Study on the Influencing Factors of Ecosystem Service Value: Based on Urban Environmental Governance in Beijing

Xinyu Wang*, Wensen Wu

North China University of Technology, Shijingshan District, Beijing, China
*Corresponding author: Xinyu Wang

Abstract: Urban environmental governance, as an important part of urban governance, is an important part of ecological civilization construction in the comprehensive deepening reform. This paper is dedicated to analyzing the environmental governance part of traditional urban habitat research and analyzing the spatial spillover effect of urban environmental policy effectiveness based on the regional linkage perspective using the spatial Durbin model. In this paper, data of 16 districts in Beijing for four periods of 2010, 2013, 2015, and 2018 were selected to reflect the main influencing elements of governance effectiveness using ecosystem service values. The analysis of regression results found that: ①Urban governance and environmental construction in Beijing have achieved a relatively good coordination and interaction in general. ②Environmental governance policies in each district still have shortcomings, with blind expansion and lack of overall development awareness being the two main problems.

Keywords: ecosystem service value; urban environmental governance; spatial effects

1. Introduction

As an important part of urban governance, urban environmental management is an important part of ecological civilization construction, and urban construction has undergone the transformation from serving the needs of initial agricultural production to clean urban life [1], meanwhile the research on the evaluation criteria of urban ecological construction has been enriched, from the evaluation of green areas, industries, three waste treatment and other aspects of construction [2], and also focusing on the design of the element layer to the target layer of urban sustainable layer evaluation [3]. There are also studies that focus on the evaluation of sustainable urban layers from the design element layer to the target layer [3]. A large number of studies have emphasized the need to establish multi-level and multi-element evaluation guidelines based on certain evaluation guidelines [4], and to adopt different urban evaluation guidelines for different types of cities, among which urban environment, as an important part of urban hard environment quality evaluation, is directly related to the quality of habitat [5]. At present, the study of urban habitat impact factors has become the core of urban governance research [6-8], and the urban environment research under the independent module is mainly combined with urban economic development to analyze the interactive impact and spatial spillover effect of both sides, and the concept of regional synergy is emphasized [9], while the field of ecological compensation has been expanded in urban ecology research [10], which indicates that urban environment is becoming an increasingly This indicates that urban environment is becoming an important research subject.

Traditional urban governance studies focus more on the habitat environment and often involve the environmental part as a sub-part in the overall habitat quality analysis, thus failing to make a more detailed discussion and analysis of the influencing factors of changes in these sub-part. Ecosystem services value refers to the benefits that humans obtain from the ecosystem in a direct or indirect way in order to survive or improve the quality of life, and the quantitative assessment of the value is important for maintaining regional ecological security and promoting the coordinated development of regional economy and environment [11], by studying the positive or negative service functions provided by land as a spatial carrier, the different utilization intensity states shaped by different land use methods By studying the impact of different land use methods on the overall coordination and balance of service functions and economic growth [12], the effectiveness and ecological potential of urban ecological construction can be effectively presented. This paper aims to introduce the advantages of the spatial Durbin model in the study of spatial interactions into the study, and to clarify the influence of the intrinsic factor action mechanism on urban environmental management initiatives from a regional linkage perspective. It also integrates carbon neutrality and carbon peaking targets with the effectiveness of urban environmental management, and incorporates the effectiveness of plant carbon sequestration and CO2 emissions into the overall research analysis.

2. Study Design

2.1. Selection of Indicators

The research sample of this paper is sixteen districts in Beijing, and the time periods are 2010, 2013, 2015 and 2018 in total. The land use data and other economic data are obtained from the Beijing Statistical Yearbook and the Beijing Regional Statistical Yearbook.

Table 1. Variable Selection

Variable type	**Variable code**	**Variable name**	**Unit**
Dependent variable	ESV	Ecosystem service value	Yuan/hm2
Independent variable	CSP	Carbon sequestration of terrestrial plants	Ton
	I	Environmental Investment	Billion
	Energy	Energy consumption reduction rate of 10,000 Yuan	%
	Greening rate	Forest greening rate	%
	GDR	Garbage disposal rate	%
	GDC	Garbage disposal capacity	Ton
	PM2.5	Fine particulate matter	μg/m3

As shown in Table 1, ecosystem services value is the benefit that human beings obtain from the ecosystem in a direct or indirect way in order to survive or improve the quality of life, and the magnitude of its benefit directly reflects the ecological civilization of a region. The amount of carbon sequestered by terrestrial ecosystems is the amount of carbon dioxide fixed by plants through photosynthesis, which together with carbon dioxide emission reflects the effectiveness of urban vegetation environment and atmospheric control. The energy consumption reduction rate reflects the overall reduction rate of production energy consumption. The forest greening rate reflects the proportion of urban forest. PM2.5 reflects the quality of air environment.

