefore, factor 1 is named as a medical condition. Factor 2 has a higher load on the Engel coefficient and per capita disposable income, so factor 2 is named the standard of living. Factor 3 has a larger load on the natural growth rate of the permanent population and the number of kindergartens per 10,000 people, so factor 3 is named population growth. Factor 4 has a relatively large load on per capita investment in fixed assets and per capita real estate investment, so factor 4 is named economic development. Factor 5 has a relatively large load on the proportion of public service expenditures and per capita public budget revenue, so factor 5 is named public service. Factor 6 has a large load on the proportion of energy conservation and environmental protection expenditures and per capita sewage discharge, so factor 6 is named governance investment. Factor 7 has a large load on the proportion of infrastructure investment in fixed-asset investment, so factor 7 is named infrastructure. Factor 8 has a large load for the proportion of community health service stations and the tertiary industry per 10,000 people, so factor 8 is named community service. Factor 9 is for the number of traffic accidents per 100,000 people. The electricity consumption per capita has a relatively large load, and factor 9 is named public safety.

Medical conditions (MC), standard of living (LS), population growth (PG), economic development level (EDL), public services (PS), environmental governance input (EGI), infrastructure construction level (ICL), community services (CS), and public safety (PSI) were integrated and used as the independent variable, and the Human Settlement Environmental Quality Evaluation Index (HEI) was used as the dependent variable. Based on the panel data of 16 regions in Beijing from 2010 to 2019, panel model were established to quantitatively analyze the positive and negative effects of the extracted main factors, the human settlement environment, and their degree of correlation. Further, the mechanism and factors influencing Beijing's human settlement environment were analyzed.

Table 4. Rotated factor loading matrix.

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9
X_1	0.646	0.466	−0.019	−0.133	0.344	−0.104	0.054	0.082	0.197
X_2	0.391	0.772	−0.090	0.035	0.167	−0.207	0.094	−0.049	−0.019
X_3	−0.006	−0.848	−0.028	−0.092	−0.032	−0.049	−0.029	−0.034	0.135
X_4	−0.176	0.045	0.079	0.910	0.095	0.032	−0.090	0.010	0.076
X_5	0.355	0.248	0.011	0.028	−0.044	−0.292	0.120	0.019	0.351
X_6	0.631	0.231	0.189	−0.051	0.504	−0.057	−0.045	0.159	0.019
X_7	−0.139	−0.092	0.341	0.551	−0.198	0.336	0.115	−0.055	−0.249
X_8	0.256	0.224	−0.145	−0.183	0.204	−0.271	0.121	0.409	−0.085
X_9	−0.728	0.106	0.127	0.426	0.009	0.309	−0.042	0.133	0.036
X_{10}	0.873	0.180	−0.163	−0.236	0.193	−0.147	0.063	−0.082	−0.005
X_{11}	−0.261	−0.131	−0.753	−0.088	−0.073	−0.017	−0.019	0.021	−0.185
X_{12}	0.258	0.683	−0.051	0.120	0.018	0.331	−0.068	0.040	0.423
X_{13}	0.281	0.119	−0.655	0.048	0.344	0.149	0.134	0.098	0.195
X_{14}	−0.369	−0.308	0.161	0.079	−0.233	0.168	−0.106	−0.019	0.652
X_{15}	0.175	0.610	−0.242	0.092	0.090	0.157	0.071	0.142	−0.203
X_{16}	0.431	0.628	−0.151	−0.117	0.065	−0.105	0.242	0.036	0.047
X_{17}	−0.130	0.070	−0.179	0.885	−0.051	−0.056	−0.199	0.018	0.051
X_{18}	−0.856	0.073	0.172	−0.036	0.092	−0.057	−0.020	0.078	0.136
X_{19}	−0.647	−0.019	0.371	0.170	0.243	−0.206	−0.138	0.022	−0.002
X_{20}	−0.484	0.080	0.374	0.031	−0.279	0.098	0.026	0.084	−0.325
X_{21}	−0.202	−0.569	0.046	0.127	−0.435	0.067	−0.078	0.296	0.057
X_{22}	0.183	−0.769	−0.431	0.045	0.024	−0.108	0.017	0.025	−0.126
X_{23}	0.580	0.306	0.114	−0.050	−0.190	−0.345	−0.199	−0.083	−0.046
X_{24}	−0.234	0.179	0.067	0.049	0.060	0.797	−0.090	0.055	0.053
X_{25}	0.901	0.181	0.148	0.104	0.086	−0.073	−0.075	0.001	−0.159
X_{26}	0.888	0.278	0.183	−0.124	0.155	−0.102	−0.006	0.027	0.068
X_{27}	−0.366	0.002	0.714	−0.088	−0.105	0.101	−0.068	0.335	0.070
X_{28}	0.021	−0.447	0.684	0.050	−0.216	0.212	−0.017	0.287	−0.059
X_{29}	−0.216	−0.044	0.274	0.080	−0.170	0.120	−0.113	0.813	0.017
X_{30}	−0.091	0.281	−0.122	−0.080	0.298	−0.181	0.693	0.100	−0.149
X_{31}	−0.052	−0.148	0.285	−0.032	−0.790	−0.112	−0.089	0.132	0.126
X_{32}	0.862	0.146	−0.217	−0.210	0.132	−0.107	0.026	−0.063	0.139
X_{33}	0.041	0.015	0.002	−0.155	−0.070	0.018	0.856	−0.119	0.049

