Evaluation of Urban Spatial Resilience and Its Influencing Factors: Case Study of the Harbin–Changchun Urban Agglomeration in China

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Abstract: This study constructs a framework for evaluating urban spatial resilience based on five dimensions: scale, intensity, morphology, function, and benefit. Likewise, it empirically analyzes the spatial differences and influencing factors of urban spatial resilience in the Harbin–Changchun urban agglomeration from 2000 to 2019. Overall, the spatial resilience of the Harbin–Changchun urban agglomeration declined from 2000 to 2019. In addition, its ability to resist external disturbances weakened. The five dimensions of spatial resilience declined. However, urban spatial morphological resilience slightly increased. The spatial diversity of the Harbin–Changchun urban agglomeration is obvious, implying that the spatial resilience of cities in the central region, mainly in Suihua and Songyuan, is higher than in peripheral areas of the urban agglomeration, mostly in the Yanbian Korean Autonomous Prefecture, Siping, and Qiqihar. The period between 2000 and 2019 was dominated by cities with fluctuating spatial resilience. Furthermore, urban spatial resilience is influenced by a combination of factors, with economic support being the primary one. The selection of the urban spatial resilience research index system in this study is more spatially oriented and more accurately reflects the urban spatial resilience situation, which, in turn, provides a new planning perspective for urban planning in China.

Keywords: scale–intensity–morphology–function–benefit; urban spatial resilience; spatio-temporal differentiation; influence factor; Harbin–Changchun urban agglomeration

1. Introduction

Resilience research was first applied to the fields of engineering, physics, and ecology, but in 2002, the International Council for Advocating Regional Sustainable Development (ICLEI) first proposed the concept of urban resilience in relation to urban disaster prevention and mitigation, extending resilience research to the urban domain [1]. In the late 1990s, resilience theory was introduced in planning so as to provide a fresh perspective on planning theory by coordinating the allocation of spatial resources to cope with external uncertainties. Spatial resilience goes hand in hand with not only resilience theory, but also cities. As complex giant systems that can regulate social order, economic development, and ecological construction, cities are excellent targets for the study of spatial resilience [2]. Along with the development of cities, inter-regional exchange and collaboration gradually increased and urban agglomerations slowly became basic units of regional economic competition. The National Urbanization Plan of the People's Republic of China (2014–2020) states that urban agglomerations should be improved in order to become the cores that drive regional common development and promote regional economic growth [3]. Therefore, research on urban spatial resilience of urban agglomerations gradually became a popular topic among researchers, geographers, and scholars of urban planning and other fields in...
order to enhance the coordination and interaction between regions and improve sustainable urban development.

Domestic and international scholars mostly base the definition of urban spatial resilience on the fact that urban systems absorb shocks and mitigate disturbances, focusing on spatial properties as a material form possessed by cities. This basis provides a new perspective for understanding urban space in complex social–ecological systems [4]. Allen proposed that spatial resilience is based on the asymmetry, connectivity, and information exchange of complex systems and the ability of the system’s spatial properties to generate resilient feedback when faced with external shocks [5]. Regarding research content, urban spatial resilience attempts to construct an indicator system with specific entry points, including urban road traffic [6], urban local space [7], multiscale urban resilience construction [8–11], etc. Evaluation indicators can be categorized into four types: urban social, economic, environmental, and institutional resilience. They reflect the diversity of urban spatial structure and function and the sustainability of urban spaces. In terms of research methodology, urban spatial resilience is a key component in the urban context because it is closely linked to landscape ecology [12–15] research, which represents resilience as the location of landscape elements and the ecological services provided by the landscape as a whole. Spatial syntax is often used as an analytical tool for urban configurations and [16,17] combines syntactic indicators with urban morphology to provide feasibility for quantifying urban spatial resilience.

From the conceptual point of view, most domestic and foreign scholars define the concept of urban spatial resilience in terms of urban systems absorbing shocks and attenuating disturbances. To be more precise, they focus on spatial attributes of urban systems as a material form possessed by cities, broadening the understanding of urban space in complex social–ecological systems [18–23]. In terms of research content, scholars at home and abroad have attempted to construct indicator systems with specific entry points, which include urban road traffic [6], local urban space [24–30], and multiscale urban resilience constructions [31]. Furthermore, evaluation indicators can be grouped into four categories, i.e., urban social resilience, economic resilience, environmental resilience, and institutional resilience, which comprehensively reflect the diversity of urban spatial structure and its functions and the sustainability of urban spaces. Although research on urban spatial resilience in the areas of conceptual definition and quantitative evaluation exists, it is still a complex and interdisciplinary matter requiring more in-depth research. Firstly, the current research perspective is relatively one-sided since it is confined to a city’s landscape ecology and physical space form, while ignoring the spatial connection between cities and the social factors within an urban space. Secondly, there is a tendency to use a large number of indicators to ensure the accuracy of the evaluation results in the process of index evaluation, while ignoring the fact that some indicators do not have spatial attributes. As a consequence, the spatial resilience of cities cannot be shown in its essence. Therefore, this paper summarizes the existing research results. Furthermore, it constructs a conceptual framework of urban spatial resilience and establishes a precise evaluation index system. Next, it conducts a comprehensive measurement of the urban spatial resilience of the Harbin–Changchun urban agglomeration and explores its spatio-temporal differentiation characteristics through five dimensions: scale, intensity, morphology, function, and benefit. Lastly, it recognizes factors that influence urban spatial resilience and proposes coping strategies to improve it, with the aim of providing a basis for the sustainable development of Chinese cities.

2. Theoretical Basis
2.1. The Concept and Connotation of Urban Spatial Resilience

Urban spatial resilience interprets urban resilience through a spatial dimension. It explores the exposure and sensitivity of cities when resisting disturbances caused by natural or human factors, while maintaining the stability of the urban system and adapting it to the changes in time based on morphology, infrastructure, and other functions of the city.
With reference to studies on urban resilience [32,33] and urban spatial resilience [34], the concept of urban spatial resilience was further developed in this study, considering that, at a certain level, urban spatial resilience is jointly impacted by its spatial structure and other spatial interactions, rather than just physical space, which consists of five major factors: urban scale improvement, land use intensity, spatial morphological evolution, rational distribution of functions, and urban spatial effectiveness. Urban spatial resilience may also be impacted by economic support, social coordination, and environmental construction.

