

# Research on the Efficiency Evaluation of Economy-Society-Ecology Coordinated Governance in the Beijing-Tianjin-Hebei Region

Dan Wu<sup>1</sup> Mengyao Liu<sup>2</sup>

<sup>1,2</sup> School of Economics and Management, North China University of Technology, Beijing 100144, China

<sup>1</sup>Corresponding author. Email: wudan@ncut.edu.cn

## ABSTRACT

An efficiency evaluation index system for economy-society-ecology coordinated governance is constructed based on the economic, social, and ecological governance needs in the Beijing-Tianjin-Hebei region. A model for the efficiency evaluation of economy-society-ecology coordinated governance in the Beijing-Tianjin-Hebei region is constructed by using the ideal solution model and the coupling coordination degree model. The efficiency of economy-society-ecology coordinated governance in the Beijing-Tianjin-Hebei region is comprehensively evaluated on the basis of evaluating the level of economic, social, and ecological governance. Research shows that from 2017 to 2021, the urban economy and ecological governance level in the Beijing-Tianjin-Hebei region shows an upward trend, with a relatively fast growth rate; however, the level of urban social governance shows a slight fluctuation and an overall growth trend. Finally, based on the evaluation conclusion, the authors propose countermeasures and suggestions for improving the efficiency of economy-society-ecology coordinated governance in the Beijing-Tianjin-Hebei region.

**Keywords:** *Beijing-Tianjin-Hebei region, Governance, Coordination, Efficiency, Evaluation.*

## 1. INTRODUCTION

The Beijing-Tianjin-Hebei region is a growth pole and an important spatial carrier for promoting economic development in the region. The United Nations has proposed 17 goals and 169 sub goals in the areas of economy, society, and ecological environment to achieve the global sustainable development goals in the "2015 Development Agenda". Therefore, from the three dimensions of economy, society, and ecology, efforts should be made to improve the level of economic, social, and ecological governance in the Beijing-Tianjin-Hebei region, as well as the efficiency of economy-society-ecology coordinated governance, which are of great significance for accelerating the high-quality development of the Beijing-Tianjin-Hebei region.

According to literature review, the efficiency evaluation of regional economy-society-ecology coordinated governance has gradually become a research hotspot. In terms of feature analysis, Wang Jinying et al. [1] explored the spatiotemporal

differentiation characteristics of the level of new urbanization in 13 cities in the Beijing-Tianjin-Hebei region; Lu Jitong [2] used entropy weight assignment method and coupling coordination degree model to analyze the comprehensive development level, coordination relationship, and evolutionary characteristics of economy, technology, population, and land in the Beijing-Tianjin-Hebei region from 2005 to 2015. In terms of designing evaluation index systems, scholars mainly construct a coordinated evaluation index system from the three dimensions of economy, society, and ecology. Xu et al. [3-4] regarded economic development and ecological environment protection as a whole and constructed a low-carbon city evaluation index system based on the low-carbon concept; Wang Huizhi [5] constructed an evaluation index for the coordination between the economy, society, and ecological environment in the Beijing-Tianjin-Hebei region from eight aspects: economic growth, population development, spatial development, social benefits, resource transformation, ecological status, ecological

environment pressure, and ecological environment protection; Jiang Yue et al. [6] constructed a comprehensive evaluation index system for the economic development level, social stability, and ecological environment quality of the Loess Plateau region from eight aspects: economic foundation, economic quality and efficiency, medical resources, educational resources, social services, ecological resources, ecological pressure, and ecological response; Gao Yan et al. [7] combined the characteristics of ecology, economy, and social development to construct an economic, social, and ecological evaluation index system for Qilian Mountain National Park. In terms of evaluation methods research, scholars often use evaluation methods such as principal component analysis [8], system analysis [9], analytic hierarchy process [10], entropy method [11], grey theory model [12], and fuzzy classification evaluation to measure the coordinated development efficiency of regional economy, society, and ecology.

In summary, based on the reference of existing evaluation index and methods for regional economy-society-ecology coordinated governance, there is a necessity to construct a comprehensive efficiency evaluation system of economy-society-ecology coordinated governance in the Beijing-Tianjin-Hebei region to evaluate the level of economic, social, and ecological governance in the region, and comprehensively evaluate the efficiency of economy-society-ecology coordinated governance, solve the problems in the practice of economic, social, and ecological governance, as well as promote high-quality development in the Beijing-Tianjin-Hebei region.

