

Conceptual Model of Factors Influencing on the Value of Urban Ecosystem Services

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Abstract:

With the continuous acceleration of global urbanization, the importance of urban ecosystems and the services they provide for maintaining residents' well-being is becoming increasingly prominent. Scientific evaluation and effective enhancement of urban ecosystem services value (ESV) have become core issues in urban planning and management. However, this value is influenced by complex multidimensional factors such as nature, economy, society, and policies, and its internal underlying mechanisms are not yet clear. The paper aims to systematically identify the key driving factors that affect urban ESV and construct a comprehensive conceptual model to abstract a holistic cognition of the factors that affect urban ESV from a universal perspective. Through literature review and systematic analysis, the study identifies three major influencing factors: land use change, natural geographic conditions (such as altitude, slope, temperature, and precipitation), and socio-economic development (such as population density, economic density, and public fiscal expenditure). On this basis, the nonlinear relationship between the interaction and feedback of various factors was analyzed, and finally integrated into a multi-level, multi-feedback conceptual model of influencing factors. The model reveals the complex mechanism of the formation and evolution of urban ecosystem service value, and emphasizes the synergistic effect of the "nature-economy-society" composite system. The research can provide a theoretical framework for a deeper understanding of urban ecological processes and identification of key regulatory nodes, and offer decision-making basis for optimizing urban ecosystem services and enhancing urban resilience through scientific territorial spatial planning and precise urban management policies.

Keywords:

Ecosystem Service Value, Driving Factors, Conceptual Model, Urban

1. Introduction

Under the background of the national strategy for ecological civilization in the new era, the value of ecosystem services (ESs) is highlighted. Scientific understanding of the ecosystem service value (ESV) and its driving factors in urban ecosystems is a fundamental task in constructing urban ecological patterns and improving urban environmental quality. At present, studies on the driving factors of ESV in urban scenarios have achieved some research results with theoretical significance and practical value. However, the number of achievements is relatively limited, and they are mostly based on a specific case, obtaining the influencing factors of the ESV in that particular case. It is still necessary to abstract a holistic cognitive model of the influencing factors of urban ESV from a universal perspective, identify key driving factors, explore the interaction relationships between factors and the characteristics of their impact on urban ESV, in order to enhance the holistic understanding of the influencing factors of urban ESV. It provides decision-making references for urban ecological space planning, construction, layout optimization, and planning management policy formulation under the background of ecological civilization.

2. Data Sources and Methods

2.1. Data Sources

For foreign literature, Web of Science was used as the retrieval platform. The key search terms “urban” + “ecosystem services” + “value” were input to search the SCI-EXPANDED, SSCI, A&HCI, and ESCI databases within the Web of Science core collection. Over the past five years, a total of 1808 articles related to the topic were retrieved. After reading the titles and abstracts of 1808 theme-related literature, 32 papers focusing on the spatiotemporal influencing factors of urban ESV were identified. Subsequently, full-text intensive reading of these papers was conducted, and the driving factors of urban ESV were extracted.

In the China National Knowledge Infrastructure (CNKI) journal database, using the aforementioned search keywords, we searched for five major journal source categories: SCI source journals, EI source journals, core journals, CSSCI, and CSCD. Using the past five years as the search period, we obtained a total of 260 papers related to the topic. After reading the 260 papers, it was found that 7 of them involved research on the driving factors of urban ESV. By searching the CNKI dissertation database from 2018 to 2023, a total of 33 topic related doctoral dissertations and 195 master's dissertations were obtained. After reading the titles and abstracts of 33 doctoral and 195 master's theses, it was found that 7 doctoral and 9 master's theses involved research on the driving factors of urban ESV.

2.2. Research Ideas and Methods

This paper uses the method of summarization and induction to summarize, classify, and refine the existing research results on urban ESV and its spatiotemporal influencing factors, and establishes a framework for the driving factors of urban ESV. This framework highly summarizes the composition and influence process of urban ESV from the perspective of first-level driving factors. Furthermore, it classifies and deduces the composition and influence process of first-level driving factors, identifies key secondary driving factors, explores the interaction relationships between factors, and analyzes the characteristics of the impact of factors on urban ESV, then

establishes a conceptual model of urban ESV driving factors. Based on this, we establish a comprehensive understanding of the influencing factors of urban ESV from a universal perspective. The specific construction approach is shown in Figure 1.

