land

Article

Spatial Responses of Ecosystem Service Value during the Development of Urban Agglomerations

Huisheng Yu [1], Jun Yang [1,2,3,*], Dongqi Sun [4], Tong Li [1] and Yanjun Liu [5]

[1] School of Humanities and Law, Northeastern University, Shenyang 110169, China; 1810019@stu.neu.edu.cn (H.Y.); 1810021@stu.neu.edu.cn (T.L.)
[2] School of Jangho Architecture, Northeastern University, Shenyang 110169, China
[3] Human Settlements Research Center, Liaoning Normal University, Dalian 116029, China
[4] Key Laboratory of Regional Sustainable Development Modeling, Institute of Geographic Sciences and Natural Resources Research, Beijing 100101, China; sundq@igsnrr.ac.cn
[5] School of Geographical Sciences, Northeastern Normal University, Changchun 130024, China; liuyj323@nenu.edu.cn
* Correspondence: yangjun8@mail.neu.edu.cn

Abstract: This study analyzed data from 1995, 2005, and 2015 using mathematical calculations, spatial analysis, and a geographically weighted regression model. The results showed that from 1995 to 2015, the comprehensive regional development degree (RDD) of urban agglomeration in the middle of Jilin Province increased overall, with the average RDD increasing from 0.250 in 1995 to 0.323 in 2015. Especially in Changchun, a sub-provincial city, the RDD increased by nearly one-third, and the gap between this and other cities has been increasing. However, the ecosystem service value (ESV) decreased overall, with the average ESV decreasing from 108.3 in 1995 to 105.4 in 2015, and showed a strong spatial correlation. The maximum quantile in southeast–northwest direction was 1.712, with good homogeneity. The spatial influence coefficient of the RDD on the ESV showed a trend from positive to negative in the northwest–southeast direction. This value decreased continuously while the negative agglomeration area was gradually expanding, corresponding to the stressful effects of the RDD on ESV. The results of this study can provide a reference for urban planning and development as well as encourage reasonable regional spatial planning to ensure the sustainable development of urban agglomerations.

Keywords: regional development degree; ecosystem services value; spatial response; geographically weighted regression; urban agglomeration; Jilin province

Citation: Yu, H.; Yang, J.; Sun, D.; Li, T.; Liu, Y. Spatial Responses of Ecosystem Service Value during the Development of Urban Agglomerations. *Land* **2022**, *11*, 165. https://doi.org/10.3390/land11020165

Academic Editor: Brian Fath

Received: 30 December 2021
Accepted: 17 January 2022
Published: 20 January 2022

1. Introduction

An urban agglomeration is an important aspect and endpoint of urbanization for rural hinterlands. The impact of the social, economic, and land development processes caused by rapid regional urbanization on ecosystem services is a research topic of academic concern [1–7]. It is predicted that in the first 50 years of the 21st century, urban development will eventually result in 60–70% degradation of ecosystem services worldwide. There are similarities and differences between urban and regional development, especially in the important hinterlands of China's rapid urbanization. The spatial response characteristics of the ecosystem service value (ESV) during the development of specific regions have practical value for the sustainable development of urban agglomerations [8–12].

The interactions between regional development processes and ecosystems have become the focus of the human–land relationship worldwide. Previous studies on regional development and ecosystem services have focused on the following three aspects: the impact of land use change and landscape pattern evolution on ESV and the response of ESV to land use degree [3,13–21]; anthropogenic changes to the quantity, patterns, functions, and structures of land use through urbanization that affect ecosystem services or the relationship between urbanization and ecosystems [22–31]; and the formulation and implementation of spatial land planning, which raises awareness regarding the multi-objective development of urban space for society, economy, and ecology [32–37]. It is critical to consider ESV and spatial responses to regional sustainable development and optimize land resource management policies to improve ecosystem services. Therefore, multi-dimensional, coordinated development of cities and regions under the constraints of spatial planning has gradually become a research focus [34,38–41].

Since Costanza et al. published the article "Global Ecosystem Service Value and Natural Capital" in Nature in 1997 [42], the principles and methods of estimating the ESV have been clarified scientifically [43]. Institutions and scholars increasingly prefer this method of evaluating ESV, which has undoubtedly promoted research on ecosystem services. However, relevant Chinese experts have questioned whether these methods are suitable for China's reality and have improved them based on China's ecological and socio-economic conditions; as a result, "a method of valuing ecosystem services based on expert knowledge," which has been widely used since, was established [44,45].

Urban agglomerations are critical areas to coordinate national and regional development [46]. Many studies have focused on the development processes and ecosystem services of urban agglomerations [9,47]; however, studies on spatial responses based on ESV in urban agglomerations, especially discussions on the impact of spatial development structure, are lacking. The purpose of this study was to provide a scientific reference for regional spatial development and policies to ensure the sustainable regional development of urban agglomerations.

Jilin Province is a major grain-producing area and a pilot province for ecological environmentalism in China. The urban agglomeration in the middle of Jilin Province was chosen as the study area. Using socio-economic and land use data from 1995 to 2015, this study analyzes the changes in the regional development degree (RDD) and ESV in this urban agglomeration in 1995, 2005, and 2015 through mathematical calculations, spatial analysis, and a geographically weighted regression (GWR) model. Further, this study examines the spatial differentiation and response characteristics of ESV in this urban agglomeration, providing a theoretical and empirical reference for promoting the revitalization of northeast China and the sustainable development of urban agglomerations.

2. Materials and Methods

2.1. Study Area

The urban agglomeration in the central region of Jilin Province (Figure 1) shows a rich gradient of changing characteristics as the terrain transitions from mountains in the east to relatively flat plains in the central and western regions. As a whole, it belongs to a temperate continental monsoon climate. Due to the apparent terrain characteristics of the mountain-plain transition from east to west, precipitation and temperature also show obvious echelon changes, characterized by a transition from a humid climate in eastern mountainous areas to a semi-arid climate in western China. The temperature increases from east to west, whereas the precipitation decreases from east to west. It is characterized by hot and humid weather with periods of moderate dryness and wetness during the same season.