## 2. RESEARCH METHODS

### 2.1 *Design of Evaluation Index System*

The coordinated governance of the economy-society-ecology in the Beijing-Tianjin-Hebei region involves three aspects: high-quality economic development, social security, and ecological comfort and livability. The efficiency evaluation of economy-society-ecology coordinated governance in the Beijing-Tianjin-Hebei region is a comprehensive efficiency evaluation of economy-society-ecology coordinated governance based on the evaluation of the governance level in the three dimensions of economy, society, and ecology in the region. To this end, an evaluation index of economy-society-ecology coordinated governance efficiency in the Beijing-Tianjin-Hebei region is

constructed around three dimensions: high-quality economic development, social security, and ecological comfort and livability. Meanwhile, the researchers can construct evaluation index for high-quality economic development from three aspects: economic growth, economic structure, and technological innovation driven. In the selection of measurement indicators, the per capita GDP and per capita disposable income are used to measure economic growth; the proportion of output value of the tertiary industry to GDP and the upgrading of industrial structure are selected to measure the economic structure situation; the number of patent authorizations and the proportion of scientific and technological expenditures are chosen to measure the driving force of technological innovation.

The researchers can also construct social security evaluation index from three aspects: urban life, social security, and public services, targeting the dimension of social security. In the selection of measurement indicators, the natural growth rate of permanent population, population density, year-on-year increase or decrease in consumer price index, urban household electricity consumption, and household water consumption are used to measure the current state of urban life; urban registered unemployment rate and the number of urban employees participating in basic pension insurance are selected to measure the social security situation; highway passenger volume, urbanization rate, and hospital beds per 10,000 people are chosen to measure the public service situation.

The researchers can construct ecological comfort and livability evaluation index from three aspects: ecological resources, ecological environment, and ecological governance, targeting the dimension of ecological comfort and livability. In the selection of measurement indicators, the ecological resource status is measured using energy consumption per 10,000 yuan of GDP and per capita water resources; the ecological environment status is evaluated using industrial wastewater discharge, annual average concentration of inhalable particulate matter, and urban green space area; The ecological governance situation is measured by the comprehensive utilization rate of general industrial solid waste, the proportion of days with air quality reaching level 2 or above to the whole year, and the green coverage rate of built-up areas.

In summary, the evaluation index system of economy-society-ecology coordinated governance

efficiency in the Beijing-Tianjin-Hebei region is shown in "Table 1".

Table 1. Evaluation index system for economy-society-ecology coordinated governance efficiency in the Beijing-Tianjin-Hebei region

Dimension	Indicators		Affiliation
	First-level indicator	Second-level indicator	
High-quality economic development	Economic growth	per capital GDP	yuan/person
		Disposable income per capita	yuan
	Economic structure	The output value of the tertiary industry as a proportion of GDP	%
		Industrial structure being advanced	%
	Innovation output	Number of patents granted	Piece
	Innovation input	Proportion of expenditure on science and technology	%
Social security guarantee	City life	Natural growth rate of permanent resident population	%
		Population density	Number of people/km <sup>2</sup>
		Year-on-year increase and decrease in consumer price index	%
	Social security	Urban residential electricity consumption	Ten thousand kilowatt-hours
		Residential household water consumption	Ton
	Social insurance	Urban registered unemployment rate	%
		Number of participants in basic old-age insurance for urban workers	Person
	Public service	Highway passenger volume	10,000 people
		Urbanization rate	%
		Number of hospital beds per 10,000 people	piece
Ecological comfort and livability	Ecological resources	Energy consumption per 10,000 yuan of GDP	Tons of standard coal/10,000 yuan
		Water resources per capita	m <sup>3</sup> /person
		Industrial wastewater discharge	m <sup>3</sup> /person
	Ecological environment	Average annual concentration of inhalable particulate matter	μg/m <sup>3</sup>
		Urban green space area	hectare
	Ecological governance	Comprehensive utilization rate of general industrial solid waste	%
		Harmless treatment rate of household waste	%
		The proportion of days with air quality reaching level 2 or above in the whole year	%
	Green coverage rate in built-up areas	%	