The dimensions of spatial resilience, namely scale, intensity, morphology, function, and benefit, are complementary to each other, which improves the spatial resilience of cities [35]. Firstly, urban spatial resilience scale is the key factor in urban development, while urban use intensity drives urban development and influences urban functioning to some extent. Next, urban spatial morphology ensures the quality of life in cities. The higher its spatial resilience value, the more it helps cities resist external disturbances. Furthermore, the function of urban land resilience represents the foundation of the city and has a positive driving effect on urban development. The development of the city is strongly influenced by the interaction between the different urban functions. Finally, the spatial benefit resilience of the city is the ultimate goal of urban development. Similar to urban spatial morphology, it helps to enhance the urban development performance when its spatial resilience value is higher. Combining all these factors may promote the enhancement of urban spatial resilience.

2.2. Overview of the Study Area

The Harbin–Changchun urban agglomeration is an important growth pole for the revitalization of Northeast China and the opening of Northeast Asia to the outside world (Figure 1). The Harbin–Changchun urban agglomeration is in the later stage of its growth, but the urban system still remains underdeveloped [36], as demonstrated in the following points: (1) The absorptive and inclusive capacity of the city is not strong. According to the seventh pillar data, the population loss per unit of land area in the Harbin–Changchun urban agglomeration is about 2905 people/km$^2$; (2) the carrying capacity of economic land resources was proclaimed weak in 2019. The average land gross domestic product (GDP) of the Harbin–Changchun urban agglomeration was 6,403,600 CNY/km$^2$, much lower than that of the Yangtze River Delta, the Pearl River Delta, and other urban agglomerations; (3) the inter-regional links are not strong, and the central cities do not have a strong pull. Since Harbin and Changchun are both central cities, the Harbin–Changchun urban agglomeration is economically directed towards others, but its spatial links mainly exist between neighboring cities with relatively weak connections to the peripheral areas of the urban agglomeration, such as Mudanjiang and the Yanbian Korean Autonomous Prefecture; and (4) the ecological environment of the Harbin–Changchun urban agglomeration is vulnerable and has a poor ecological recovery capacity. Overall, the Harbin–Changchun urban agglomeration suffers from overexploitation of its urban space [37], low-quality urban sprawl, and the overall low carrying efficiency [38]. Moreover, this urban agglomeration is exposed to natural disasters, accidental disasters, public health events, and social security events, making the process of improving the spatial resilience of the city particularly challenging. Therefore, this region is typical and exemplary for the study of spatial resilience of urban agglomerations.
3. Research Data and Methods

3.1. Data Sources

In this study, 11 prefecture-level cities in the Harbin–Changchun urban agglomeration were selected as the study areas. The year of the completion of the Ninth Five-Year Plan (2000) was considered as the starting year for this study. Because of the long timespan, a five-year interval was included in the current study.

The administrative zoning vector data were obtained from the National Basic Geographic Information Center (http://www.resdc.cn accessed on 26 August 2021), while the land use data were taken from the Data Center for Resources and Environmental Science of the Chinese Academy of Sciences (http://www.resdc.cn accessed on 1 September 2021). The administrative division data for 2000, 2005, 2010, and 2015 were geometrically corrected and preprocessed with land use and land cover change data. Afterwards, they were overlaid for analysis to obtain the corresponding land use data. Statistics on the population, economy, and resources of each county-level city were first taken from the China Urban Statistical Yearbook, the Heilongjiang Provincial Statistical Yearbook, the Jilin Provincial Statistical Yearbook, and the social development statistical bulletins, then analyzed for the benefit and intensity tenacity analysis. The area of each urban land type was obtained from the Economy Prediction System (EPS) Data Center (https://www.epsnet.com.cn accessed on 10 December 2021). Due to the limited access to data for the years 2000 and 2005, the study on the functional resilience of urban land for these two years was not carried out. As this paper involves five time points, i.e., 2000, 2005, 2010, 2015, and 2019, that is, a time span of 20 years, some statistical data exist with different statistical calibers and some data are missing. Therefore, data for the adjacent two years were used to substitute missing data depending on whether the difference between them was significant or not. If the change was not significant, we used the data of the adjacent years as substitutes. However, if the data difference was significant, the data were filled in by the interpolation method.

3.2. Research Framework and Methodology

3.2.1. Construction of an Urban Spatial Resilience Indicator System

In geography, population size is often used as an effective measure for the size and development of a city, so this paper uses total population size at the end of a year to characterize the spatial scale of a city. Including the population and economic utilization intensity indices, the utilization intensity index was used to monitor the dynamic change of land use. In this context, the population utilization intensity index involves the population density of urban and rural construction land, while the economic utilization intensity index involves the average fixed-asset investment in construction land and the average regional GDP of
that land. This paper, therefore, selected the population density of urban construction land to represent the population utilization intensity index, while the average land investment in fixed assets represents the economic utilization intensity index. Furthermore, spatial morphology consists of a variety of physical and spatial forms presented through urban entities in the environment and various activities. The diversity of urban landforms is used to support the stable development of cities and their ability to resist external disturbances. Consequently, the external geometry of urban land and the differentiation pattern of each function within the city were selected to comprehensively measure whether the urban spatial morphology was good. Moreover, urban function refers to the ability of a city to support social, political, and cultural activities and economic production in a certain area. The distribution of urban areas serves as a barrier which shields urban agglomerations from risks, so the proportion of functional urban land was used as an indicator to determine the resilience of urban function. Spatial efficiency refers to the value created by human activities or the natural environment in the process of urban development.

Based on the results from previous studies [34,39], the urban spatial resilience indicator system was developed for the Harbin–Changchun urban agglomeration. It was based on five major domains, namely city scale, intensity, morphology, function, and benefit (Table 1). The spatial scale of cities is depicted by the total population at the end of the year. Next, the urban use intensity of cities refers to the economic and demographic use intensity. Urban spatial morphology resilience is connected to the external form and internal diversity. Furthermore, urban spatial function resilience is reflected in the construction of residential, commercial, industrial, public service, green space, logistics, and storage land in the city. Finally, urban spatial benefit resilience is based on the economic, social, and ecological benefits created through urban development. In this study, a total of 5 primary and 11 secondary indicators were selected for the calculation of five major urban spatial resilience values. Then, the multi-indicator comprehensive evaluation method based on the entropy method [40,41] was used to measure the urban spatial resistance index.