Rotation method: Caesar normalization maximum variance method; the rotation converged after nine iterations.

5.2.2. Construction of Panel Data Model

In order to prevent the pseudo-regression phenomenon caused by non-stationary data, before the panel model regression, the data need to be tested for unit root first to ensure the stability of the data and the validity of the regression estimation. Commonly used methods for unit root inspection of panel data include LLC, HT, IPS, Breitung, ADF-Fisher, PP-Fisher, and Hadri methods. Among them, the LLC and Breitung methods are tested for smooth panel data and are based on the same root assumption, while the ADF, PP, and IPS methods are for unbalanced panels and are based on the assumption that they contain different unit roots. LLC and ADF-Fisher tests, which represent the same root and different root conditions, were selected to perform a unit root test on the data. If in both cases, the test statistics rejected the null hypothesis that the variables have unit roots, then the panel data series was considered to be stationary. The two methods cannot reject the null hypothesis, indicating that the unit root exists and the data are not stable. The first-order difference of the data with the horizontal series was not stable enough to continue to test stationarity after the difference.

It can be seen from Table 5 that according to the LLC test results, all variables rejected the null hypothesis at the 1% level, and the variable sequence was stable. The ADF-Fisher test results showed that the variables HEI, MC, LS, PS, EGI, CS, PSI were in at least 5% of the significance level, rejecting the null hypothesis that the variable sequence was stationary.

The variables PG, EDL, and ICL did not reject the null hypothesis, and the variable sequence was not stable.

Table 5. Results of Panel data unit root.

Variable	LLC	Results	ADF−Fisher	Results
HEI	−9.6056 *** (0.0000)	stable	71.5375 *** (0.0001)	stable
MC	−9.6716 *** (0.0000)	stable	59.3417 ** (0.0023)	stable
LS	−5.8069 *** (0.0000)	stable	54.6701 * (0.0075)	stable
PG	−3.1605 *** (0.0008)	stable	36.4943 (0.2676)	not stable
EDL	−5.2864 *** (0.0000)	stable	41.5416 (0.1204)	not stable
PS	−7.7638 *** (0.0000)	stable	44.6805 * (0.0475)	stable
EGI	−13.6784 *** (0.0000)	stable	66.2708 *** (0.0003)	stable
ICL	−5.0915 *** (0.0000)	stable	27.6765 (0.0853)	not stable
CS	−8.3467 *** (0.0000)	stable	63.555 *** (0.0007)	stable
PSI	−8.3844 *** (0.0000)	stable	63.7379 *** (0.0007)	stable
D(PG)	−9.8479 (0.0000)	stable	88.9441 (0.0000)	stable
D(EDL)	−9.13916 (0.0000)	stable	62.3166 (0.0010)	stable
D(ICL)	−16.7525 (0.0000)	stable	84.166 (0.0000)	stable

*** indicates that the variable is significant at the 0.1% significance level, ** indicates that the variable is significant at the 0.1% significance level, * indicates that the variable is significant at the 0.1% significance level.

Based on non-stationary variables in the above unit root test, a co-integration test of panel data was carried out to determine whether there was a long-term equilibrium relationship between the variables, and then to determine whether the selected variables could be used to construct a panel measurement model. To enhance the reliability of the empirical results, two methods, the Kao cointegration test and the Pedoni cointegration test based on the Engle–Granger two-step method, were used for testing.