The agglomeration includes 27 county units, including one sub-provincial city: Changchun (4741 km^2); four prefecture-level cities: Jilin (3781 km^2), Siping (1007 km^2), Liaoyuan (317 km^2), and Songyuan (1250 km^2); 11 county-level cities: Jiutai (2841 km^2), Yushu (4717 km^2), Dehui (3012 km^2), Shulan (4550 km^2), Panshi (3859 km^2), Jiaohe (6348 km^2), Huadian (6503 km^2), Gongzhuling (4171 km^2), Shuangliao (3091 km^2), Fuyu (4638 km^2), and Meihekou (2171 km^2); and 11 counties: Nongan (5234 km^2), Yongji (2626 km^2), Lishu (3585 km^2), Yitong (2536 km^2), Dongfeng (2524 km^2), Dongliao (2290 km^2), Qianguo (6018 km^2), Changling (5739 km^2), Qianan (3517 km^2), Liuhe (3318 km^2), and Huinan (2274 km^2), with a regional area of 96,658 km^2, accounting for 51.23% of the total area of the province. The agglomeration is the core area of social and economic development in Jilin Province. In 2015, the total population was 20.3675 million, accounting for 73.98%

of the total population of the province, and the gross domestic product (GDP) was CNY 1204.135 billion, which was 85.62% of the provincial GDP.

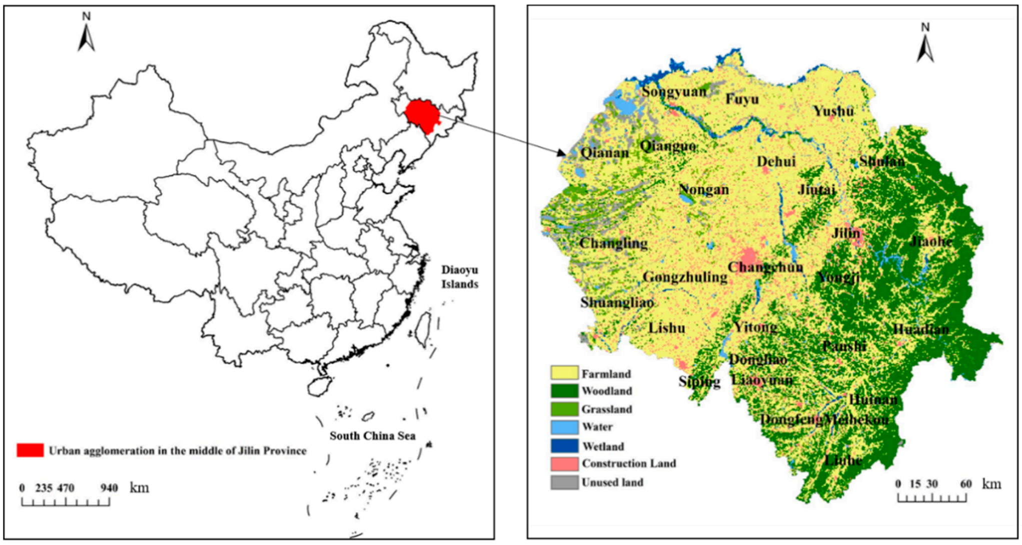

Figure 1. Location of the study area and the urban agglomeration in the middle of Jilin Province, China.

2.2. Research Methodology

2.2.1. Measurement of the RDD

In this study, the "RDD Index" was used to evaluate the comprehensive RDD of the urban agglomeration and its evolutionary characteristics (Table 1). The basic data were standardized according to two types of positive and negative indices, and their weight was determined by the entropy method. The level of comprehensive regional development was measured by the linear weighted sum method; the formula is as follows [48]:

$$\mathrm{RDD} = \sum_{i=1}^{m} \mathrm{RDD}_i \lambda_i (i = 1, 2, 3 \ldots 9) \tag{1}$$

where RDD is the index of comprehensive regional development degree, RDDi is the standardized value of the index, and λi is the weight of the index i.

Table 1. Regional development degree index evaluation system.

Development Dimension Classification	Indicator Code	Indicator Name	Index Weight
Economic Development Degree (EDD)	RDD_1	Per capita GDP	0.1273
	RDD_2	Proportion of secondary production	0.0627
	RDD_3	Per capita investment in fixed assets	0.1889
Social Development Degree (SDD)	RDD_4	Regional population density	0.1923
	RDD_5	Urbanization rate	0.1087
	RDD_6	Per capita social consumption level	0.1162
Land Development Degree (LDD)	RDD_7	Per capita construction land	0.0605
	RDD_8	Land use degree [49]	0.0545
	RDD_9	Proportion of construction land	0.0889

2.2.2. Methodology for the Valuation of Ecosystem Services

The ESV represents the benefits that human beings derive directly or indirectly from the ecosystem, which can be divided into four categories: supply, regulation, culture, and support services. Based on the research by Costanza et al. [42], Xie et al. established a table showing the ESV of different terrestrial ecosystems in China, which achieved good results. ESV can be calculated as follows [45].

$$\mathrm{ESV} = \sum_{i=1}^{n} A_i VC_i (i = 1, 2, 3 \ldots \mathrm{m}) \quad (2)$$

where ESV is the value of ecosystem services, *Ai* is the area of land use type *i*, *VCi* is the ESV coefficient of the *i* land use type, and m is the number of land use types.

ESV per unit area was used to analyze the temporal and spatial evolution of ESV in the urban agglomeration. Regional ESV was calculated first, which was then divided by the total area of each unit to obtain the ESV per unit area.

2.2.3. Spatial Variation Function

The spatial variogram was based on regional variables, and its factors were random and structural. It is an effective method for reflecting spatial correlation and heterogeneity that can be calculated as follows [50]:

$$\gamma(h) = \sum_{i=1}^{N(h)} [Z(x_i) - Z(x_i + h)]^2 / 2N(h) \quad (3)$$

$$2\gamma\,(h) = h^{(4-2D)} \quad (4)$$

where *Z(x)* is a regional random variable, *h* is the spatial distance between two sample points, and *N(h)* is the total number of sample point pairs when the segmentation distance is *h*.

2.2.4. Geographically Weighted Regression Model

The GWR model is an extension of an ordinary linear regression model, wherein the spatial position of the data is embedded into the regression equation. The general form is as follows [51,52]:

$$y_i = \beta_0(u_i, v_i) + \sum_k \beta_k(u_i, v_i) x_{ik} + \varepsilon_i \quad (5)$$

where (u_i,v_i) is the coordinate of the sampling point *i* and $\beta_k(u_i,v_i)$ is the *k* regression parameter at the sampling point *i*, which is a function of geographical position. In the GWR model, each spatial unit has a specific coefficient, and spatial non-stationarity is expressed by statistics based on the influencing factors in different spatial unit coefficients.

2.3. Data Sources

Table 2 describes the data sources used in this study. Using ArcGIS 10.2 (ESRI, Redlands, CA, USA), the land use was classified into seven types: cultivated land, woodland, grassland, water area, wetland, and construction land; unused land, as well as socio-economic and administrative division data, were integrated into the framework above. Thus, we established a research database of RDD and ESV of the urban agglomeration in the middle of Jilin Province.