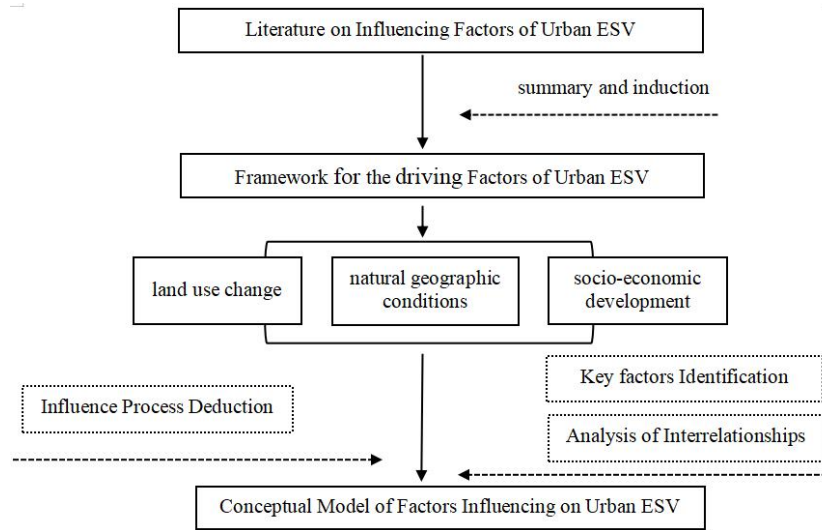


Figure 1. Framework of the Conceptual Model Construction.

3. Results

3.1. Summary of Spatiotemporal Driving Factors of Urban ESV

By synthesizing and reviewing existing studies on urban ESV and its spatiotemporal driving factors, it has been found that researchers both domestically and internationally have employed various methods, such as the geographically weighted regression model [1], panel quantile regression model [2], and conditional inference tree model [3], etc, to identify key drivers across multiple dimensions in specific case studies. We classify and sort the driving factors by category and frequency of occurrence, and obtain a frequency table for the secondary classification of urban ESV driving factors (Table 1).

Table 1. Frequency Table of urban ESV driving factors.

First-level classification	Secondary classification	Frequency
land use change	—	27
natural geographic conditions	altitude	15
	temperature	15
	slope	13
	precipitation	12
	normalized difference vegetation index (NDVI)	7
	soil erosion degree	3
	net primary productivity (NPP)	2
	distance from the water body	2
socio-economic development	population density	22
	gross domestic product	13
	population size	9
	GDP per capita	8
	average GDP per unit area	8
	urbanization Rate	7
	proportion of secondary industry	4
	road density	3

First-level classification	Secondary classification	Frequency
	distance from the road	3
	land use integrity	3
	GDP energy intensity	3
	proportion of the tertiary industry	3
	public fiscal expenditure (general public budget expenditure)	2
	distance from central cities	2
	GDP of the primary industry	2
	nighttime illumination	2

Note: Due to the limited number of empirical research results on the driving factors of urban ESV, the frequency of specific secondary classification factors is relatively low. Therefore, this paper only lists the driving factors with a frequency of 2 or more.

Source: Drawn by the author based on references [1-43].

3.2. Framework for the Driving Factors of Urban ESV

This paper uses the research method of summarization and induction, combined with Table 1, to classify and extract the existing research results on urban ESV and its spatiotemporal driving factors. It is found that the three major aspects of land use change (LUC), natural geographic conditions (NGC), and socio-economic development (SED) can cover all the driving factors of urban ESV [28] (Figure 2).

Firstly, LUC is the most direct factor affecting urban ESV, which directly changes the type, quantity and layout relationship of surface vegetation, thereby altering the layout structure of urban ecological space. Structural changes lead to changes in material flow, energy flow, information flow, etc. within the ecological space system and between it and the environment, that is, it changes the processes and functions of urban ecosystems, thereby altering ESs and ESV.

Secondly, the natural geographical location and conditions serve as the background and foundation of urban ESV, defining the tone of ESs from the material basis level. The natural geographical location determines the climate zone conditions of the research object, which in turn limits the vegetation types, growth status and production capacity. In addition, NGC such as altitude, slope, temperature, and precipitation also limit the types of vegetation and the range and intensity of human activities. Therefore, the spatial heterogeneity of NGC directly affects the supply capacity of regional ESs on relatively macro temporal and spatial scales. In the long run, the impact of natural geographical factors on ESV is fundamental and decisive [44].

The valuation of ESs from the perspectives of LUC and NGC usually only considers changes in the supply of ESs. However, ESV is simultaneously influenced by changes in the supply-demand relationship related to its relative scarcity. It is widely believed that socioeconomic factors will lead to changes in the supply-demand relationship of ESs [45]. Urbanized areas, where human activities are most active, are also regions with the highest intensity and frequency of eco-environmental changes. Socioeconomic factors are important driving forces behind the changes in their ecosystems. On the one hand, urbanization reduces the capacity of ESs by altering land surface cover, pollutant emissions, and other means; meanwhile, environmental protection policies and actions such as afforestation in the process of urbanization also restore and improve the ecological environment. On the other hand, ecosystems affect urbanization process through environmental degradation, resource scarcity, and other

factors, which increases the scarcity of ESs. Combined with the rising demand for ESs caused by factors such as population concentration, this further drives up the ESV.

The types, structure, and ecological processes of an ecosystem determine its functions. These ecosystem functions are manifested in the form of ecological products and services, generating multi-faceted value benefits in ecological, cultural, social, and economic aspects. The assessment of ESV first requires evaluating it from the supply level of ecosystem products and services. Additionally, due to the strong influence of supply-demand on the value of goods, the factors from the demand side also need to be taken into account to objectively and targetedly evaluate the urban ESV at that time and location.