It can be seen from Table 6 that the three statistics of the two tests passed the significance test at the 1% confidence level, indicating that there is a significant co-integration relationship between the quality of Beijing's human settlements and the factors that influence them, which is suitable for constructing a panel model for quantitative analysis.

Table 6. Cointegration test result.

	Statistics Name	Statistics	*p*-Value
Kao cointegration test	ADF	−2.2347	0.000
Pedoni cointegration test	Panel—ADF	−7.6544	0.000
	Group—PP	−4.8192	0.000

To determine a suitable estimation model, a null hypothesis was established for Formula (10): H_0: $\alpha_i = \alpha_j$, $\beta_i = \beta_j$, which means that explanatory variable coefficients and intercept terms in the model are the same for all cross-section individual members. Further, we used Eviews software to perform the F test on the model and obtain the residual sum of squares under the mixed model, variable intercept model, and variable coefficient model.

The value of the F test was 0.1021, which is less than the critical value under the 0.05 confidence level, so the null hypothesis was accepted, and the mixed regression model was used in this study. The formula of the mixed regression model is as follows:

$$y_{it} = \alpha + \sum_{j} \beta_j x_{j,it} + \mu_i \tag{11}$$

where i is the 16 districts of Beijing, t is the study year, y is the comprehensive index of the human settlements, α is the intercepted item common to the study individuals, x_j is the jth explanatory variable, β_j is the regression coefficient of each variable, and μ_i represents the unobservable regional effect.

5.2.3. Panel Model Fitting Estimation and Result Analysis

We use Eviews software to estimate the data of 16 districts in Beijing in a mixed regression model, and the results are shown in Table 7. According to the significant result of the model estimation, the F value is 60.2345, and the corresponding p-value is 0.0000, indicating that the overall fitting of the model is better. From the goodness of fit of the model, the value of R^2 is 0.7833, and the value of R^2 after adjustment is 0.7703, indicating that the goodness of fit is better. In addition, the *D-W* value is 1.8776, which can indicate that there is no serial autocorrelation in the regression residuals. Based on the above results, it can be considered that the selected explanatory variables have strong explanatory power. It can be seen from Table 5 that the variables that failed the 5% significance test include living standards, community services, and public safety. Except for the above three variables, all other variables passed the 5% significance test.

Table 7. Results of model estimation.

Variable	Coefficient	Standard Deviation	$T-$Statistics	$p-$Value
constant	0.2835	0.0323	8.7654	0.0000
medical condition	0.0509 ***	0.0055	9.2238	0.0000
standard of living	−0.0018	0.0173	−0.1013	0.9194
population growth	−0.0280 **	0.0095	−2.9616	0.0036
economic development	0.0370 ***	0.0114	3.2481	0.0014
public service	0.0310 *	0.0159	1.9510	0.0429
governance investment	0.1135 ***	0.0144	7.8828	0.0000
infrastructure	0.0518 ***	0.0135	3.8325	0.0002
community service	−0.0687	0.4285	−0.1604	0.8728
public safety	0.1256	0.4273	0.2940	0.7692

*** indicates that the variable is significant at the 0.1% significance level, ** indicates that the variable is significant at the 0.1% significance level, * indicates that the variable is significant at the 0.1% significance level.

Analyzing the numerical value of the regression coefficient, it can be seen that the degree of impact of different indicators on the quality of human settlements varies greatly. Among all the variables, the medical level, economic development, public services, governance investment, and infrastructure showed a significant positive correlation at the 5% level; for every increase of 1 unit, the comprehensive evaluation index of human settlement environment quality increased by 0.0509, 0.0370, 0.0310, 0.1135, 0.0518, and 0.0370, respectively. Population growth shows a significant negative correlation at the level of 5%; for every increase of 1 unit, the comprehensive evaluation index of the quality of the human settlements decreased by 0.0280. From the perspective of the degree of impact, governance investment has the greatest impact on the quality of human settlements, and it plays an important role in environmental pollution prevention and control, energy conservation and emission reduction, and natural ecological protection. The second is infrastructure. As the material support of the human settlement environment, infrastructure is of great significance in improving the convenience and satisfaction of residents' lives. Population growth has a negative effect on human settlements, which is mainly due to problems such as the shortage of public resources and traffic congestion due to excessive population growth. In addition, rapid population growth will also cause increased pressure on resources and the environment. The regression results of variables such as living standards, community services, and public safety are not significant, and these variables have little effect on the quality of Beijing's human settlements. There is a certain negative correlation between the living standard and the quality of Beijing's human settlements; perhaps due to the increase in residents' living standards, the demand for the human settlements also increased, resulting in a widening gap between the current human settlement environment and the needs of residents. Community services are negatively correlated with the quality of Beijing's human settlements, indicating that more facilities such as community service stations will provide residents with convenient services and may also cause new problems such as environmental pollution and community traffic congestion.