Table 2. Data sources and descriptions.

Data Types	Data Sources
Land use data	Chinese Academy of Sciences Resource and Environmental Data Center (http://www.resdc.cn/, at 28 December 2017)
Socio-economic data	Statistical Bureau of Jilin Province (http://tjj.jl.gov.cn/, at 8 September 2017)
Administrative division data	Chinese Academy of Sciences Resource and Environmental Data Center (http://www.resdc.cn/, at 19 February 2017)

3. Results

3.1. Changes in RDD and ESV

Using the calculated RDD and ESV, a heat map was created through analysis in Origin2021 (Figure 2). From 1995 to 2015, the RDD of the urban agglomeration showed an overall growth trend, with the average RDD increasing from 0.250 in 1995 to 0.323 in 2015. Especially in Changchun, a sub-provincial city, the RDD increased by nearly one-third, and the gap between this and other cities has been increasing. Notably, the urban agglomeration had a single-core urban agglomeration development model. Notably, the Changji metropolitan area is the core of the urban agglomeration. In addition, further comparisons showed that the comprehensive development degree of each prefecture-level city in the agglomeration was evidently higher than that of the surrounding counties and cities. Therefore, the urban area drives the development of the surrounding counties and cities, which agrees with the objective law of urban development; however, the driving effect was insufficient. Furthermore, the RDD of Jilin declined extensively. The speed and quality of urban development were higher than those of other marginal areas. However, the ESV of the agglomeration showed a downward trend overall, and the average ESV decreased from 108.3 in 1995 to 105.4 in 2015. On the administrative level, the ESV of Changchun was evidently lower than that of other regions.

3.2. Spatial Differentiation of ESV

According to the spatial variogram results for each parameter (Table 3), from 1995 to 2015, the nugget coefficient first increased and then decreased, which indicates that the spatial correlation of ESV in the urban agglomeration first decreased and then increased; additionally, it showed strong spatial correlation. The decision coefficient was also relatively large, indicating that the theory corresponded well to the actual situation. Furthermore, it demonstrated that the ESV of the urban agglomeration had a strong spatial correlation and that the interaction and linkage effect in ESV among the various units of the agglomeration were significant. Furthermore, its spatial heterogeneity was affected by both structural and random components, and the spatial variation in ESV caused by random components (policies and regulations, human factors, etc.) was less than that caused by the structural components (social, economic, and land factors). The spatial variation fitting model selected by the least square method was a Gaussian model with three periods, and the simulation fitting degree was high.

Table 3. Variogram function fitting parameters for the spatial structure of the ESV of the urban agglomeration in the middle of Jilin Province.

Name	Parameter	1995	2005	2015
Variable range	a	212,522.63	280,072.61	221,702.50
Nugget value	C_0	0.01	0.03	0.02
Base value	$C_0 + C$	0.09	0.11	0.09
Nugget coefficient	$C_0/C_0 + C$	0.19	0.27	0.25
Fitting model	Model	Gaussian	Gaussian	Gaussian
Determining coefficient	R^2	0.82	0.69	0.74

The spatial variations in the ESV in the agglomeration showed (Table 4) that the fractal dimension first increased and then decreased from 1995 to 2015 in all directions, and was the highest in 2005 and lowest in 1995. The closer the fractal dimension to 2, the more balanced was the spatial distribution, indicating that the spatial differences in ESV first decreased and then increased. From 1995 to 2015, the fractal dimension was maximum in the southeast–northwest direction. The fitting degree was relatively good, indicating that the homogeneity of ESV in this direction was likewise good. The Kriging interpolation 3D fitting in Figure 3 shows that the number of peaks first increased and then decreased from 1995 to 2015; they were concentrated in the east, with a gradual distribution in the central and western regions.