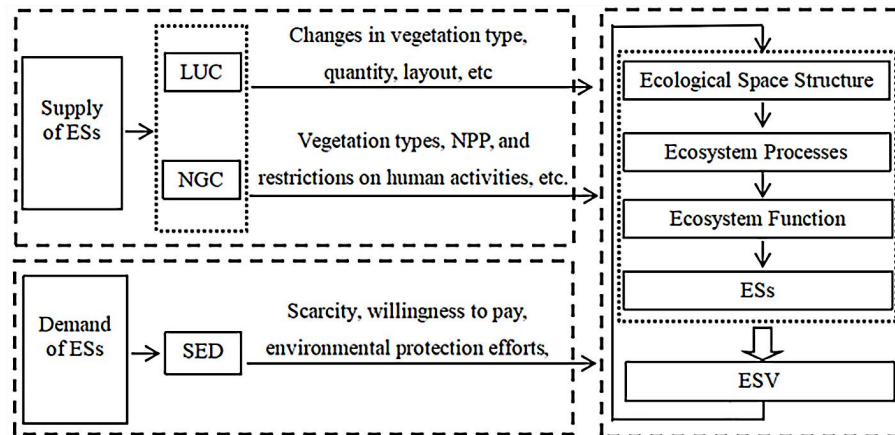


Figure 2. Framework for the Driving Factors of Urban ESV.

4. Discussion

4.1. Land Use Change (LUC)

Due to economic development, population growth, and urban expansion, significant changes have occurred in urban land use/land cover. Scholars have found that the main driving factor behind changes in ESV is land use/land cover change [46], as well as population factors, followed by economic factors (GDP) and socio-political factors (public fiscal expenditure) [47]. The process of urbanization is the primary driving factor of LUC in urban areas. With the acceleration of urbanization, ecological land such as original agricultural land, forest land, and wetlands has been converted into artificially dominated ecosystems like urban construction land at an unprecedented scale and speed, leading to significant changes in land surface cover. LUC and the fragmentation of landscape patterns directly affect the ecological spatial structure and functions. They exert significant impacts on the supporting, provisioning, regulating, and cultural services of ESs, thereby influencing the quantity and quality of ESs supply.

Against the backdrop of global urbanization, a large number of scholars have studied the impact of LUC on regional ESV. Most studies hold that urban expansion exerts a negative impact on regional ESV. However, some studies argue that there exists a more complex driving mechanism behind the impact of urban expansion on ESV [44]. Existing studies have shown that a non-linear relationship, typically represented by an “inverted U” shape, may exist between urbanization and ESs [48,49]. Specifically, ESs increase in the early stage of urbanization, but after reaching a certain threshold, they begin to decline. The main reasons for these changes can be summarized into two aspects. First of all, in the process of rapid

urbanization, due to changes in land use policies and human activities such as afforestation, land use/land cover has undergone changes. The increase in water areas, forests and grasslands in non-urban areas can offset the reduction in ESs caused by urban expansion [50]. Second, the relationship between urbanization and ESs is highly dependent on the regional environmental context of the study area. For instance, Phoenix, a desert city, has received extensive irrigation during its urbanization process, which has significantly enhanced the productivity and biodiversity of plant communities, thereby increasing the urban ESV [36].

To sum up, the process of urbanization leads to significant changes in land use, and LUC exerts a direct impact on the structure, processes, and functions of ecological space, thereby influencing the ESV. LUC is the most intuitive factor contributing to changes in urban ESV (Figure 3).

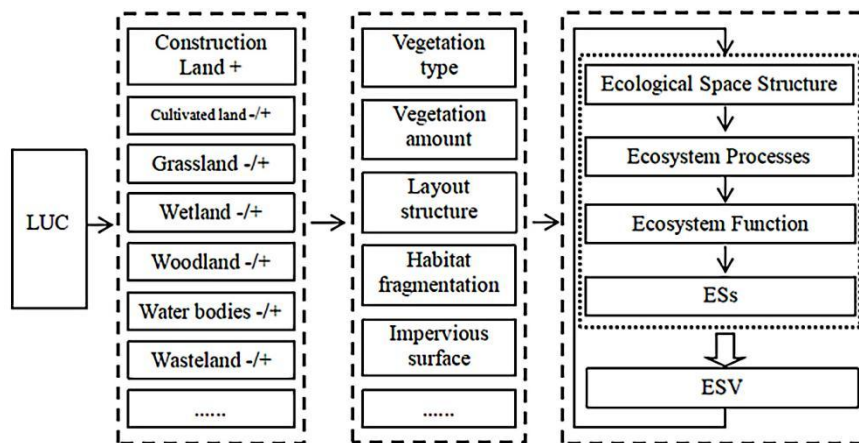


Figure 3. Deduction of the Impact Process of LUC on Urban ESV.