**Table 1.** Evaluation system of urban spatial resilience of Harbin–Changchun urban agglomeration.

| Guideline Level | Domain Level | Nature of Indicator | Indicator Meaning |
|-----------------|--------------|---------------------|-------------------|
| Urban spatial scale resilience | Spatial scale of the city (X1) | + | Total population of the city at the end of the year |
| Urban use intensity resilience | Population use intensity index (X2) | + | Population density of urban building sites |
| | Economic use intensity index (X3) | + | Average land value of fixed-asset investment |
| Urban spatial morphological resilience | Compactness of external space (X4) | + | Area/perimeter of the city |
| | Internal morphological diversity (X5) | + | Area of different urban land use types/urban land |
| Functional resilience of urban sites | Urban land use types (X6) | + | Percentage of functional land areas |
| Spatial diversity of industry (X7) | + | Industry output as a proportion of total regional output |
| Specialization in leading regional industries (X8) | + | Entropy in the location of secondary employment |
| Unit area pollution control (X9) | + | Domestic waste removal volume/building site area |
| City beautification per unit area (X10) | - | Urban cleaning and sanitation area/building site area |
| Green space ownership per unit (X11) | + | Green space per capita/built-up land area |

X1, X2, X3, X4, X5, X6, X7, X8, X9, and X11 are positive indicators, indicating positive driving effects on urban spatial resilience, while X10 is a negative indicator, suggesting negative impacts on urban spatial resilience.
3.2.2. Factors Influencing Urban Spatial Resilience

Urban spatial resilience and urban development positively correlate, i.e., the stronger the urban spatial resilience, the better the urban development, and conversely, the better the urban development prospects, the greater the urban spatial resilience. In reference to research methods in the related literature [41,42], urban development requires economic support, intersociety cooperation, and interecological and environmental construction. Therefore, this study chose three main indicators—economic support, environmental construction, and social coordination—to analyze the factors influencing urban spatial resilience. Economic support is the driving force in the operation of the city and to a certain extent determines the development potential of it. Three indicators were selected to reflect the development vitality of the city. They were represented by the level of urban development (Y1), the level of investment in urban economic development (Y2), and the contribution of the primary industry to the economy (Y3). Furthermore, environmental construction power is the cornerstone for coordinating urban construction. The promotion of economic development cannot be sacrificed at the expense of the environment. Hence, environmental construction has a preventive effect on the city’s resistance to disasters to a certain extent. Three indicators were selected to reflect the rationality of urban development, i.e., the overall level of urban environment (Y4), the level of urban construction and greening (Y5), and the level of urban pollutant emissions (Y6). Lastly, social coordination guarantees the development of a city. Having good social coordination can ensure a city’s quick response to shocks and maintenance of its own stable development. Three indicators were chosen to reflect the stability of a city in the process of development: the level of urban employment (Y7), the level of urban livelihood (Y8), and the level of urban medical protection (Y9). Thus, a total of nine indicators related to economic support, environmental construction, and social coordination systems were first selected (Table 2). Afterwards, factor and interaction detections were carried out using geographic probes to identify the most important factor or to classify the factors according to their importance for urban resilience.

Table 2. Index system of factors influencing the urban spatial resilience in Harbin–Changchun urban agglomeration.

| Detection Systems | Indicators                        | Detection Factor | Direction of Action | Indicator Interpretation                        |
|-------------------|----------------------------------|------------------|---------------------|-------------------------------------------------|
| Economic support  | Level of urban development       | Y1               | +                   | GDP per capita                                  |
|                   | Urban economic development input levels | Y2       | +                   | Investment in fixed assets per capita           |
|                   | Contribution of the primary sector to the economy | Y3       | -                   | Primary sector share in GDP                     |
| Environmental construction | Overall level of the urban environment | Y4       | +                   | Green space per capita                          |
|                   | Greening level of urban construction | Y5       | +                   | Area of green space coverage in built-up areas |
|                   | Urban pollutant emission levels   | Y6               | -                   | Industrial wastewater discharge                |
| Social coordination | Urban employment levels          | Y7               | +                   | Share of employees in the secondary sector      |
|                   | City livelihood Levels           | Y8               | -                   | Unemployed persons/the total population         |
|                   | Level of urban medical coverage  | Y9               | +                   | Number of hospital beds                         |

Y1, Y2, Y4, Y5, Y7, and Y9 are positive indicators, indicating positive driving effects on urban spatial resilience, while Y3, Y6, and Y8 are negative indicators, suggesting negative impacts on urban spatial resilience.
3.3. Research Methodology

3.3.1. Methods for Urban Spatial Resilience Measurement

The spatial resilience of each of the five major dimensions of the 11 prefecture-level cities in the Harbin–Changchun urban agglomeration was measured by considering 11 indicators (e.g., the total urban population size at the end of the year, urban compactness, and industrial diversity).

The total population at the end of the year was included in the urban spatial scale resilience in order to characterize the urban spatial scale since the scale of the urban system has self-similarity and is scale-free. According to the fractal theory, empirical research showed a certain relationship between the fractal dimensional value (D) of urban spatial scale distribution and Zipf’s dimension, using the binary order scaling rule [43,44] and fractal theory [45] in determining urban spatial scale resilience. For each prefecture-level city of the Harbin–Changchun urban agglomeration, urban spatial morphological resilience was determined using the peripheral contour morphological compactness index [46] and the diversity index [47] to analyze the external contour changes and to assess the spatial intrinsic morphological evolution process, respectively. Urban spatial benefit resilience was measured by the industrial diversity index [41] and the entropy of secondary employment location so as to measure the economic and social benefits of the city, respectively. Conversely, the entropy method was used to measure the ecological benefit and the final urban benefit resilience. In the dimensionless processing of indicators, the entropy value method was applied to obtain the urban use intensity, urban use function, and the final urban spatial resistance values to analyze the urban spatial resistance across the Harbin–Changchun urban agglomeration. Details of the methods used are reported in Table 3.