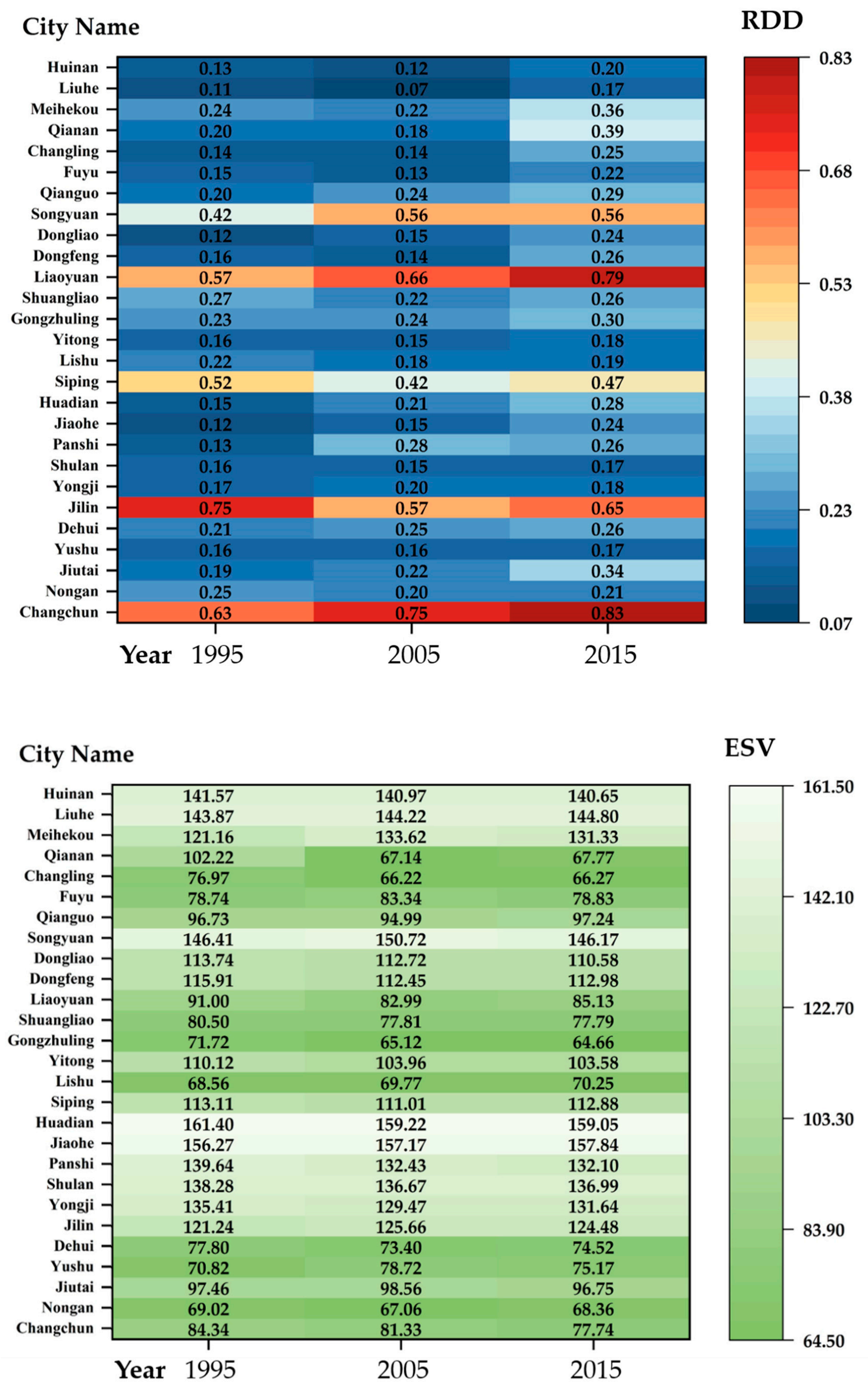

Figure 2. RDD and ESV of the urban agglomeration in the middle of Jilin Province.

Table 4. Dimensional variations in the spatial structure of the ESV of the urban agglomeration in the middle of Jilin Province.

	Omni-Directional		**South-North (0°)**		**Northeast-Southwest (45°)**	
	D *	R^2	*D* *	R^2	*D* *	R^2
1995	1.700	0.755	1.354	0.581	1.085	0.525
2005	1.812	0.446	1.325	0.410	1.277	0.273
2015	1.754	0.640	1.248	0.362	1.475	0.270

	East-West (90°)		**Southeast-Northwest (135°)**	
	D *	R^2	*D* *	R^2
1995	1.350	0.303	1.677	0.556
2005	1.498	0.517	1.778	0.307
2015	1.527	0.487	1.712	0.465

* D: Fractal dimension.

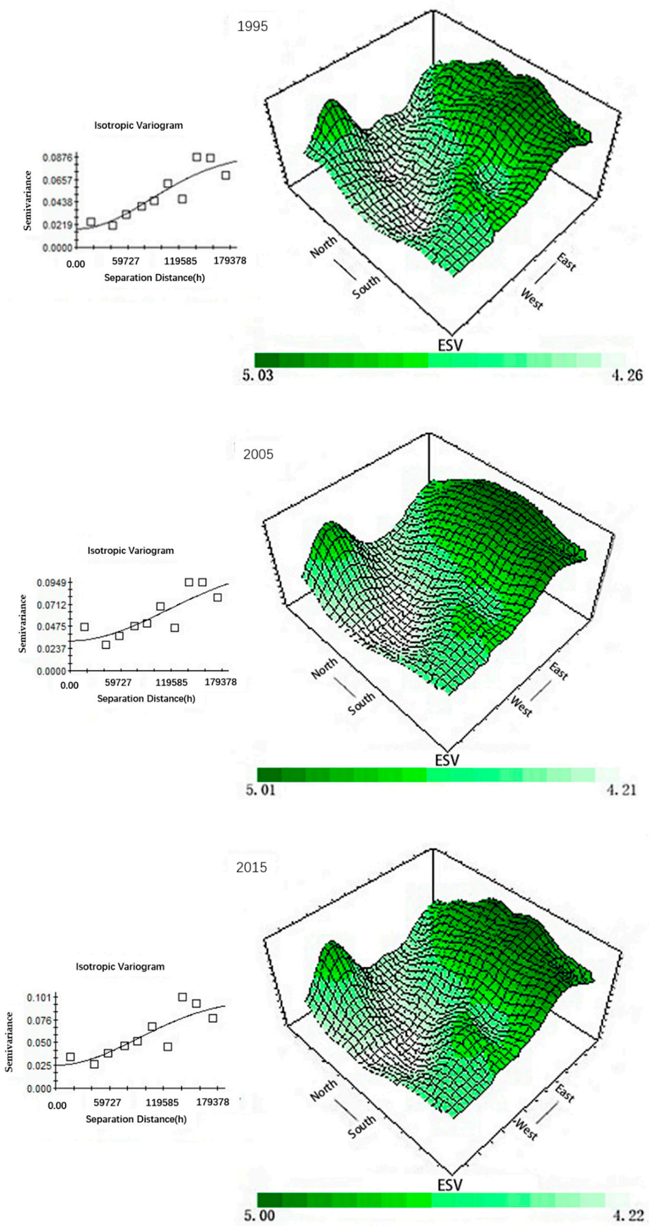

Figure 3. Variogram of the evolution of the ESV of the urban agglomeration in the middle of Jilin Province.

3.3. Spatial Response Characteristics of ESV

The influence coefficient was calculated using the GWR tool in the ArcGIS 10.2 software (ESRI, Redlands, CA, USA), and the model bandwidth was calculated by the Akaike Information Criterion of the corrected (AICc) method. In the GWR model, each spatial unit had a specific coefficient estimation method; therefore, the GWR results comprehensively reflected the influence of independent variables on the ESV in various locations. The results were visualized using the natural fracture method. The R^2 values of the models in 1995, 2005, and 2015 were 0.747, 0.761, and 0.702, respectively, which showed a high degree of fitting, and the fitting results of the GWR model were significant.

Figure 4 shows the spatial evolution of the intensity of the influence of the RDD on ESV in the urban agglomeration. From 1995 to 2015, both positive and negative impacts weakened. Additionally, the spatial impact coefficient showed a positive to negative trend in the northwest–southeast direction, and this value decreased continuously. However, in the southeastern region from 1995 to 2015, the impact coefficient changed evidently. The negative agglomeration area was gradually expanding, corresponding to the stressful effects of the RDD on ESV. This effect was especially noticeable in Changchun, the core city of the agglomeration.