4.2. Natural Geographic Conditions (NGC)

Natural geographic location and conditions serve as the background and base of urban ESs, determining the capacity and level of ESs over a relatively long-term time scale. From the perspective of stability and change frequency, natural geographic factors are more stable and have a lower frequency of change compared to socio-economic factors. From the perspective of spatial heterogeneity, China has a vast territory, spanning a wide range of climate zones and featuring diverse landforms. Consequently, there are significant differences in NGC across different regions, which exert a fundamental impact on urban ESs (Figure 4). According to literature studies, the physical geographical factors affecting urban ESV mainly include elevation, slope, temperature, and precipitation.

4.2.1. Altitude

The impact of altitude on the value of regional ESs is relatively stable. Overall, it has a negative impact on ESs. As the altitude increases, the natural ecological environment becomes increasingly harsh, the types and quantities of vegetation undergo significant changes, resulting in a weaker supply capacity of ESs. However, in some rapidly urbanizing areas, the advancement of urbanization is hindered due to high elevation, which exerts a promoting and protective effect on ESs [44].

4.2.2. Slope

Topographic slope can affect factors such as soil fertility, local microclimate, runoff, and seed dispersal. These impacts can further alter the growth status and distribution pattern of vegetation. Additionally, under normal circumstances, human activities

show a negative correlation with altitude and slope. Areas at high altitudes with steep slopes are characterized by low economic development levels and low intensity of human activities. This indirectly protects the original ecosystem, thereby ensuring the supply of ESs [51]. Geomorphic factors (altitude and slope) influence the functions of ESs by regulating the distribution of NPP [39].

4.2.3. Temperature

Vegetation types and productivity are intuitive reflections of various ESs. The climatic conditions of a region have a direct and significant impact on vegetation types and growth status. Among climatic factors, temperature and precipitation are the primary factors affecting vegetation growth. A suitable temperature is an essential condition for plant growth. If the temperature is lower or higher than that, it will affect the growth of plants. Under different climatic conditions (such as temperature and precipitation), the types and lushness of vegetation vary, as do their potential to convert solar energy and their NPP. NPP is the most direct manifestation of regional ESs. A variety of ESs are directly or indirectly influenced and reflected by the growth status of regional vegetation. Therefore, climate (such as temperature and precipitation) serves as the natural foundation of ESs and is a crucial natural factor affecting urban ESV.

4.2.4. Precipitation

The productive capacity of vegetation is a direct manifestation of the functions of ESs. Adequate precipitation is an essential condition for plant growth, and the amount of rainfall directly affects the types and growth status of vegetation. Abundant precipitation promotes vigorous vegetation growth, while scarce precipitation may lead to sparse vegetation and even deserts in extreme cases. Generally speaking, where the annual precipitation is less than 200 millimeters, the natural vegetation is desert. When it ranges from 200 to 400 millimeters, the natural vegetation is grasslands. When it ranges from 400 to 800 millimeters, the natural vegetation is forest steppe. When it exceeds 800 millimeters, the natural vegetation is forest. Due to the significant impact of precipitation on vegetation types and productivity, it has become an important natural driving factor for the functions of urban ESs.

In summarization, the process of driving factors on the natural geography of urban ESV is shown in Figure 4:

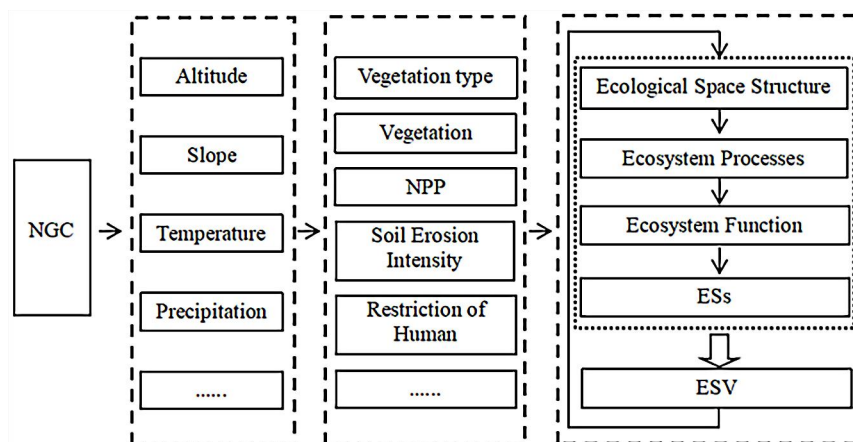


Figure 4. Deduction of the Impact Process of NGC on Urban ESV.

4.3. Socio-Economic Development (SED)

It has become a consensus in the industry that SED affects urban ESV in rapidly urbanizing areas. With the rapid advancement of China's urbanization process, population and economy are highly concentrated. While this changes the urban land surface coverage, human environmental protection policies and behaviors such as returning farmland to forests and afforestation are conducive to promoting the improvement of ESV. Additionally, in urbanized areas with relatively high population density, the increase in population density and the reduction in ecological space supply have led to a rise in the scarcity of ESs. Due to the interaction between the supply and demand sides, urban ESV has consequently increased.