## 2.2 Evaluation Model Construction

Based on the evaluation index system of economy-society-ecology coordinated governance efficiency in the Beijing-Tianjin-Hebei region, a corresponding evaluation model is constructed. Based on the evaluation of the governance level in the economic, social, and ecological dimensions of the Beijing-Tianjin-Hebei region, a comprehensive evaluation of economy-society-ecology coordinated

governance efficiency is conducted. The specific steps are:

Step 1 is to standardize the evaluation index using the following formula:

$$\text{Positive indicator: } x'_{ijk}(t) = \frac{x_{ijk}(t) - x_{ij\min}}{x_{ij\max} - x_{ij\min}} \quad (1)$$

Negative indicator:  $x'_{ijk}(t) = \frac{x_{ij\max} - x_{ijk}(t)}{x_{ij\max} - x_{ij\min}} \quad (2)$

In equation (1) - equation (2):  $x_{ijk}(t)$  and  $x'_{ijk}(t)$  respectively represent the original values and standardized values of  $i$  city  $j$  dimension  $k$  indicator of the Beijing-Tianjin-Hebei region in the  $t$  period.  $x_{ij\max}$  and  $x_{ij\min}$  represent the maximum and minimum values of  $i$  city  $j$  dimension  $k$  indicator in the Beijing-Tianjin-Hebei region, respectively.

Step 2 is to use the hierarchical equal weight method and comprehensive weighting method to evaluate the governance level of the economic, social, and ecological dimensions in the Beijing-Tianjin-Hebei region. It can be expressed as:

$$A_{ij}(t) = \sum_{k=1}^K [x'_{ijk}(t) \cdot w_{ijk}] \quad (3)$$

In equation (3),  $A_{ij}(t)$  represents the governance level of the  $j$  dimension of  $i$  city in the Beijing-Tianjin-Hebei region during the  $t$  period ( $i = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13$  represents Beijing, Tianjin, Shijiazhuang, Tangshan, Qinhuangdao, Handan, Xingtai, Baoding, Zhangjiakou, Chengde, Cangzhou, Langfang, and Hengshui, respectively;  $j = 1, 2, 3$ , represents the dimensions of high-quality economic development, social security, and ecological comfort and livability, respectively);  $w_{ijk}$  is the weight value of the index in the  $j$  dimension of the  $i$  city in the Beijing-Tianjin-Hebei region.

Step 3 is to use a coupled coordination degree model to evaluate the economic social ecological coordinated governance efficiency in the Beijing-Tianjin-Hebei region, which can be expressed as:

$$D_i(t) = \sqrt{C_i(t) \cdot P_i(t)}$$

$$C_i(t) = \left[ \frac{\prod_{j=1}^3 A_{ij}(t)}{P_i(t)^3} \right]^{1/2} \quad (4)$$

$$P_i(t) = \frac{\sum_{j=1}^3 A_{ij}(t)}{3}$$

In equation (4),  $D_i(t)$  represents the economic social ecological coordinated governance efficiency of  $i$  city in the Beijing-Tianjin-Hebei region during the  $t$  period;  $C_i(t)$  is the degree of coupling between the economic, social, and ecological governance levels of  $i$  city in the Beijing-Tianjin-Hebei region during the  $t$  period;  $P_i(t)$  is the degree of coordination between the economic, social, and ecological governance levels of  $i$  city in the Beijing-Tianjin-Hebei region during the  $t$  period.

### 3. EMPIRICAL RESEARCH

#### 3.1 Data Sources

The ecological, economic, and social indicator data involved in the Beijing-Tianjin-Hebei region are all sourced from the 2017-2021 China Urban Statistical Yearbook, China Statistical Yearbook, and statistical yearbooks of various provinces and cities. A few missing data are replaced with similar years to ensure data integrity and accuracy.

#### 3.2 Analysis of Evaluation Results

Based on the evaluation index system and method of economy-society-ecology coordinated governance efficiency in the Beijing-Tianjin-Hebei region, the economic, social, and ecological governance levels and economy-society-ecology coordinated governance efficiency of each city in the region from 2017 to 2021 were calculated, as shown in "Figure 1", "Figure 2", "Figure 3", and "Figure 4".