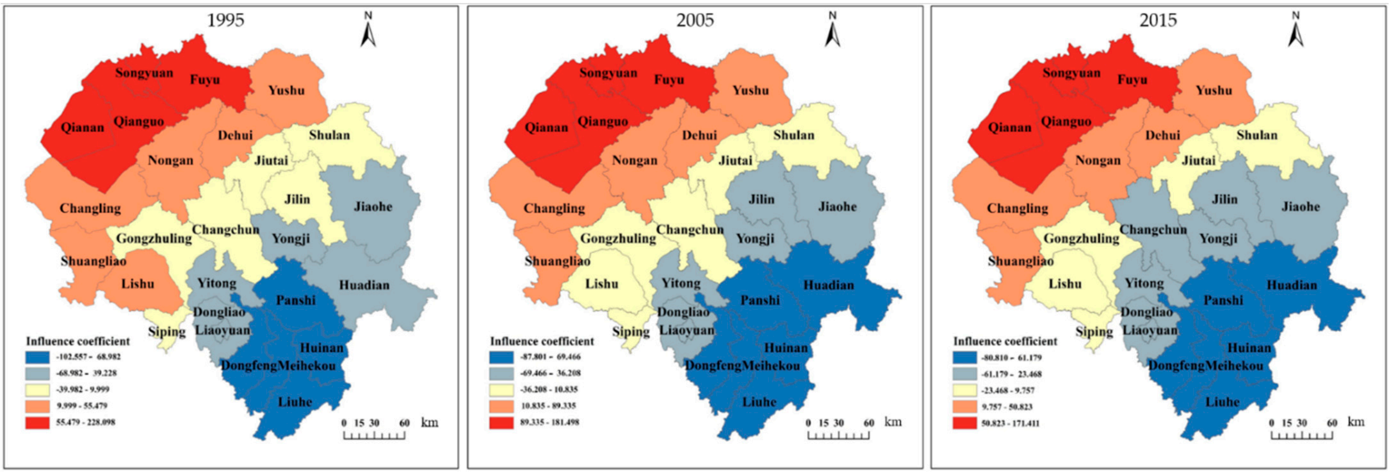

Figure 4. Spatial distribution of the influence coefficient.

4. Discussion

4.1. Impact of Land Use Distribution on ESV

The unused land in the northwestern areas of the urban agglomeration was widely distributed, rich in resources, and high in development potential. This unused land could be transformed into construction land by the urban agglomeration development process; therefore, the positive values in the northwest were significant. The eastern region was dominated by forest and water ecosystems, and the development process may destroy forests or water bodies having high ESVs. Hence, the negative values in the northeast were significant. This study directly evaluated the actual values of the converted ecosystem services of each land type but did not consider ecosystem services and trade-off evaluations. In a follow-up study, the InVEST model could be implemented to draw and evaluate the goods and services in the ecosystems of urban agglomerations [53].

4.2. Influence of Different Dimensional Development Degrees on ESV

Urban agglomerations are important for spatial considerations in national development and construction and are a complex social, economic, and natural ecosystem. The changes in ESV are affected by many factors, such as economic, social, and land-related development [3,4]. Additionally, GDP, industrial output value, investment in fixed assets, population density, urbanization level, social consumption level, and the quantity and structure of construction areas all have a certain influence. Figure 4 shows the differences between the RDD and the spatial response of ESV in each city. Additionally, the influence coefficient shows a trend from positive to negative in the northwest–southeast direction, with a continuously decreasing value. The regression variable diagram can further explain the influence of the different dimensions of economy, society, and land on ESV (Figure 5). The results showed that economic development degree was the main factor affecting the negative ESV, and social development degree had less of a promoting effect on ESV than LDD land development degree.

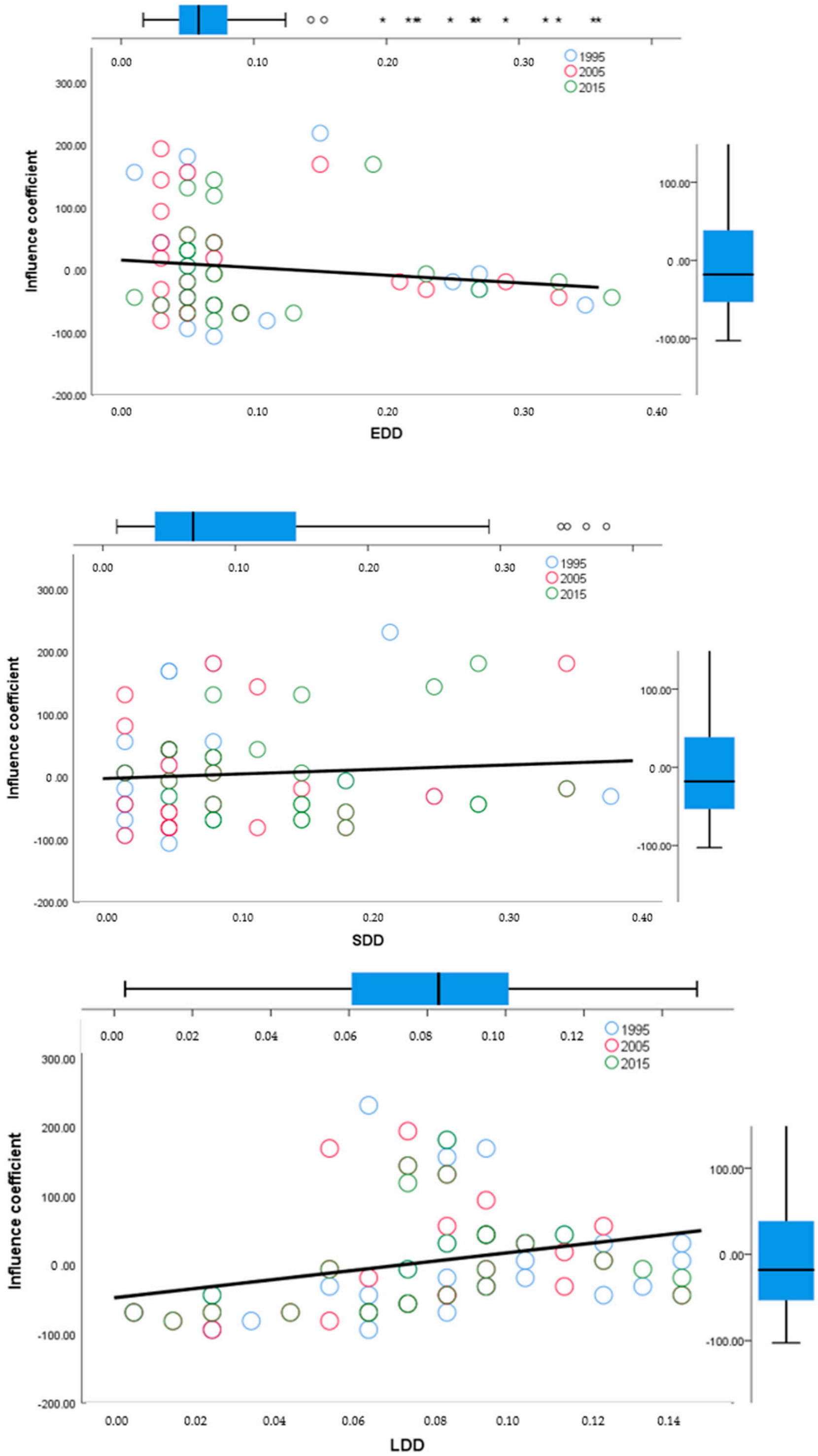

Figure 5. Regression variable diagram of the different dimensions.