3.3.2. Measurement of Impact Factors

In this study, the Geodetector method [47] was used to assess the influence of factors affecting the urban spatial resilience as well as their spatial differentiation in the Harbin–Changchun urban agglomeration, according to the following equation:

\[
q(Y/h) = 1 - \left[ \sum_{h=1}^{L} \frac{(N_h \sigma_h^2)}{N \sigma^2} \right]
\]

where \( q(Y/h) \) is the value of the detection indicator of influencing factors of urban spatial resilience; \( N_h \) is the number of selected indicators; \( N \) is the number of evaluation units; \( \sigma_h^2 \) and \( \sigma^2 \) are the variances of the indicator layer \( h \) and the area-wide \( Y \) value, respectively. The \( q \) values are in the range between 0 and 1. The larger the value of \( q \), the stronger the influence of factors on the spatial and temporal differentiation of urban spatial resilience.

Table 3. Methods of urban spatial resilience used in this study.

| Method                                      | Equations                                      | Significance                                                                                       | Range of Values |
|---------------------------------------------|-----------------------------------------------|---------------------------------------------------------------------------------------------------|-----------------|
| Law of displacement scale and fractal theory | \( P_i = K \times R_i^{-q} \), its corresponding logarithmic expression is \( \ln P_i = \ln K - q \ln R_i \); \( D \times q = R_i^2 \), where \( P_i \) is the size of the city at the size of the city’s population at the end of the year, \( K \) is a constant; \( R_i \) is the rank order of a city at \( i \); \( q \) is the Zipf dimension; \( D \) is the sub-dimensional value; and \( R_i^2 \) is the determination coefficient. | \( q = 1 \) and \( D = 1 \) suggest the most ideal and optimal natural state and resilience of urban spatial scale, respectively; \( q > 1 \) and \( D > 1 \) indicate that the distribution of urban scale is more concentrated, the population distribution is balanced, the differences in town scale levels are small, and the resilience of urban spatial scale is good; \( q < 1 \) and \( D > 1 \) indicate that the scale of cities is more dispersed, the differences in population distribution are large, the urban system is underdeveloped, and the resilience of urban spatial scale is poor. | \( (0, +\infty) \) |
Table 3. Cont.

| Method                     | Equations | Significance                                                                 | Range of Values |
|----------------------------|-----------|-------------------------------------------------------------------------------|-----------------|
| Compactness index          | \( D = 2 \sqrt{\frac{\pi}{QY}} \), \( D \) is the compactness index. Where \( Y \) is the perimeter of the urban periphery profile of the study area; and \( Q \) is the urban area. | The Urban Spatial Compactness Index reflects the degree of the spatial aggregation across patches in the prefecture-level cities of the Harbin–Changchun urban agglomeration. The larger the value, the more aggregated it is. | \((0, +\infty)\) |
| Diversity index            | \( C = -\frac{1}{j} \sum_{i=1}^{j} \log_{2} \frac{P_i}{P} \), \( C \) is the diversity index. Where \( j \) is the number of site types in the study area; \( P_i \) is the area of site type \( i \) as a percentage of the overall urban site. | The greater the value, the greater the spatial integrity of the urban patch and the greater the capacity for stable development. | \((0, +\infty)\) |
| Herfindahl–Hirschman index | \( HHI = \frac{\sum_{i=1}^{N} \left( \frac{X_i}{X} \right)^2}{\sum_{i=1}^{N} \frac{S_i^2}{S}} \), \( HHI \) is the Herfindahl–Hirschman Index. Where \( N = 3; X_i \) is the output value of industry \( i \); \( X \) is the regional GDP; \( S_i \) is the output value of industry \( i \) as a proportion of regional GDP. | This index measures the concentration of the three industrial structures. The higher the concentration of the industrial structure, the lower the industrial diversity. | \((0, +\infty)\) |
| Entropy in the location of secondary employment | \( LE = \frac{G_j}{G_j'}, \( LE \) is the location quotient; \( G_j \) is the number of employees in industry \( j \) in city \( i; G \) is the total number of employees in the city \( i; G_j' \) is the number of employees in industry \( j \) nationwide; \( G \) is the total number of employees nationwide; \( F \) is urban eco-efficiency. | Entropy in the location of secondary employment reflects the spatial distribution of secondary industry workers in each city of the Harbin–Changchun urban agglomeration across the region. | \((0, +\infty)\) |

4. Research Results

4.1. Temporal Evolution of Urban Spatial Resilience in the Harbin–Changchun Urban Agglomeration

4.1.1. Evolution of Spatial Scale Resilience in Cities

Table 4 shows that the determination coefficient of \( R^2 \) values of the rank–size for the Harbin–Changchun urban agglomeration from 2000 to 2019 was close to 1, conforming to the rank–size law. Moreover, the results indicate that \( q \) values were higher than 1, while \( D \) values were less than 1. This suggests that the size distribution of the Harbin–Changchun urban agglomeration is relatively concentrated, with large differences in the distribution of the urban population. In terms of city size, Harbin and Changchun place first and second, respectively. The distribution of resources and elements in the Harbin–Changchun urban agglomeration is too concentrated to play a leading role in the development of the surrounding area.

Table 4. Results of the rank–size measurement for the Harbin–Changchun urban agglomeration (2000–2019).

| Year | \( 1q \) | \( R^2 \) | \( D \) |
|------|--------|--------|------|
| 2000 | 7.40   | 0.872  | 0.1178 |
| 2005 | 7.54   | 0.873  | 0.1158 |
| 2010 | 7.59   | 0.870  | 0.1146 |
| 2015 | 7.60   | 0.872  | 0.1147 |
| 2019 | 7.65   | 0.875  | 0.1143 |
4.1.2. Evolution of Urban Use Intensity Resilience

According to the results reported in Table 5, the urban use intensity resilience index of the Harbin–Changchun urban agglomeration was constant and significantly higher than that of prefecture-level cities for the period between 2000 and 2005. On one hand, the intensity of urban use resistance indices of six cities, mainly Harbin, Qiqihar, and Daqing, showed a decreasing trend from 2000 to 2005 through local analysis, while the rest of the cities showed an increasing trend. The urban use resistance index declined from 2005 to 2015 in five cities, namely Mudanjiang, Daqing, and Harbin, while it increased in the rest of the cities. In addition, an increasing trend was also observed in the urban intensity resilience indices of five cities from 2010 to 2015, more particularly in Liaoyuan, Mudanjiang, and Suihua, while Daqing revealed no significant fluctuations. From 2015 to 2019, the rest of the cities exhibited a decrease in the urban intensity resilience indices of the rest of the cities, notably Jilin, Suihua, and Siping. The urban use intensity resilience of six cities, namely Jilin, Suihua, and Siping, decreased from 2015 to 2019, while in the rest of the cities it increased.