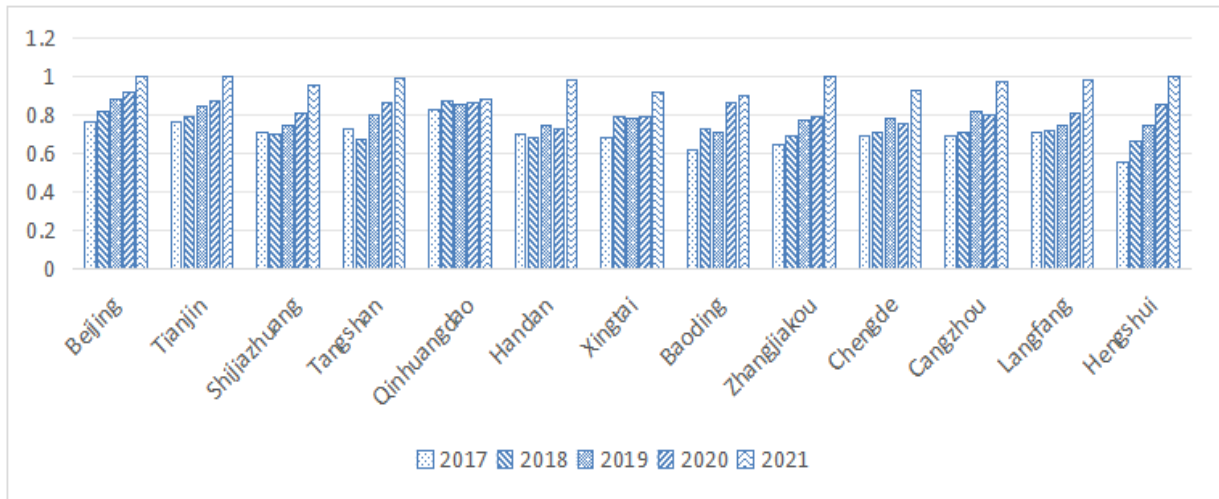


Figure 1 Economy governance efficiency in the Beijing-Tianjin-Hebei Region.

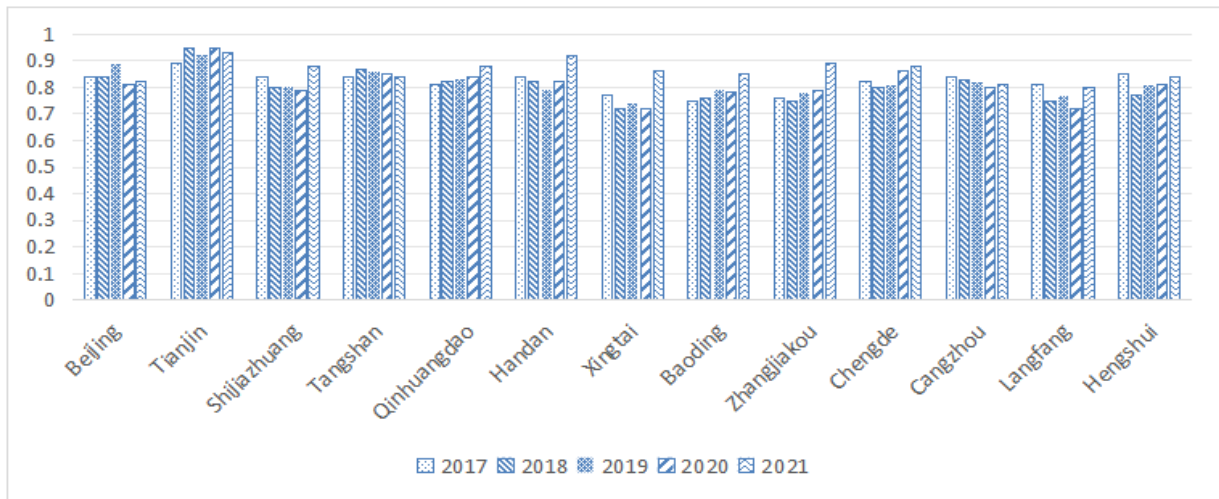


Figure 2 Society governance efficiency in the Beijing-Tianjin-Hebei Region.