4.3. Climate Change and Regional Economic Development

Urban agglomerations face greater climate change risks and environmental challenges than other regions, even during pandemics [54–56]. The regional space has different geographical landscapes and climate risks, including, for instance, urban heat islands, soil salinization, and environmental pollution [57–60]. The unequal allocation of resources caused by the difference in urban scale is likely to render small and medium-sized cities unable to respond effectively to potential climate change risks. Therefore, in the face of climate change risk, ensuring the overall common sustainable development of urban agglomeration is an important issue.

5. Conclusions

The urban agglomeration is a complex socio-ecological system. Economic and social activities and their resulting regional land use are expanding continuously, affecting ecosystem patterns and leading to the evolution of ecosystem services. From 1995 to 2015, the RDD of the urban agglomeration in the middle of Jilin Province exhibited an overall growth, with the average value increasing from 0.250 in 1995 to 0.323 in 2015. The comprehensive development degree of each prefecture-level city was higher than that of the surrounding counties and cities. Furthermore, the comprehensive development degree of Changchun increased by nearly one-third. However, the ESV of the urban agglomeration decreased overall, with the average value decreasing from 108.3 in 1995 to 105.4 in 2015; additionally, it showed a strong spatial correlation. Spatial heterogeneity in ESV in the urban agglomeration was more affected by social, economic, and land factors than policies, regulations, and human factors. Over time, both positive and negative effects of RDD influence intensity weakened, and the spatial influence coefficient transitioned from positive to negative in the northwest–southeast direction. Additionally, the influence coefficient of the southeastern area had evident spatial changes, and the range of the area with a negative value gradually expanded. The results of this study can provide a reference for urban planning and development as well as encourage reasonable regional spatial planning to ensure the sustainable development of urban agglomerations. Furthermore, climate change will hit the threshold of 1.5 °C with more severe environmental, economic, and social consequences in the coming decades; this study can reflect the spatial response of ESV in the process of urbanization under the natural and climatic differences in different areas of urban agglomeration. In the future, under the background of new urbanization and carbon neutrality, facing the potential risks of climate change, it provides a foundation for the sustainable development of urban agglomerations.

Author Contributions: Conceptualization, H.Y.; methodology, H.Y.; software, H.Y. and T.L.; data curation, H.Y.; writing—original draft preparation, H.Y.; writing—review and editing, J.Y., D.S. and Y.L.; visualization, H.Y.; supervision, J.Y.; funding acquisition, J.Y. and D.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research study was supported by the National Natural Science Foundation of China (grant no. 41771178, 42030409, 41771172, 42171191), the Fundamental Research Funds for the Central Universities (grant no. N2111003), the Basic Scientific Research Project (Key Project) of the Education Department of Liaoning Province (grant no. LJKZ0964), the Second Tibetan Plateau Scientific Expedition and Research Program (STEP) (grant no. 2019QZKK1004), and the Innovative Talents Support Program of Liaoning Province (grant no. LR2017017).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Except for the quotation noted, the data are from the authors' own measurements and calculations.

Acknowledgments: The authors would like to acknowledge all colleagues and friends who have voluntarily reviewed the translation of the survey and the manuscript of this study.