Table 5. Results of the urban use intensity resilience measure for the Harbin–Changchun urban agglomeration (2000–2019).

| City                        | Year | 2000 | 2005 | 2010 | 2015 | 2019 |
|-----------------------------|------|------|------|------|------|------|
| Harbin                      |      | 0.08 | 0.07 | 0.06 | 0.07 | 0.08 |
| Qiqihar                     |      | 0.03 | 0.03 | 0.04 | 0.05 | 0.07 |
| Suihua                      |      | 0.29 | 0.27 | 0.29 | 0.32 | 0.27 |
| Daqing                      |      | 0.09 | 0.06 | 0.02 | 0.02 | 0.00 |
| Mudanjiang                  |      | 0.08 | 0.08 | 0.06 | 0.08 | 0.13 |
| Changchun                   |      | 0.09 | 0.08 | 0.05 | 0.04 | 0.05 |
| Jilin                       |      | 0.07 | 0.09 | 0.07 | 0.07 | 0.01 |
| Siping                      |      | 0.09 | 0.12 | 0.13 | 0.13 | 0.07 |
| Songyuan                    |      | 0.13 | 0.16 | 0.22 | 0.21 | 0.13 |
| Liaoyuan                    |      | 0.05 | 0.03 | 0.07 | 0.08 | 0.08 |
| Yanbian Korean Autonomous Prefecture | | 0.01 | 0.01 | 0.04 | 0.01 | 0.02 |
| Harbin–Changchun urban agglomeration | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

4.1.3. Evolution of Urban Spatial Morphology Resilience

The resistance index of the urban spatial morphology of the Harbin–Changchun urban agglomeration showed an inverted “V” shape influenced by the intricacy diversity index and compactness. Moreover, the compactness index of each prefecture-level city in the Harbin–Changchun urban agglomeration was greater than 0.5, which indicates that the cities are in compact states. From 2000 to 2010, the compactness index of each prefecture-level city in the entire Harbin–Changchun urban agglomeration showed a decreasing trend, with a slight decrease, suggesting that the Harbin–Changchun urban agglomeration experienced a transition from compactness to diffusion. However, various parts of the patches are still closely connected. Apart from some areas, such as Changchun City and Siping City, the compactness of most cities increased from 2010 to 2019. The range of increase lies between 0 and 0.05, indicating that cities are compact and closer to each other, leading to an increase in land use. The diversity index plays a significant role in the spatial morphological resilience of cities. Additionally, the diversity index of the prefecture-level cities in the Harbin–Changchun urban agglomeration clearly decreased, suggesting the low ability of the agglomeration in resisting external disturbances (Table 6).
Table 6. Compactness index and diversity index of Harbin–Changchun urban agglomeration.

| City                        | Compactness Index | Diversity Index |
|-----------------------------|-------------------|-----------------|
|                             | 2000  | 2005  | 2010  | 2015  | 2019  | 2000  | 2005  | 2010  | 2015  | 2019  |
| Harbin                      | 0.80  | 0.70  | 0.66  | 0.70  | 0.70  | 0.55  | 0.45  | 0.55  | 0.54  | 0.51  |
| Qiqihar                     | 0.60  | 0.58  | 0.58  | 0.62  | 0.63  | 0.47  | 0.46  | 0.47  | 0.45  | 0.35  |
| Suihua                      | 0.61  | 0.59  | 0.56  | 0.58  | 0.55  | 0.70  | 0.69  | 0.69  | 0.69  | 0.61  |
| Daqing                      | 0.72  | 0.63  | 0.66  | 0.66  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |
| Mudanjiang                  | 0.78  | 0.72  | 0.75  | 0.74  | 0.77  | 0.23  | 0.23  | 0.23  | 0.22  | 0.28  |
| Changchun                   | 0.75  | 0.70  | 0.68  | 0.53  | 0.55  | 0.17  | 0.17  | 0.18  | 0.49  | 0.13  |
| Jilin                       | 0.92  | 0.85  | 0.86  | 0.79  | 0.83  | 0.35  | 0.37  | 0.37  | 0.37  | 0.38  |
| Siping                      | 0.72  | 0.69  | 0.70  | 0.59  | 0.46  | 0.26  | 0.25  | 0.25  | 0.25  | 0.39  |
| Songyuan                    | 0.77  | 0.78  | 0.80  | 0.75  | 0.80  | 0.67  | 0.66  | 0.66  | 0.65  | 0.64  |
| Liao yuan                   | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 0.50  | 0.50  | 0.53  | 0.52  | 0.44  |
| Yanbian Korean Autonomous Prefecture | 0.60  | 0.57  | 0.59  | 0.53  | 0.64  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  |
| Harbin–Changchun urban agglomeration | 0.00  | 0.73  | 0.00  | 0.00  | 0.00  | 0.73  | 0.72  | 0.73  | 0.72  | 0.71  |

4.1.4. Evolution of Functional Resilience of Urban Sites

Observations of Mudanjiang and Qiqihar from 2010 to 2019 reveal a slight decline in the overall spatial urban functional resilience index of the Harbin–Changchun urban agglomeration and a slight increase in the urban land use functional resilience index (Table 7). Overall, urban land use functional resilience was closely related to the spatial evolution of land use functions in the cities of the Harbin–Changchun urban agglomeration. Likewise, the construction of urban green space systems proved to be an important part of urban ecological construction. Furthermore, the spatial distribution of urban land use functions in the prefecture-level cities of the Harbin–Changchun urban agglomeration was relatively low. However, the distribution of green space was high and improved the functional resilience of urban land use.