2.2. Model Design

This paper combines the research methodology established by Xie Heights (2015) and others based on Costanza (1997) and improved with the ecosystem and socioeconomic conditions in China and refers to existing studies. The net profit of food production per unit area of farmland ecosystem was calculated as the ecosystem services value with one standard equivalent factor based on 2010 data, and ecosystem services value with one standard equivalent factor (Yuan/hm2) was obtained as 3406.5 Yuan/hm2, and the ratio of grain production per unit area in the study area to grain production per unit area nationwide was used to determine the correction factor for Beijing. A more mature method was used to determine the correction factor for Beijing. Equation (1), f is the grain yield per unit area in Beijing, and F is the national grain yield for the same period, to calculate the correction factor of 1.034 for Beijing. The base table was derived from the table of equivalence factors of terrestrial ecosystems and land use area in China. The basic geographic data were obtained from the Resource and Environmental Science and Data Center of the Chinese Academy of Sciences, and the agricultural economic data were obtained from the China Statistical Yearbook and the National Compilation of Cost and Benefit Information of Agricultural Products.

At the same time, in order to eliminate the impact of price changes, the consumer price index for food in the relevant years in Beijing, Tianjin and Hebei Province was introduced to unify the price levels, calculated as follows.

$$W_{ij} = \frac{1}{7} \times P_{ij} \times Q_{ij}, i = 1,2,3; j = 1,2,3,4 \quad (1)$$

In Eq. (1), W_{ij} denotes the economic value quantity of 1 standard equivalent factor (yuan/hm2) in different years in each province and city; $i = 1,2,3$ denotes Beijing, Tianjin and Hebei Province, respectively; $j = 1,2,3,4$ denotes 2010, 2013, 2015 and 2018, respectively; P_{ij} is the average price of grain in different years in each province and city after unified price; Q_{ij} denotes the unit area yield (kg/hm2) in different years in each province and city

$$ESV = \sum_{k=1}^{4} (S_k \times UESV_k) \quad (2)$$

$$\overline{ESV_{pj}} = \frac{ESVpj}{S_{pj}}, p = 1,2,...43 \quad (3)$$

$$R = \frac{\overline{ESV_{p(j+1)}} - \overline{ESV_{pj}}}{\overline{ESV_{pj}}} \times 100\% \quad (4)$$

In Eqs.2, ESV is the ecosystem service value; A_K is the area of land use type K; VC_K is the coefficient of ecosystem service value of land use type K; ESV_N is the Nth service function ecosystem service value; In Eqs.3, VC_{Nk} is the Nth service function value coefficient of land use type K. The results are shown in Table 2.

Table 2. The economic value of 1 standard equivalent factor of Beijing

	2010	**2013**	**2015**	**2018**
Beijing	1518.08	2219.70	2016.83	2097.80

The spatial weight matrix describes the neighboring relationship between a region and other regions whose proximity has an impact on the degree of mutual influence of variables. The spatial weight matrix W is a normalized 16×16 (0-1) geographic adjacency matrix, i.e., 1 for the existence of bordering two regions and 0 for the opposite. its matrix elements are as follows.

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$$W_{ab} = f(x) = \begin{cases} 1, & \text{a is adjacent to b} \\ 0, & \text{a is not adjacent to b} \end{cases} \quad (5)$$

The four time points are based on the 12th Five-Year Plan of Beijing, and the interaction of the 12th Five-Year Plan with the two systems of urban environment and ecological changes in Beijing is analyzed through the pre-implementation, pre-implementation, mid-implementation, and new periods of the plan. In terms of policy orientation, the 2011 Beijing Environmental Protection and Construction Plan for the 12th Five-Year Plan began to require the implementation of environmental protection measures in nine aspects of the urban environment, and to investigate various pollution treatments. By observing three times before, during and after the implementation of the relevant policies, the impact of policy-oriented urban environmental governance on the ecosystem service value in Beijing can be analyzed.