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

References

1. Valencia Torres, A.; Tiwari, C.; Atkinson, S.F. Progress in Ecosystem Services Research: A Guide for Scholars and Practitioners. *Ecosyst. Serv.* **2021**, *49*, 101267. [CrossRef]
2. Escobedo, F.J.; Bottin, M.; Cala, D.; Sandoval Montoya, D.L. Spatial Literacy Influences Stakeholder's Recognition and Mapping of Peri-Urban and Urban Ecosystem Services. *Urban Ecosyst.* **2020**, *23*, 1039–1049. [CrossRef]
3. Ferreira, L.M.R.; Esteves, L.S.; de Souza, E.P.; dos Santos, C.A.C. Impact of the Urbanisation Process in the Availability of Ecosystem Services in a Tropical Ecotone Area. *Ecosystems* **2019**, *22*, 266–282. [CrossRef]
4. Zhou, R.; Lin, M.; Gong, J.; Wu, Z. Spatiotemporal Heterogeneity and Influencing Mechanism of Ecosystem Services in the Pearl River Delta from the Perspective of LUCC. *J. Geogr. Sci.* **2019**, *29*, 831–845. [CrossRef]
5. Bolund, P.; Hunhammar, S. Ecosystem Services in Urban Areas. *Ecol. Econ.* **1999**, *29*, 293–301. [CrossRef]
6. Stein, S. *Capital City: Gentrification and the Real Estate State*; Verso Books: London, UK, 2019; ISBN 978-1-78663-639-3.
7. Atkinson, R. *Alpha City: How London Was Captured by the Super-Rich*; Verso Books: London, UK, 2021; ISBN 978-1-78873-798-2.
8. Jiang, W. Ecosystem Services Research in China: A Critical Review. *Ecosyst. Serv.* **2017**, *26*, 10–16. [CrossRef]
9. Haas, J.; Ban, Y. Urban Growth and Environmental Impacts in Jing-Jin-Ji, the Yangtze, River Delta and the Pearl River Delta. *Int. J. Appl. Earth Obs. Geoinf.* **2014**, *30*, 42–55. [CrossRef]
10. Yu, G. *Scientific Frontier on Human Activities and Ecosystem Changes*; Higher Education Press: Beijing, China, 2009.
11. Camerin, F.; Álvarez Mora, A. Regenerating Bilbao: From Productive Industries to Productive Services. *Territorio* **2019**, *89*, 145–154. [CrossRef]
12. Sklair, L. *The Icon Project: Architecture, Cities, and Capitalist Globalization*; Oxford University Press: New York, NY, USA, 2017; ISBN 978-0-19-046418-9.
13. Song, W.; Deng, X. Land-Use/Land-Cover Change and Ecosystem Service Provision in China. *Sci. Total Environ.* **2017**, *576*, 705–719. [CrossRef] [PubMed]
14. Pickard, B.R.; Van Berkel, D.; Petrasova, A.; Meentemeyer, R.K. Forecasts of Urbanization Scenarios Reveal Trade-Offs between Landscape Change and Ecosystem Services. *Landsc. Ecol.* **2017**, *32*, 617–634. [CrossRef]
15. Lawler, J.J.; Lewis, D.J.; Nelson, E.; Plantinga, A.J.; Polasky, S.; Withey, J.C.; Helmers, D.P.; Martinuzzi, S.; Pennington, D.; Radeloff, V.C. Projected Land-Use Change Impacts on Ecosystem Services in the United States. *Proc. Natl. Acad. Sci. USA* **2014**, *111*, 7492–7497. [CrossRef]
16. Wu, M.; Ren, X.; Che, Y.; Yang, K. A Coupled SD and CLUE-S Model for Exploring the Impact of Land Use Change on Ecosystem Service Value: A Case Study in Baoshan District, Shanghai, China. *Environ. Manag.* **2015**, *56*, 402–419. [CrossRef] [PubMed]
17. Polasky, S.; Nelson, E.; Pennington, D.; Johnson, K.A. The Impact of Land-Use Change on Ecosystem Services, Biodiversity and Returns to Landowners: A Case Study in the State of Minnesota. *Environ. Resour. Econ.* **2011**, *48*, 219–242. [CrossRef]
18. Lin, X.; Xu, M.; Cao, C.; P Singh, R.; Chen, W.; Ju, H. Land-Use/Land-Cover Changes and Their Influence on the Ecosystem in Chengdu City, China during the Period of 1992–2018. *Sustainability* **2018**, *10*, 3580. [CrossRef]
19. Yang, J.; Liu, W.; Li, Y.; Li, X.; Ge, Q. Simulating Intraurban Land Use Dynamics under Multiple Scenarios Based on Fuzzy Cellular Automata: A Case Study of Jinzhou District, Dalian. *Complexity* **2018**, *2018*, e7202985. [CrossRef]
20. Yang, J.; Guo, A.; Li, Y.; Zhang, Y.; Li, X. Simulation of Landscape Spatial Layout Evolution in Rural-Urban Fringe Areas: A Case Study of Ganjingzi District. *GISci. Remote Sens.* **2019**, *56*, 388–405. [CrossRef]
21. Yang, R.; Qin, B.; Lin, Y. Assessment of the Impact of Land Use Change on Spatial Differentiation of Landscape and Ecosystem Service Values in the Case of Study the Pearl River Delta in China. *Land* **2021**, *10*, 1219. [CrossRef]
22. Zang, S.; Wu, C.; Liu, H.; Na, X. Impact of Urbanization on Natural Ecosystem Service Values: A Comparative Study. *Environ. Monit. Assess.* **2011**, *179*, 575–588. [CrossRef]
23. Su, S.; Xiao, R.; Jiang, Z.; Zhang, Y. Characterizing Landscape Pattern and Ecosystem Service Value Changes for Urbanization Impacts at an Eco-Regional Scale. *Appl. Geogr.* **2012**, *34*, 295–305. [CrossRef]
24. Wang, S.; Liu, J.; Wang, R.; Ni, Z.; Xu, S.; Sun, Y. Impact of Socioeconomic Development on Ecosystem Services and Its Conservation Strategies: A Case Study of Shandong Province, China. *Environ. Monit. Assess.* **2012**, *184*, 3213–3229. [CrossRef]
25. Song, W.; Deng, X. Effects of Urbanization-Induced Cultivated Land Loss on Ecosystem Services in the North China Plain. *Energies* **2015**, *8*, 5678–5693. [CrossRef]
26. Sannigrahi, S.; Zhang, Q.; Pilla, F.; Joshi, P.K.; Basu, B.; Keesstra, S.; Roy, P.S.; Wang, Y.; Sutton, P.C.; Chakraborti, S.; et al. Responses of Ecosystem Services to Natural and Anthropogenic Forcings: A Spatial Regression Based Assessment in the World's Largest Mangrove Ecosystem. *Sci. Total Environ.* **2020**, *715*, 137004. [CrossRef]
27. Wu, K.; Ye, X.; Qi, Z.; Zhang, H. Impacts of Land Use/Land Cover Change and Socioeconomic Development on Regional Ecosystem Services: The Case of Fast-Growing Hangzhou Metropolitan Area, China. *Cities* **2013**, *31*, 276–284. [CrossRef]
28. Li, W.; Wu, C. A Spatially Explicit Method to Examine the Impact of Urbanisation on Natural Ecosystem Service Values. *J. Spat. Sci.* **2013**, *58*, 275–289. [CrossRef]
29. Liu, Y.; Zhou, G.; Liu, D.; Yu, H.; Zhu, L.; Zhang, J. The Interaction of Population, Industry and Land in Process of Urbanization in China: A Case Study in Jilin Province. *Chin. Geogr. Sci.* **2018**, *28*, 529–542. [CrossRef]
30. Wang, X.; Yan, F.; Zeng, Y.; Chen, M.; He, B.; Kang, L.; Su, F. Ecosystem Services Changes on Farmland in Response to Urbanization in the Guangdong–Hong Kong–Macao Greater Bay Area of China. *Land* **2021**, *10*, 501. [CrossRef]