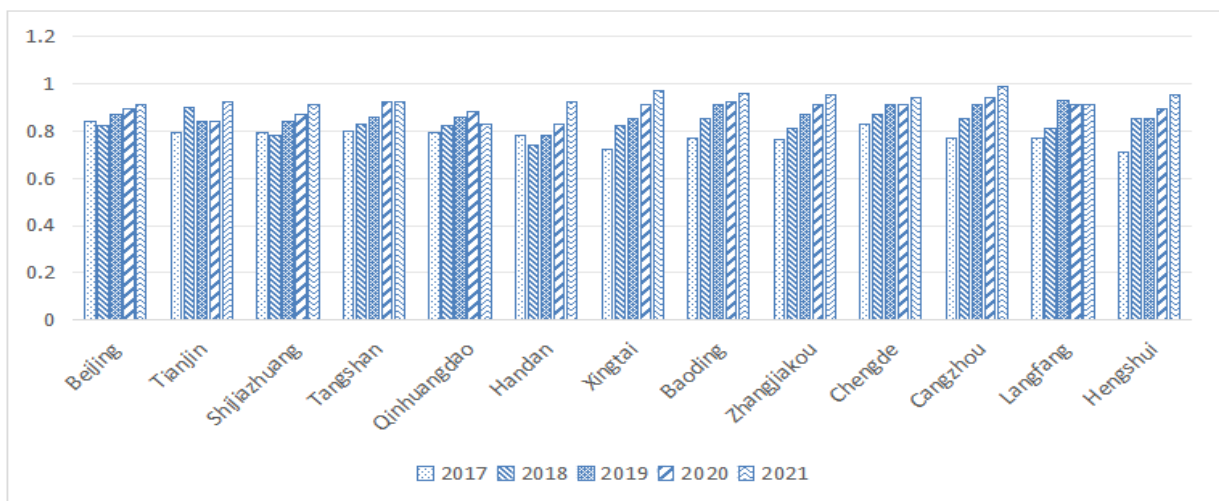


Figure 3 Ecology governance efficiency in the Beijing-Tianjin-Hebei Region.

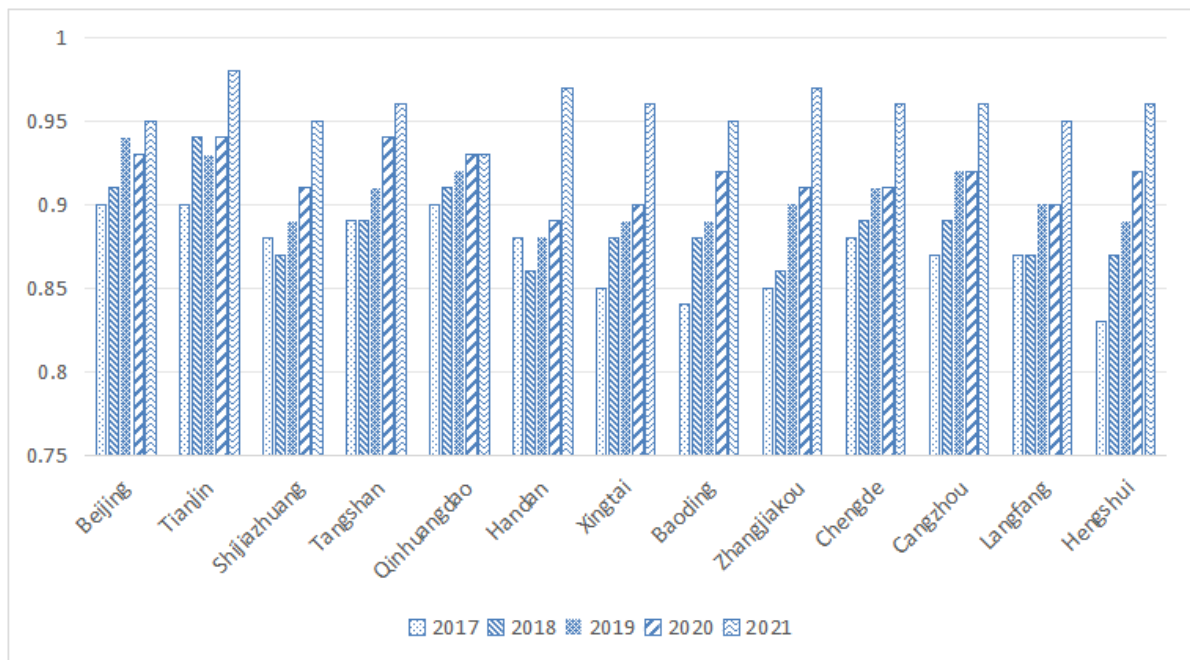


Figure 4 Coordinated governance efficiency in the Beijing-Tianjin-Hebei Region.