Table 7. Results of the functional resilience measure of urban land use in the Harbin–Changchun urban agglomeration (2000–2019).

| City                        | Year | Year |
|-----------------------------|------|------|
|                             | 2010 | 2015 | 2019 | Changchun | 2010 | 2015 | 2019 |
| Harbin                      | 0.45 | 0.38 | 0.36 | Changchun | 0.45 | 0.40 | 0.41 |
| Qiqihar                     | 0.53 | 0.54 | 0.55 | Jilin | 0.55 | 0.44 | 0.28 |
| Suihua                      | 0.69 | 0.58 | 0.35 | Siping | 0.42 | 0.59 | 0.31 |
| Daqing                      | 0.76 | 0.72 | 0.44 | Songyuan | 0.41 | 0.55 | 0.38 |
| Mudanjiang                  | 0.81 | 0.74 | 0.86 | Liao yuan | 0.44 | 0.42 | 0.36 |
| Harbin–Changchun urban agglomeration | 0.54 | 0.49 | 0.49 | Yanbian Korean Autonomous Prefecture | 0.46 | 0.41 | 0.45 |

4.1.5. Evolution of Spatial Benefit Urban Resilience

The results show an overall decline in the spatial benefit resilience index of cities in the Harbin–Changchun urban agglomeration (Table 8), more particularly for the years 2010 through 2015. Daqing, Songyuan, Mudanjiang, and Liao yuan Cities exhibited the highest spatial benefit resilience. However, the spatial benefits in Daqing have decreased since 2010. In particular, the urban spatial benefit resilience has decreased significantly. Ecological benefits are essential for urban spatial benefits. Qiqihar’s ecological benefits significantly weakened from 2000 to 2019. Overall, Qiqihar’s results show a significant decrease in urban benefit resilience, resulting in a less shock-resistant and spatially resilient city.
Table 8. Results of the urban spatial benefit resilience measure for the Harbin—Changchun urban agglomeration (2000–2019).

| City                        | Year | 2000 | 2005 | 2010 | 2015 | 2019 |
|-----------------------------|------|------|------|------|------|------|
| Harbin                      |      | 0.63 | 0.78 | 0.50 | 0.23 | 0.53 |
| Qiqihar                     |      | 0.16 | 0.57 | 1.14 | 0.74 | 0.09 |
| Suihua                      |      | 0.82 | 0.54 | 1.16 | 0.91 | 0.69 |
| Daqing                      |      | 3.35 | 3.14 | 1.29 | 1.40 | 0.60 |
| Mudanjiang                  |      | 1.81 | 2.51 | 1.23 | 1.23 | 0.80 |
| Changchun                   |      | 1.10 | 1.23 | 0.76 | 0.69 | 0.63 |
| Jinlin                      |      | 1.73 | 1.24 | 0.83 | 0.78 | 0.29 |
| Songyuan                    |      | 1.51 | 0.51 | 2.55 | 0.92 | 1.19 |
| Liaooyuan                   |      | 3.11 | 2.87 | 3.66 | 2.51 | 3.98 |
| Yanbian Korean Autonomous Prefecture |      | 3.11 | 2.30 | 3.41 | 10.94 | 6.07 |
| Harbin—Changchun urban agglomeration |      | 0.86 | 2.10 | 1.27 | 0.51 | 1.21 |

4.2. Spatial Differentiation Characteristics of Urban Resilience in the Harbin—Changchun Urban Agglomeration

4.2.1. Characteristics of the Spatial Pattern of Urban Resilience in the Harbin—Changchun Urban Agglomeration

The Jenks natural break classification is used to classify the urban spatial resilience index (R) from 2000 to 2019 into three levels, namely low (R ≤ 0.1), medium (0.1 < R ≤ 0.2), and high resilience (R > 0.2). Additionally, the results were mapped using ArcGIS (Figure 2). The overall urban spatial resilience of the Harbin–Changchun urban agglomeration was strong in 2000. Three cities, Suihua, Daqing, and Songyuan, showed high resilience, while the Yanbian Korean Autonomous Prefecture and Qiqihar exhibited low resilience. On one hand, a change in the urban spatial resilience of the Harbin–Changchun urban agglomeration was observed in 2005. The resilience moved from high to medium in Suihua, from medium to low in Siping, from low to medium in the Yanbian Korean Autonomous Prefecture, and from medium to high in Mudanjiang. Urban spatial resilience in Qiqihar and Siping has increased since 2010, reaching the medium resilience zone, while Liaooyuan and Suihua moved to the high one. Moreover, Changchun and the Yanbian Korean Autonomous Prefecture moved from the medium to the low resilience zone. Furthermore, urban spatial resilience showed a significant decline in 2015, changing from high to medium in Mudanjiang, and from medium to low in Harbin and Jilin. Medium resilience was observed in about 50% of the total surface area of the Harbin–Changchun urban agglomeration in 2019. The results reveal that Mudanjiang City moved from medium to high urban resistance, while Suihua, Daqing, Harbin, and Changchun exhibited medium urban resistance. In addition, low resilience was found in three urban areas, namely Jilin, Siping, and the Yanbian Korean Autonomous Prefecture. Overall, the spatial heterogeneity of urban spatial resistance in the Harbin–Changchun urban agglomeration from 2000 to 2019 is present, showing high resistance values in Songyuan, Daqing, and Suihua. However, Qiqihar, Siping, and the Yanbian Korean Autonomous Prefecture are located in the outskirts of the Harbin–Changchun urban agglomeration; thus, they exhibited low urban spatial resistance values. Moreover, the central cities do not have a significant driving effect on their surroundings. Consequently, the overall spatial resilience showed a decreasing trend.
The level of economic development was high during the period between 2000 and 2005, rising from sixth place in 2000 to fifth place in 2005, and then second place in 2010 and 2019, suggesting that the level of urban spatial resilience in one place during the periods and is greater than the average value of the overall change. On the other hand, the slow-declining class represents a continuous decrease observed after an increase in urban spatial resilience in one place during the periods and is greater than the average value of the overall change. The fluctuating-declining and fluctuating-rising classes exhibit irregular decreases and increases, respectively, in the urban spatial resilience over the given periods. (Figure 3).