31. Rahman, M.M.; Szabó, G. Impact of Land Use and Land Cover Changes on Urban Ecosystem Service Value in Dhaka, Bangladesh. *Land* **2021**, *10*, 793. [CrossRef]
32. Ooi, G.L. Challenges of Sustainability for Asian Urbanisation. *Curr. Opin. Environ. Sustain.* **2009**, *1*, 187–191. [CrossRef]
33. Chesney, M.; Gheyssens, J.; Pana, A.C.; Taschini, L. Economic Growth and the Environment. In *Environmental Finance and Investments*; Springer Texts in Business and Economics; Springer: Berlin/Heidelberg, Germany, 2016; pp. 73–101. ISBN 978-3-662-48174-5.
34. Jin, G.; Deng, X.; Chu, X.; Li, Z.; Wang, Y. Optimization of Land-Use Management for Ecosystem Service Improvement: A Review. *Phys. Chem. Earth Parts ABC* **2017**, *101*, 70–77. [CrossRef]
35. Ma, S.; Wen, Z. Optimization of Land Use Structure to Balance Economic Benefits and Ecosystem Services under Uncertainties: A Case Study in Wuhan, China. *J. Clean. Prod.* **2021**, *311*, 127537. [CrossRef]
36. Karimi, A.; Yazdandad, H.; Fagerholm, N. Evaluating Social Perceptions of Ecosystem Services, Biodiversity, and Land Management: Trade-Offs, Synergies and Implications for Landscape Planning and Management. *Ecosyst. Serv.* **2020**, *45*, 101188. [CrossRef]
37. Yang, J.; Yang, R.; Chen, M.-H.; Su, C.-H.; Zhi, Y.; Xi, J. Effects of Rural Revitalization on Rural Tourism. *J. Hosp. Tour. Manag.* **2021**, *47*, 35–45. [CrossRef]
38. de Groot, R.S.; Alkemade, R.; Braat, L.; Hein, L.; Willemen, L. Challenges in Integrating the Concept of Ecosystem Services and Values in Landscape Planning, Management and Decision Making. *Ecol. Complex.* **2010**, *7*, 260–272. [CrossRef]
39. Ahmadi Mirghaed, F.; Mohammadzadeh, M.; Salmanmahiny, A.; Mirkarimi, S.H. Decision Scenarios Using Ecosystem Services for Land Allocation Optimization across Gharehsoo Watershed in Northern Iran. *Ecol. Indic.* **2020**, *117*, 106645. [CrossRef]
40. Bryan, B.A.; Raymond, C.M.; Crossman, N.D.; Macdonald, D.H. Targeting the Management of Ecosystem Services Based on Social Values: Where, What, and How? *Landsc. Urban Plan.* **2010**, *97*, 111–122. [CrossRef]
41. Mascarenhas, A.; Ramos, T.B.; Haase, D.; Santos, R. Integration of Ecosystem Services in Spatial Planning: A Survey on Regional Planners' Views. *Landsc. Ecol.* **2014**, *29*, 1287–1300. [CrossRef]
42. Costanza, R.; Limburg, K.; Naeem, S.; O'Neill, R.V.; Paruelo, J.; Raskin, R.G.; Sutton, P. The Value of the World's Ecosystem Services and Natural Capital. *Nature* **1997**, *387*, 253–260. [CrossRef]
43. Serafy, S.E. Pricing the Invaluable: The Value of the World's Ecosystem Services and Natural Capital. *Ecol. Econ.* **1998**, *25*, 25–27. [CrossRef]
44. Chen, Z.; Zhang, X. Value of Ecosystem Services in China. *Chin. Sci. Bull.* **2000**, *45*, 870–876. [CrossRef]
45. Xie, G.; Zhen, L.; Lu, C.; Xiao, Y.; Chen, C. Expert Knowledge Based Valuation Method of Ecosystem Services in China. *J. Nat. Resour.* **2008**, *23*, 911–919.
46. Alfonso Álvarez, M.O.R.A.; Camerin, F. La Herencia Del Urban Renewal En Los Procesos Actuales de Regeneración Urbana: El Recorrido Renovación-Regeneración a Debate. *Índice/Contents* **2019**, *51*, 5–26.
47. Chen, W.; Chi, G.; Li, J. The Spatial Association of Ecosystem Services with Land Use and Land Cover Change at the County Level in China, 1995–2015. *Sci. Total Environ.* **2019**, *669*, 459–470. [CrossRef] [PubMed]
48. Liu, Y.; Zhang, J.; Li, C.; Zhou, G.; Fu, Z.; Liu, D. Influential Intensity of Urban Agglomeration on Evolution of Eco-Environmental Pressure: A Case Study of Changchun, China. *Chin. Geogr. Sci.* **2017**, *27*, 638–647. [CrossRef]
49. Hu, H.; Liu, H.; He, J.; An, J. Spatio-temporal variation in the value of ecosystem services and its response to land use intensity in an urbanized watershed. *Acta Ecol. Sin.* **2013**, *33*, 2565–2576.
50. Rossi, R.E.; Mulla, D.J.; Journel, A.G.; Franz, E.H. Geostatistical Tools for Modeling and Interpreting Ecological Spatial Dependence. *Ecol. Monogr.* **1992**, *62*, 277–314. [CrossRef]
51. Yang, J.; Bao, Y.; Zhang, Y.; Li, X.; Ge, Q. Impact of Accessibility on Housing Prices in Dalian City of China Based on a Geographically Weighted Regression Model. *Chin. Geogr. Sci.* **2018**, *28*, 505–515. [CrossRef]
52. McMillen, D.P. Geographically Weighted Regression: The Analysis of Spatially Varying Relationships. *Am. J. Agric. Econ.* **2004**, *86*, 554–556. [CrossRef]
53. Hamel, P.; Guerry, A.D.; Polasky, S.; Han, B.; Douglass, J.A.; Hamann, M.; Janke, B.; Kuiper, J.J.; Levrel, H.; Liu, H.; et al. Mapping the Benefits of Nature in Cities with the InVEST Software. *Npj Urban Sustain.* **2021**, *1*, 1–9. [CrossRef]
54. Mueller, N.; Rojas-Rueda, D.; Khreis, H.; Cirach, M.; Andrés, D.; Ballester, J.; Bartoll, X.; Daher, C.; Deluca, A.; Echave, C.; et al. Changing the Urban Design of Cities for Health: The Superblock Model. *Environ. Int.* **2020**, *134*, 105132. [CrossRef]
55. Slater, S.J.; Christiana, R.W.; Gustat, J. Recommendations for Keeping Parks and Green Space Accessible for Mental and Physical Health During COVID-19 and Other Pandemics. *Prev. Chronic Dis.* **2020**, *17*, 200204. [CrossRef]
56. OECD. Policy Responses to Coronavirus (COVID-19). In *Cities Policy Responses*; OECD: Paris, France, 2020.
57. Zhang, G.; He, B.-J. Towards Green Roof Implementation: Drivers, Motivations, Barriers and Recommendations. *Urban For. Urban Green.* **2021**, *58*, 126992. [CrossRef]
58. Zhao, Z.; Sharifi, A.; Dong, X.; Shen, L.; He, B.-J. Spatial Variability and Temporal Heterogeneity of Surface Urban Heat Island Patterns and the Suitability of Local Climate Zones for Land Surface Temperature Characterization. *Remote Sens.* **2021**, *13*, 4338. [CrossRef]
59. Zhao, D.; Zhao, X.; Khongnawang, T.; Arshad, M.; Triantafilis, J. A Vis-NIR Spectral Library to Predict Clay in Australian Cotton Growing Soil. *Soil Sci. Soc. Am. J.* **2018**, *82*, 1347–1357. [CrossRef]
60. Zhao, D.; Arshad, M.; Wang, J.; Triantafilis, J. Soil Exchangeable Cations Estimation Using Vis-NIR Spectroscopy in Different Depths: Effects of Multiple Calibration Models and Spiking. *Comput. Electron. Agric.* **2021**, *182*, 105990. [CrossRef]