The difference between spatial econometric models and general econometric models lies in the introduction of spatial effects, the former emphasizing regional variability and regional dependence of the cross-sectional dimension of the data compared with the latter, and conducting sequential analysis in each temporal and spatial dimension, which mainly includes spatial Durbin model, spatial autoregressive model, and spatial error model.

$$Y_{it} = \delta W Y_{it} + \alpha X_{it} + \mu W X_{it} + \varepsilon_{it} \quad (6)$$

$$\varepsilon_{it} = \theta W \varepsilon_{it} + \varphi_{it} \quad (7)$$

In Eqs. (13) and (14), Y_{it} is the explained variable in the spatial econometric model, which denotes the ESV of city (district) i in year t; X_{it} is the explanatory variable, W is the spatial weight matrix based on the distance function, α is the regression coefficient of the explanatory variable, μ is the spatial spillover coefficient, ε_{it} is the random error term, φ_{it} is the random error term of normal distribution, θ is the spatial autocorrelation coefficient. WY_{it} is the cross product term of the spatial weights and the explanatory variables, WX_{it} is the cross product term of the spatial weights and the explanatory variables, and Wε_it is the cross product term of the spatial weights and the random error term.

Where Eq. 1 is the SDM model when $\theta = 0$ and neither δ nor μ is zero; Eq. 1 is the SAR model when $\delta \neq 0$ and $\mu = 0$; and Eq. 1 is the SEM model when $\theta \neq 0$ and $\delta = 0$.

As shown in Table 3, the model passed the 5% and 1% significance levels in the LR test and Wald test, respectively, proving that the SDM model does not degenerate into the SAR model and SEM model. the Hausman test passed the 10% significance level test.

Table 3. Results of LR test, Wald test and Hausman test

LR Test	Wald Test	Hausman test
Likelihood ratio test LR chi2(6) =16.14 Prob > chi2 = 0.02 (Assumption: SAR is nested in SDM) Likelihood ratio test LR chi2(6) = 15.97 Prob > chi2 = 0.02 (Assumption: SEM is nested in SDM)	chi2(7) =18.85 Prob > chi2 = 0.00	chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)=13.06 Prob>chi2 =0.07

3. Analysis of Regression Results

In this paper, based on the stata15.0 econometric software and referring to the processing methods of Zhonglin Bai [13] and Yujun Lian [14] on panel data, the SDM model was used to analyze the drivers of dui ecosystem service value change. Variables with significantly large coefficient interpretations that were influenced by the magnitude were logarithmized. The results are shown in Table 4, and in Table 5 and create a panel regression model to form a control.

Table 4. Regression results of SDM model

Variables	Main	Wx	Spatial	Variance	LR_Direct	LR_Indirect	LR_Total
Ln_ CRP	-4.620***	-3.777			-4.458***	-0.835	-5.294**
P	-0.0002	-0.216			-0.0014	-0.709	-0.0141
Ln_ Energy	-0.0224	-1.341**			0.137	-0.987**	-0.850*

P	-0.9	-0.0139			-0.415	-0.013	-0.0545
Ln_ I	-0.288*	-1.446***			-0.119	-0.951***	-1.069***
P	-0.051	-0.0003			-0.393	-0.001	-0.0018
Ln_ GR	5.097***	10.10**			4.219**	5.256*	9.475***
P	-0.0072	-0.0136			-0.0218	-0.0657	-0.0048
Ln_ GDR	-8.092***	-32.26***			-4.703*	-20.43***	-25.13***
P	-0.0067	-0.0001			-0.0878	-0.0014	-0.0007
Ln_ GDC	0.693	3.959***			0.248	2.624***	2.872***
P	-0.149	-0.0022			-0.594	-0.0053	-0.004
Ln_PM2.5	-5.115***	-1.652			-5.277***	1.079	-4.199
P	-0.0012	-0.625			-0.0027	-0.663	-0.121
rho			-0.580***				
P			-0.0043				
sigma2_e				0.136***			
Observations	64						
R-squared	0.047						
Number	16						

Note: Note: P is the p-values. *** p<0.01, ** p<0.05, * p<0.1

Table 5. Panel regression results

Variables	**Panel regression**
Ln_ CRP	-2.668*
P	(-1.92)
Ln_Energy	0.318
P	(1.57)
Ln_I	0.156
P	(1.07)
Ln_GR	2.469
P	(1.11)
Ln_GDR	-1.052
P	(-0.31)
Ln_GDC	-0.103
P	(-0.19)
Ln_PM2.5	-0.969*
P	(-1.93)
Constant	1.773
P	(0.15)