4.3. Differentiation of the Urban Spatial Characteristics in the Harbin–Changchun Urban Agglomeration

In this study, the rates of change in the urban spatial resilience of each prefecture-level city over the five time periods, 2000–2005, 2005–2010, 2010–2015, and 2015–2019, were classified into four categories. These categories are fast-declining, slow-declining, fluctuating-declining, and fluctuating-rising urban spatial resilience. The categories were created to assess the dynamic changes in the urban spatial resilience of the prefecture-level cities in the Harbin–Changchun urban agglomeration from 2000 to 2019. On one hand, the fast-declining class represents a continuous decrease in urban spatial resilience over the five study periods, which is greater than the average value of the overall change. On the other, the slow-declining class represents a continuous decrease observed after an increase in urban spatial resilience in one place during the periods and is greater than the average value of the overall change. The fluctuating-declining and fluctuating-rising classes exhibit irregular decreases and increases, respectively, in the urban spatial resilience over the given periods. (Figure 3).
To some extent, the results indicate a change in the spatial resilience classes in the Harbin–Changchun urban agglomeration over the period 2000–2019. More than half of the cities showed a decline in urban spatial resilience. Daqing and Harbin were observed to be in the slow-declining class. In addition, Siping, Changchun, and Suihua were in the fluctuating-declining class, while the Yanbian Korean Autonomous Prefecture, Mudanjiang, Qiqihar, Songyuan, and Liaoyuan were considered to be in the fluctuating-rising class.

4.3. Factors Influencing the Spatiotemporal Differentiation of Urban Spatial Resilience

4.3.1. Analysis of the Factors Influencing the Spatial Resilience in Cities

Economic support is the driving force behind a city’s good functioning and is the primary factor influencing its spatial resilience. The level of a city’s economic development represents the basis for enhancing its resilience. The results indicate that its influence ranked first in 2000, 2005, and 2019, then second in 2010 and 2015, suggesting that the level of economic development is crucial for the spatial resilience of the Harbin–Changchun urban agglomeration. The increase in the contribution of urban economic development helps in further adjusting the economic structure, strengthening the economy, positively affecting the lives of urban residents, and creating material conditions for the city. However, the influence of economic development was low during the period between 2000 and 2019, rising from sixth to fifth place in 2000 and 2019, respectively. The contribution degree of the primary industry to economic production negatively correlated with the spatial resilience of cities. In fact, it was observed that, for the same period, the lower the contribution of the primary industry, the relatively higher the proportions of secondary and tertiary industries and the higher the vitality possessed by urban development. The influence of the primary industry moved from third place in 2000 to sixth in 2019, indicating a decrease in the contribution of the primary industry to the economic structure of the Harbin–Changchun urban agglomeration. The increased urban dynamism of the urban agglomeration is important for the growth of urban spatial resilience (Table 9).

Table 9. Summary of factors influencing the urban spatial resilience in the Harbin–Changchun urban agglomeration.

| Years | Economic Support | Environmental Construction | Social Coordination |
|-------|------------------|---------------------------|---------------------|
|       | Economic Support | Environmental Construction | Social Coordination |
|       | Y1   | Y2   | Y3   | Y4   | Y5   | Y6   | Y7   | Y8   | Y9   |
| 2000  | 0.80 | 0.70 | 0.66 | 0.70 | 0.70 | 0.55 | 0.45 | 0.55 | 0.54 |
| 2005  | 0.60 | 0.58 | 0.58 | 0.62 | 0.63 | 0.47 | 0.46 | 0.47 | 0.45 |
| 2010  | 0.61 | 0.59 | 0.56 | 0.58 | 0.55 | 0.70 | 0.69 | 0.69 | 0.69 |
| 2015  | 0.72 | 0.63 | 0.66 | 0.66 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 2019  | 0.78 | 0.72 | 0.75 | 0.74 | 0.77 | 0.23 | 0.23 | 0.23 | 0.22 |

Environmental construction is the cornerstone of coordinated urban development and a key factor influencing the spatial resilience of cities. The level of greenery in urban construction can, to some extent, be presented through the blind expansion of cities, while, at the same time, it functions as disaster prevention and refuge. The sustainable development of green areas in built-up areas can also provide ecological benefits to cities and effectively enhance urban spatial resilience. Its influence was ranked in top three from 2000 to 2019, indicating its important role in enhancing urban spatial resilience. The level of urban pollutant emissions negatively correlated with urban spatial resilience. When the pollutant emission value was high, the urban environment worsened, and urban spatial resilience to external disturbances was lowered. During the period between 2000 and 2019, the influence of urban pollutant emissions moved from the fourth to the eighth place in 2000 and 2010, respectively, and subsequently remained constant. This indicates an increase in the environmental control of the Harbin–Changchun urban agglomeration and decrease in pollutant emission levels. The overall ecological level of the city plays a vital role in
preventing conflicting land, improving the quality of the resident’s life, enhancing the ecological quality of the city, and, consequently, promoting sustainable urban development.

Social coordination is a stabilizer of urban development and a fundamental factor impacting the spatial resilience of cities. The level of urban employment may support the urbanization process and significantly impact regional economic development. From 2000 to 2019, the influence of urban employment wildly fluctuated, which may have been due to the implementation of the Northeast Revitalization Strategy. Moreover, the adjustment of industrial structure and the dynamic energy for economic development have an impact on the employment environment. In addition, the level of urban livelihoods negatively correlated with the spatial resilience of the city. The larger its value, the lower the capacity of urban residents to improve their employment. Due to the same reasons, the ability of urban economic development and the capacity of cities to resist disturbances is lowered as well. Over the 20-year period, the influence of urban livelihoods declined from the fifth place in 2000 to the last in 2019, indicating that the residents of the Harbin–Changchun urban agglomeration have improved their development level. Consequently, it promotes the employment development of the residents’ labor force and improves the city’s economic development. Moreover, its influence rank moved from the last place in 2000 to the second in 2019, suggesting a gradual increase in the influence of infrastructure construction on urban spatial resilience. Likewise, it suggests that improving the quality of social service protection is of immense importance in promoting efficient and sustainable development of cities.