In addition, the monetary value of ESs varies significantly due to differences in people's willingness and ability to pay. To a certain extent, the evaluation of ESs is an expression of human will, and the value of ESs evolves dynamically as people's willingness to pay. People's demand and awareness regarding the level of ESV is a gradual, progressive process. This awareness is closely related to the degree of SED and increases as the stage of SED advances. For example, in areas with developed socioeconomic conditions, people are willing to bear more economic expenses to obtain a higher-quality ecological environment and outdoor leisure and entertainment venues, while areas with underdeveloped SED are unable to take into account ESs provided by the natural environment. To sum up, the socioeconomic factors affecting urban ESV mainly involve population density, economic density, and public fiscal expenditure.

4.3.1. Population density

The impact of human activities on urban ESV is mainly reflected in two aspects: the growth of population size and the concentration of population distribution. The growth of population size requires an increasing amount of resources from nature to support the needs of human survival and development. The larger the population, the more significant the consumption of various resources, and the higher the scarcity of the remaining ecological resources. The concentration of population distribution during the urbanization process has led to a rapid increase in the demand for ESs in local areas, making the scarcity of ecological resources more prominent. The scarcity of ecological resources reflects the relationship between the supply and demand of ecological resources in a region during the process of urban development. The smaller the supply of ecological resources and the greater the demand, the higher the scarcity; consequently, people's willingness to pay becomes stronger, ESV rises, and the value of ESs is significantly enhanced. Since NGC of the same region is similar, the supply of ecological resources is relatively comparable across the region. From the perspective of demand, the scarcity of ecological resources in a specific area depends on the local population density [52].

4.3.2. Economic density

Hu et al. (2019) found that there is a positive correlation between ecological resources and economic activities (GDP). Economic growth is a crucial factor in improving vegetation or ESs, mainly due to the following three aspects: economic development promotes governments to formulate and implement environmental policies that protect natural ecosystems; economic growth can provide more financial support for environmental protection, allowing more revenues to be allocated to investments in ecological restoration and improvement of the natural environment; economic development can raise people's awareness of environmental protection and

SED acts on urban ecosystems with high intensity and frequency, leading to significant changes in ESV in the short term.

LUC is influenced by both NGC and SED. In urbanized areas, SED serves as the primary driving factor of LUC. Specifically, SED leads to the rapid conversion of ecological land into urban construction land, resulting in significant changes in land surface cover. Proactive urban ecological conservation policies (such as afforestation, converting farmland to forest, etc.) exert a positive impact on the improvement of ESs. Conversely, excessive land development and the deterioration of the ecological environment, in turn, constrain the development of society and the economy. Natural geographic factors (such as altitude and slope) limit human activities, thereby slowing down the speed and frequency of LUC; in turn, LUC affects the urban ecological environment, such as the heat island effect.

There is a complex interaction and counteraction relationship between socioeconomic factors and urban ESV. The impacts of socioeconomic factors on urban ESs are as follows: (1) The rapid urbanization process promotes the conversion of a large amount of ecological land into urban construction land, which may lead to a decrease in ESV. (2) Due to economic development, fiscal input and policy support for afforestation, environmental protection, and other related initiatives have increased, which is conducive to enhancing the capacity of ESs. (3) Economic development has improved people's living standards and increased their demand for outdoor recreation. As people's demand for the quantity and quality of ecological products rises, the scarcity of ESs increases, which in turn enhances ESV. Regarding the impact of urban ESs on SED: The degradation of ESs' capacity and the emergence of a series of eco-environmental problems have constrained the further development of cities. This has urged cities to introduce relevant policies and take actions to protect the environment, thereby facilitating the sustainable development of cities.

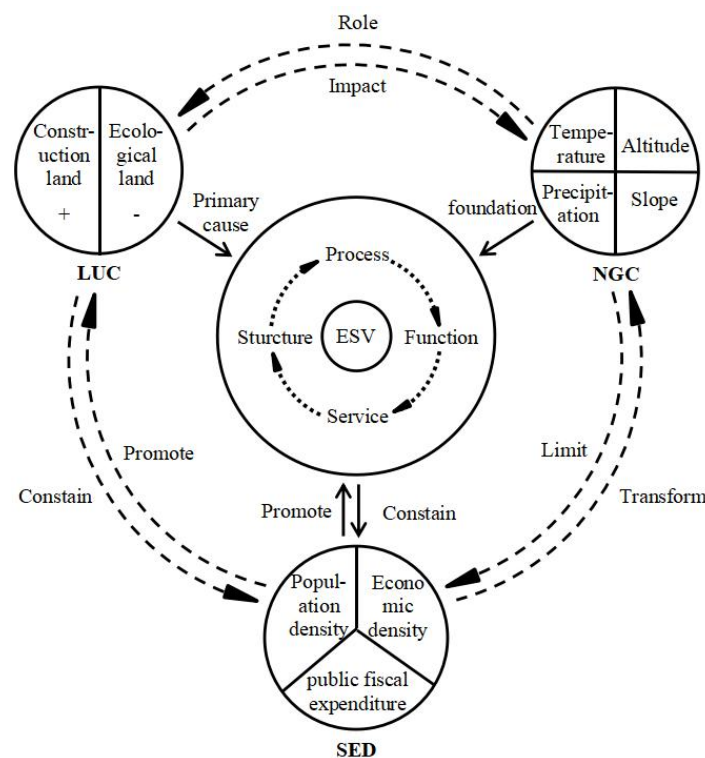


Figure 6. Conceptual Model of the Interrelationship Among the Three Spatiotemporal Driving Factors of Urban ESV (LNSIM).