Observations	64
Number of code	16
R-squared	0.284
Company FE	YES
Year FE	YES

Note: Note: P is the p-values. *** p<0.01, ** p<0.05, * p<0.1

In the table 4, the estimated value of spatial autocorrelation coefficient is -0.58, and its estimated value passes the 1% significance level test, indicating that the effectiveness of urban governance within a single region will significantly radiate outward and inhibit the enhancement of ecosystem service value in the surrounding neighboring regions, reflecting that the urban governance measures of each region are more limited to the development perspective of the region rather than based on the perspective of synergistic development.

Based on the SDM model, the direct effect represents the average impact of the variable on the local ESV, while the indirect effect represents the average impact of the variable on the ESV of the neighboring areas.

A panel regression model was developed to compare the results of the panel model with the direct coefficients of the SDM model, and the positive and negative coefficients were highly consistent, i.e., the results of the panel regression model were more specific to the impact of urban environmental management measures on ESV in the region. However, the difference lies in that the SDM model expands the influence of treatment measures in neighboring areas on the change of ESV in the region, and introduces a spatial perspective into the overall analysis, thus providing a clearer understanding of the cross-regional influence of the influencing factors. Taking the effect of the total amount of garbage disposal capacity on ESV as an example, in the analysis of panel regression, the larger the amount of environmentally sound waste disposal, the greater the inhibitory effect on the value of local ecological services, but after decomposing its direct and indirect effects in the spatial Durbin model, the effect on the ecological environment of the region and neighboring regions is positive, and the overall effect is instead positive, and the positive effect is mainly provided by the neighboring regions.

The coefficients were classified by the coefficient characteristics of the imputed variables into those with enhancing and suppressing effects for the region and those with enhancing and suppressing effects for the neighboring regions. The core elements that influence the change in the value of ecological services in the region are Carbon sequestration of terrestrial plants, Forest greening rate, Garbage disposal rate, and PM2.5 values. The coefficient of Carbon sequestration of terrestrial plants is -4.458, i.e., an increase in Carbon sequestration of terrestrial plants leads to a decrease of 4.458 units of ecological coordination in the region, which needs to be analyzed together with environmental investment and forest greening rate. The overall effect of environmental investment on ESV is negative, combined with the basic fact that urbanization is expanding rapidly and a large number of native forests are being replaced. These deciduous broadleaf forests, which have just been planted, have a short-term impact on carbon fixation and sequestration, i.e., decay and decomposition within a short period of time, and the stored carbon is released back into the atmosphere [15], which causes forest greening to inevitably have two opposite effects, one positive effect from maintaining soil and water productivity, and the other a decrease in ESV from carbon loss. The negative effect of Garbage disposal rate can be attributed to the fact that the treatment technology and landfill technology are still backward and the overall quality of the treatment is low, resulting in the land still being affected by pollution, thus reducing the ESV.

The main variables that enhance and inhibit the effect for neighboring areas are Energy, Environmental Investment. The increase of urban forest greening rate and Garbage disposal capacity increases the ecosystem service value of the neighboring areas. In contrast, the expansion of waste disposal increases the ecosystem service value of neighboring areas. Combined with the negative effect of waste disposal on the environmental impact of the region, it can be judged that each region retains its own disposed waste rather than transferring pollution costs to neighboring regions.

4. Policy Recommendations

Based on the above research analysis, it can be concluded that ① urban governance and environmental construction in Beijing have achieved a relatively good coordination and interaction, and the governance results are good. ② The urban governance policies in various regions of Beijing still have shortcomings, among which blind expansion and lack of overall development perspective are the two main problems. Blind expansion has brought about the crowding out of a large number of native plants that can improve ESV, and environmental policies lack a coordinated big-picture perspective for formulation.

Based on this conclusion, local governments should (1) formulate policies based on integrated thinking, both integrated planning and their own positioning on various development and environmental issues, realize functional collaboration among different regions, and clarify their sense of responsibility in the overall ecological construction; (2) continuously promote the transformation of development models, focus on urban environmental enhancement driven by development model transformation, and formulate coordinated environmental policies [16].

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