4.3.2. Detection Analysis of Interaction Factors

The results indicate that the interaction between any two of the three influencing factors, namely economic support, environmental construction, and social coordination, was greater than the influence of a single factor on the urban spatial resilience of the Harbin–Changchun urban agglomeration. Therefore, the influence of each factor is of a two-factor reinforcement type, i.e., the improvement of the urban spatial resilience of the Harbin–Changchun urban agglomeration is influenced by a combination of factors. Considering the factors, an increasing investment in urban economic development can promote employment and infrastructure construction. Consequently, it improves the urban environment. Therefore, each factor of economic support has a positive and driving effect on each factor of environmental construction and social coordination capacity. Moreover, improving social coordination capacity leads to an increase in environmental construction capacity, which shows the vital role of economic support in the spatio-temporal differentiation of urban spatial resilience. In addition, social coordination is becoming more important over time, which is consistent with the results of the influence factor detection.

5. Discussion

Despite it being a new perspective for geographers, the system of spatial resilience and its research framework is not perfect. Few studies have introduced it to the field of urban research and quantified the measurement and analysis of urban spatial resilience. Therefore, further studies on urban resilience are required. This study proposes a framework consisting of the dimensions of scale, intensity, morphology, function, and benefit for evaluating urban spatial resilience. With the framework, it is possible to accurately measure urban spatial resilience and enrich the research on spatial resilience. Moreover, this paper provides a reference and guidance for spatial planning of resilient national land by exploring the factors influencing urban spatial resilience.

The research in this paper has obvious value for policy guidance and practical application. Firstly, scale, intensity, morphology, and function are the basic characteristics of cities and are required for their effective urban development. The five dimensions are important elements in urban master planning as well. Thus, revealing the current situation of these characteristics is of great significance in order to maintain urban safety. Secondly, it is not only necessary to accelerate urban economic construction to promote high-quality urban
development, but also to ensure the safe development of the city, prepare in advance for external disturbances, and effectively control the scale, intensity, and morphology of the city through more scientific urban planning. Furthermore, it is important to protect the use of all functional areas of the city, improve its spatial efficiency, prevent disasters before they happen, and achieve rapid response to disasters and rapid postdisaster infrastructure reconstruction. The city’s spatial efficiency can be enhanced by preventing disasters before they occur and by responding and repairing it quickly afterwards. Therefore, Chinese cities should, in their urbanization strategies and related urban policies, not only focus on the construction of a single indicator, such as scale, intensity, and morphology, but also integrate and coordinate the development of the five dimensions to form a new research paradigm and planning principles in order to enhance China’s urban spatial resilience and further realize high-quality urban development. Hence, the action will provide important applicable values for future urban construction in China.

This paper measures the spatial resilience of cities based on their own development so as to more accurately express their spatial variability. However, the paper still has some limitations. Firstly, some data for functional resilience of urban land are missing due to limited access. The study unit is a prefecture-level city, which has its own differences between units. Secondly, the chosen unit in this study is a prefecture-level city, which shows differences in regard to other units. Since only prefecture-level cities are covered, spatial variability occurs everywhere geographically, and spatial resilience of cities is closely related to the scale at which they are located. Therefore, future research can improve the accuracy of the study area, make the assessment results more reliable, and grasp the evolutionary process, pattern, and mechanism of the role of multiscale urban spatial resilience. Moreover, it can provide important multiscale differences and correlation research results for the establishment of China’s urban spatial resilience theory and practice system and promote the paradigm shift of urban geography research and the expansion of research fields.

6. Conclusions

The main findings can be summarized as follows:

Firstly, the results indicate a decrease in the overall urban spatial resilience of the Harbin–Changchun urban agglomeration over a period of 20 years, suggesting a weakening of its ability to resist external disturbances. Thus, plenty of room is left for improving urban spatial resilience.

Secondly, the spatial divergence of urban spatial resilience is clear from the urban spatial pattern of the Harbin–Changchun urban agglomeration. The spatial resilience of the central region, mainly in the cities of Suihua and Songyuan, is higher than that observed in the peripheral regions of Qiqihar City and the Yanbian Korean Autonomous Prefecture. A gradual increase in urban spatial resilience was observed from 2000 to 2015. Moreover, a small number of medium resilience areas appeared during the period between 2015 and 2019. Conclusively, highly resilient cities do not have strong links with surrounding cities and are not effective in helping them to develop effectively, so an overall decline in spatial resilience is observable. The results of the spatial evolution analysis of the Harbin–Changchun urban agglomeration indicate that most of the cities with a declining resilience type mainly exhibited a fluctuating decline due to their blind expansion of building land, population decline, and other reasons related to the decline in urban spatial resistance. However, cities with their own economic development rely on the connection between the surrounding cities to push urban spatial resilience back up.

Thirdly, the spatial and temporal variation in urban spatial resilience in the Harbin–Changchun urban agglomeration is the result of a combination of factors. The results of geographic probing show that the strength of the factors affecting urban spatial resilience varied over different periods. The level of urban development ranked first, while the influence of social coordination dominated by the level of urban employment gradually increased. The results of interaction detection show that a greater influence on urban spatial resilience is present when multiple factors interact than when only one factor is involved.
In addition, the results highlight the driving effect of economic support on environmental construction and social coordination and the strengthening effect of the improvement of environmental construction and social coordination on economic support.

**Author Contributions:** Conceptualization, X.M., X.C. and Y.W.; methodology, X.M. and Y.D. (Yue Du); software, X.M.; validation, X.M.; formal analysis, X.M.; investigation, X.M.; resources, X.M.; data curation, X.M., Y.D. (Yue Du), X.Z., Y.D. (Yue Dai), X.L. and R.Z.; writing—original draft preparation, X.M.; writing—review and editing, X.C.; visualization, X.M.; supervision, X.C.; project administration, X.M. and X.C.; funding acquisition, X.C. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by the Natural Science Foundation of Heilongjiang Province (LH2019D008), Youth Fund for Humanities and Social Sciences of the Ministry of Education (19YJC630177), Graduate innovation project of Harbin Normal University (HSDSSCX2021-101), Innovative Youth Talent Cultivation Plan of Heilongjiang Provincial Universities (UNPYSCT-2018194), Human Civilization and Social Science Supportive Program for Excellent Young Scholars of Harbin Normal University (SYQ2014-06).

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** Not applicable.

**Conflicts of Interest:** The authors declare no conflict of interest.

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