Through literature research, summarization, and induction, this study identifies the key factors influencing on ESV in urban scenarios, explores the evolutionary characteristics of urban ESV and the interaction relationships among the systematic evolutionary factors, and establishes a conceptual model of the interrelationships among the three major spatiotemporal driving factors of urban ESV — namely the Land-Nature-Society Influenced Model of Urban ESV (LNSIM). This model enhances the holistic understanding of urban ESV (Figure 6). In conclusion, the three major influencing factors interact with and constrain each other, jointly affecting the changes in urban ESV. Therefore, the evaluation of urban ESV needs to comprehensively consider the combined impacts of these three factors.

5. Conclusions

The construction of the conceptual model in this paper is based on the results of literature research. It identifies three major categories of spatiotemporal driving factors of urban ESV, namely LUC, NGC and SED, and establishes a framework for it. By analyzing the impact processes and secondary driving factors of LUC, NGC and SED, combined with existing research findings, this study identifies the key elements affecting ESV of urban scenarios, sorts out the characteristics and functioning modes of these key elements, and explores the composition structure and interaction relationships among various elements in the "Land-Nature-Society" system. On this basis, LNSIM is constructed. This conceptual model explains the operational mechanism of the driving factors of urban ESV and the interrelationships among various elements, establishes a holistic understanding of the influencing factors of urban ESV, and provides theoretical support for urban ESV evaluation.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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References

- [1] Hu, C.G.; Wang, Z.Y.; Li, J.M.; et al. Quantifying the Temporal and Spatial Patterns of Ecosystem Services and Exploring the Spatial Differentiation of Driving Factors: a Case Study of Sichuan Basin, China. *Frontiers in Environmental Science*, 2022, 10.
- [2] Zhang, X.Y.; Shen, J.Q.; Sun, F.H.; et al. Spatial-Temporal Evolution and Influencing Factors Analysis of Ecosystem Services Value: A Case Study in

- Sunan Canal Basin of Jiangsu Province, Eastern China. *Remote Sensing*, 2023, 15(1).
- [3] Guo, S.S.; Wu, C.Y.; Wang, Y.H.; et al. Threshold effect of ecosystem services in response to climate change, human activity and landscape pattern in the upper and middle Yellow River of China. *Ecological Indicators*, 2022, 136, 108603.
- [4] Shao, M.; Wu, L.F.; Li, F.Z.; et al. Spatiotemporal Dynamics of Ecosystem Services and the Driving Factors in Urban Agglomerations: Evidence From 12 National Urban Agglomerations in China. *Frontiers in Ecology and Evolution*, 2022, 10.
- [5] Li, D.L.; Cao, W.F.; Dou, Y.H.; et al. Non-linear effects of natural and anthropogenic drivers on ecosystem services: Integrating thresholds into conservation planning. *Journal of Environmental Management*, 2022, 321.
- [6] Zhang, H.; Wang, Y.W.; Wang, C.; et al. Coupling analysis of environment and economy based on the changes of ecosystem service value. *Ecological Indicators*, 2022, 144.
- [7] Zhang, K.L.; Liu, T.; Feng, R.R.; et al. Coupling Coordination Relationship and Driving Mechanism between Urbanization and Ecosystem Service Value in Large Regions: A Case Study of Urban Agglomeration in Yellow River Basin, China. *International Journal of Environmental Research and Public Health*, 2021, 18(15), 7836.
- [8] Pan, Y.; Wang, J.; Li, J.X.; et al. Spatial and Temporal Evolution and Driving Analysis of Green Space Ecosystem Service Value of Urban Agglomeration in Central Yunnan. *Research of Soil and Water Conservation*, 2023, 30(2), 352-360.
- [9] OuYang, X.; Wang, K.; Wei, X. Impacts of urban-rural construction land linkages on ecosystem services: A case study of Dongting Lake area. *Acta Ecologica Sinica*, 2022, 42(21), 8713-8722.
- [10] Jiang, M. Study on the Spatiotemporal Variation and Associated Driving Factors of Ecosystem Services in the Southwest Karst of China. Doctor, Huazhong Agricultural University, Wuhan, 2022.
- [11] Yao, Z.Q.; Chen, S.; Hu, W.H.; et al. Evolution and Driving Analysis of Ecosystem Service Values in the Wanjiang Urban Belt. *Environmental Science & Technology*, 2022, 45(4), 218-226.
- [12] Liu, Z.T.; Wang, S.J.; Fang, C.L. Spatiotemporal evolution and influencing mechanism of ecosystem service value in the Guangdong-Hong Kong-Macao Greater Bay Area. *Acta Geographica Sinica*, 2021, 76(11), 2797-2813.
- [13] Wang, B. Study on Spatiotemporal Evolution of Ecosystem Service Value and Prediction in Yinchuan City. Doctor, Lanzhou University, Lanzhou, 2022.
- [14] Huo, R. Study on the Relationship Between Ecosystem Services and Human Well-being in Coal Resource-based Cities. Doctor, China University of Mining & Technology, Beijing, 2020.
- [15] Feng, C.Y. The Evaluation Method and Quantitative Study of the Ecological Assets in the Cenert Region of Chengdu City based on Remote Sensing and GIS. Doctor, Southwest Jiaotong University, Chengdu, 2020.