6. Discussion and Conclusions

6.1. Discussion

Taking Beijing as the research area, this paper comprehensively evaluates the quality of human settlements from the aspects of the economic environment, ecological environment, living environment, and social environment, and then discusses the spatial–temporal pattern and factors influencing the quality of Beijing's human settlements. It enriches the evaluation index system of human settlements and provides new ideas for the governance of Beijing's human settlements.

Based on the comprehensive evaluation results of human settlements, this study explored the factors that influence the quality of human settlements, which include the economic level, population growth, and social public services. We found that the quality of human settlements in Beijing has significant spatial differences and regional imbalances. In addition, the resource and environmental pressure brought about by population growth have a significant restrictive effect on human settlements. The research results prove that factors such as economic differences and social conditions have increasingly become the key factors restricting human settlements [43]. In addition, the change in land-use patterns caused by urbanization and the pollution caused by industrialization has brought severe challenges to human settlements [44]. Compared with the previous literature, research on the factors influencing human settlements in this paper is based on the evaluation of the temporal and spatial characteristics of human settlements, so it pays more attention to the internal relationship between the influencing factors and the actual evolution.

This paper makes two empirical contributions. On one hand, the coordinated development of various regions is an important condition for realizing the human settlement environment and sustainable development. It is necessary to establish an overall concept; increase cooperation and governance in the ecological environment, economic development, infrastructure, and public services; and build a shared win-win situation. The governance of the human settlement environment in the central urban area should play a demonstrative role, accelerate the transformation of old communities, improve the level of refined management, and create a first-class residential environment demonstration zone, to lead the high-quality development of the city's human settlements. On the other hand, governance investment is a key factor that affects the quality of human settlements. It is necessary to increase governance investment to ensure that public financial investment continues to increase. In addition, innovating financial products and services, encouraging the implementation of market-oriented key infrastructure projects to carry out equity and debt financing, and attracting social capital to participate in the governance of human settlements are important measures to increase governance investment.

This study also has some shortcomings. Firstly, due to the availability of data, this article does not consider physical geographical factors. The evaluation indicators for the quality of human settlements should be further improved. Secondly, research data mainly come from statistical data, and research data sources need to be further enriched. Finally, because the statistical data are based on the administrative area, the spatial autocorrelation analysis of human settlements cannot be carried out from a more microscopic scale. Therefore, applying modern big data methods to the study of human settlements, making full use of multi-source data, such as POI, comprehensively studying physical geography, spatial factors, and social attributes, and enriching the connotations of human settlement research is the direction in which improvements need to be made in the future.

6.2. Conclusions

This study comprehensively evaluates the quality of Beijing's human settlement environment by establishing an index system including the economic environment, living environment, ecological environment, infrastructure, and public service environment. More specifically, the entropy method and spatial correlation analysis are used to analyze the overall level and spatial–temporal pattern of the quality of human settlements in Beijing. Moreover, we analyzed the factors influencing human settlement quality in Beijing using the panel data model. The conclusions are as follows:

1. The quality of Beijing's human settlements has generally shown an upward trend. Since 2017, the growth rate of the evaluation index has slowed down and declined slightly. The economic environment is showing a steady improvement, and the living environment, ecological environment, infrastructure, and public service environment all show a fluctuating development trend;
2. The regional balance of the human settlements in Beijing has been enhanced, but the spatial differences are still obvious, forming a pattern of gradually decreasing towards the surrounding areas with Xicheng and Dongcheng as the core;
3. There is a significant positive spatial correlation in the human settlements in Beijing, and the overall agglomeration is tending to increase. The local spatial autocorrelation is relatively stable, but the regional relevance needs to be further improved;
4. Medical conditions, living standards, population growth, economic development, public services, governance investment, infrastructure, community services, and public safety are the main factors affecting the quality of Beijing's human settlements. Among them, medical standards, economic development, public services, governance investment, infrastructure, and the quality of human settlements are significantly positively correlated, while population growth is significantly negatively correlated. Governance investment has the most significant impact on the quality of human settlements.

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