- [16]Zhang, Y. Spatio-temporal differentiations and driving forces of ecosystem services and urban expansion situation with constraints of them:A case study of Wuhan city. Doctor, Wuhan University, Wuhan, 2020.
- [17]Ding, Y.N. Coordination and spatial effect analysis of urbanization and ecosystem services based on grid in Shanxi Province. Master, Shanxi Normal University, Taiyuan, 2022.
- [18]Ye, L.F. Spatial-temporal Characteristics and Driving Factors of Ecosystem Services in Beijing-Tianjin-Hebei Urban Agglomeration. Master, Lanzhou University, Lanzhou, 2022.
- [19]Zhang, P. The spatial-temporal evolution of ecosystem services value and the analysis of influencing factors in Urban Agglomeration around Chang-Zhu-Tan. Master, Hunan Normal University, Changsha, 2021.
- [20]Liu, S. Effect of Urbanization on Ecosystem Service Values in the Beijing-Tianjin-Hebei Urban Agglomeration of China from 2000 to 2014. Master, Northwest A&F University, Xianyang, 2021.
- [21]Zhou, Y.L. Research on the Special and Temporary Differentiation Characteristics and Driving Mechanism of Ecosystem Service Value in Guangdong-Hong Kong-Macao Greater Bay Area. Master, Yunnan University, Kunming, 2021.
- [22]Xiong, R.Y. Research on Dynamic Evaluation and Influencing Factors of Ecosystem Services Value in Fujian Province. Master, Wuhan University, Wuhan, 2021.
- [23]Yu, F.Y. Study on Scale Characteristics and Impact Mechanism of Ecosystem Service Value in the Middle Reaches of the Yangtze River. Master, Wuhan University, Wuhan, 2020.
- [24]Zhao, H.Y. Study on ecosystem service value accounting and its influencing factors in Anhui province. Master, Hefei University of Technology, Hefei, 2019.
- [25]Yang, S.H. Spatial-temporal distribution difference and influence mechanism of ecosystem service value in Wuhan Urban Agglomeration. Master, China University of Geosciences, Wuhan, 2018.
- [26]Dai, X.; Johnson, B.A.; Luo, P.; et al. Estimation of Urban Ecosystem Services Value: A Case Study of Chengdu, Southwestern China. *Remote Sensing*, 2021, 13(2).
- [27]Xing, L.; Zhu, Y.M.; Wang, J.P. Spatial spillover effects of urbanization on ecosystem services value in Chinese cities. *Ecological Indicators*, 2021, 121, 107028-107028.
- [28]Liu, Z.; Wu, R.; Chen, Y.; et al. Factors of ecosystem service values in a fast-developing region in China: Insights from the joint impacts of human activities and natural conditions. *Journal of Cleaner Production*, 2021, 297(1).
- [29]He, Y.; Wang, W.; Chen, Y.; et al. Assessing spatio-temporal patterns and driving force of ecosystem service value in the main urban area of Guangzhou. *Scientific Reports*, 2021, 11(1), 1-18.

- [30] Dai, X.; Wang, L.C.; Huang, C.B.; et al. Spatio-temporal variations of ecosystem services in the urban agglomerations in the middle reaches of the Yangtze River, China. *Ecological Indicators*, 2020, 115.
- [31] Luo, Q.L.; Zhou, J.F.; Li, Z.G.; et al. Spatial differences of ecosystem services and their driving factors: A comparison analysis among three urban agglomerations in China's Yangtze River Economic Belt. *Science of the Total Environment*, 2020, 725.
- [32] Liu, S.; Yang, M.; Mou, Y.; et al. Effect of Urbanization on Ecosystem Service Values in the Beijing-Tianjin-Hebei Urban Agglomeration of China from 2000 to 2014. *Sustainability*, 2020, 12(24).
- [33] Chen, T.; Feng, Z.; Zhao, H.; et al. Identification of Ecosystem Service Bundles and Driving Factors in Beijing and its Surrounding Areas. *Science of the Total Environment*, 2020, 711(5).
- [34] Chen, W.; Chi, G.; Li, J. Ecosystem Services and Their Driving Forces in the Middle Reaches of the Yangtze River Urban Agglomerations, China. *International Journal of Environmental Research and Public Health*, 2020, 17(10), 3717.
- [35] Hu, M.M.; Li, Z.T.; Wang, Y.F.; et al. Spatio-temporal changes in ecosystem service value in response to land-use/cover changes in the Pearl River Delta. *Resources, Conservation & Recycling*, 2019, 149, 106-114.
- [36] Wang, J.L.; Zhou, W.Q.; Pickett, S.T.A.; et al. A multiscale analysis of urbanization effects on ecosystem services supply in an urban megaregion. *Science of the Total Environment*, 2019, 662, 824-833.
- [37] Jiang, Z.; Sun, X.Y.; Liu, F.; et al. Spatio-temporal variation of land use and ecosystem service values and their impact factors in an urbanized agricultural basin since the reform and opening of China. *Environmental Monitoring and Assessment*, 2019, 191(12).
- [38] Sun, Y.; Liu, S.; Dong, Y.; et al. Spatio-temporal evolution scenarios and the coupling analysis of ecosystem services with land use change in China. *Science of the Total Environment*, 2019, 681(SEP.1), 211-225.
- [39] Zhang, Y.; Lu, X.; Liu, B.; et al. Impacts of Urbanization and Associated Factors on Ecosystem Services in the Beijing-Tianjin-Hebei Urban Agglomeration, China: Implications for Land Use Policy. *Sustainability*, 2018, 10(11).
- [40] Tang, X.M.; Hao, X.Y.; Liu, Y.; et al. Driving Factors and Spatial Heterogeneity Analysis of Ecosystem Services Value. *Transactions of the Chinese Society for Agricultural Machinery*, 2016, 47(5), 336-342.
- [41] Shao, M.; Dong, Y.X.; Lin, C.S. Spatio-temporal evolution and driving factors of ecosystem services in Chengdu-Chongqing urban agglomeration of southwestern China based on GWR model. *Journal of Beijing Forestry University*, 2020, 42(11), 118-129.
- [42] Zhu, Z.Z.; Zhong, Y.X. Spatio-Temporal Evolution of Land Use and Ecosystem Service Value in Yangtze River Delta Urban Agglomeration. *Resources and Environment in the Yangtze Basin*, 2019, 28(7), 1520-1530.

- [43] Sun, X.; Crittenden, J.C.; Li, F.; et al. Urban expansion simulation and the spatio-temporal changes of ecosystem services, a case study in Atlanta Metropolitan area, USA. *Science of the Total Environment*, 2018, 622, 974-987.
- [44] Xing, L. Study on the Spatio-temporal Impacts of Urbanization on the Ecosystem Services Value and Ecological Sustainability Assessment. Doctor, Huazhong University of Science and Technology, Wuhan, 2018.
- [45] Li, R.; Shi, Y.; Feng, C.C.; et al. The spatial relationship between ecosystem service scarcity value and urbanization from the perspective of heterogeneity in typical arid and semiarid regions of China. *Ecological Indicators*, 2021, 132, 108299.
- [46] Gao, F.J.; Cui, J.; Zhang, S.; et al. Spatio-Temporal Distribution and Driving Factors of Ecosystem Service Value in a Fragile Hilly Area of North China. *Land*, 2022, 11(12).
- [47] Luo, Q.L.; Zhou, J.F.; Li, Z.G.; et al. Spatial differences of ecosystem services and their driving factors: A comparison analysis among three urban agglomerations in China's Yangtze River Economic Belt. *Science of the Total Environment*, 2020, 725.
- [48] Li, T.H.; Li, W.K.; Qian, Z.H. Variations in ecosystem service value in response to land use changes in Shenzhen. *Ecological Economics*, 2008, 69(7), 1427-1435.
- [49] Wan, L.L.; Ye, X.Y.; Lee, J.; et al. Effects of urbanization on ecosystem service values in a mineral resource-based city. *Habitat International*, 2015, 46, 54-63.
- [50] Zhou, D.Y.; Tian, Y.Y.; Jiang, G.H. Spatio-temporal investigation of the interactive relationship between urbanization and ecosystem services: Case study of the Jingjinji urban agglomeration, China. *Ecological Indicators*, 2018, 95, 152-164.
- [51] Hu, M.M.; Xia, B.C. A significant increase in the normalized difference vegetation index during the rapid economic development in the Pearl River Delta of China. *Land Degradation & Development*, 2019, 30(4), 359-370.
- [52] Hu, X.S.; Hong, W.; Wu, C.Z. An Improved Dynamic Evaluation Model and Land Ecosystem Service Values for Fuzhou City. *Resources Science*, 2013, 35(1): 30-41.
- [53] Shen, Y. Research on the Fiscal and Taxation for Promoting the Development of Eco-city. Master, East China University of Political Science and Law, Shanghai, 2013.



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