### 3.2.1 Efficiency of Economy-Society-Ecology Coordinated Governance

The hierarchical gap in the economy-society-ecology coordinated governance efficiency among cities in the Beijing-Tianjin-Hebei region has been reduced. In 2017, Beijing, Tianjin, and Qinhuangdao were at the first level, with a coordinated governance efficiency of 0.9; Shijiazhuang, Tangshan, Handan, Xingtai, Zhangjiakou, Chengde, Cangzhou, and Langfang were the second level, with a coordinated governance efficiency of 0.85 or above; The remaining cities were at the third level, with a coordinated governance efficiency of below 0.85. The coordinated governance efficiency of Hengshui was 0.83, and the coordinated governance efficiency of Baoding was 0.84.

### 3.2.2 High Quality Economic Development Level

According to the high-quality economic development level of various cities in the Beijing-Tianjin-Hebei region, from 2017 to 2021, only Handan, Tangshan, and Shijiazhuang experienced a slight decline in 2018, followed by slow growth, while other cities continued to grow. Among them, Baoding and Handan had the largest growth rates, with Baoding increasing from 0.62 in 2017 to 0.90 in 2021, and Handan increasing from 0.70 in 2017

to 0.98 in 2021, further narrowing the gap with Beijing and Tianjin.

### 3.2.3 Social Security Level

According to the social security level of various cities in the Beijing-Tianjin-Hebei region, it can be seen that from 2017 to 2021, each city showed a slight fluctuation, with little trend change. Tianjin had always been higher than other regions, with an average of 0.92; the average of Xingtai, Baoding, Zhangjiakou, and Langfang was below 0.8, indicating that there was an unequal distribution of social resources among cities in the Beijing-Tianjin-Hebei region in terms of social security.

### 3.2.4 Ecological Comfort and Livability Level

According to the ecological comfort and livability level of various cities in the Beijing-Tianjin-Hebei region, it can be seen that from 2017 to 2021, the trend of each city was improving, with a slight increase. Among them, Xingtai and Hengshui saw significant growth, with Xingtai increasing from 0.72 in 2017 to 0.97 in 2021, and Hengshui increasing from 0.71 in 2017 to 0.95 in 2021.

#### 4. CONCLUSION AND SUGGESTIONS

By designing an evaluation index system of economy-society-ecology coordinated governance efficiency in the Beijing-Tianjin-Hebei region, using the ideal solution model and coupling coordination degree model, the authors construct a model for evaluating the efficiency of economic social ecological coordinated governance in the Beijing-Tianjin-Hebei region, and carry out empirical research based on collected data from various cities in the Beijing-Tianjin-Hebei region. Research shows that from 2017 to 2021, the economic and ecological governance levels of various cities in the Beijing-Tianjin-Hebei region showed an upward trend, with a relatively fast growth rate; the level of social governance showed a slight fluctuation, but an overall growth trend. Based on research conclusions, countermeasures and suggestions have been proposed:

The first is to strengthen the agglomeration function of the central city. In the process of coordinated development in the Beijing-Tianjin-Hebei region, there is a necessity to fully utilize the agglomeration advantages of central cities to further consolidate and strengthen the status of regional central cities. The three major central cities of Beijing, Tianjin, and Shijiazhuang have significant advantages in both economic and political aspects. Beijing's advantages lie in high-end service and high-tech industries, Tianjin's advantages lie in modern manufacturing and one of the largest ports in the north, and Shijiazhuang's advantages lie in its relatively developed industrial foundation and convenient transportation conditions. On the one hand, the three major central cities, relying on their own advantages, have attracted a large number of high-quality production factor resources through agglomeration effects, resulting in sustained population agglomeration and continuously improving economic development levels; On the other hand, the agglomeration externalities of the three major central cities continue to strengthen, and the economic radiation effect on surrounding cities continues to strengthen, providing conditions for the development of small and medium-sized cities and towns in the Beijing-Tianjin-Hebei region. Therefore, it is necessary to continue to strengthen the core position of the three major central cities in the Beijing-Tianjin-Hebei region, and deepen the cooperation areas and scope between the central cities, new cities, and surrounding areas. At the level of central cities,

there is a must to fully utilize the good opportunities of cultivating national, regional, and node cities, leverage Beijing's technological and financial advantages, accelerate the optimization and upgrading of Tianjin's industries, and promote the high-quality development of Shijiazhuang's industry.

The second is to promote the efficient and free flow of factors in the Beijing-Tianjin-Hebei region. The Beijing-Tianjin-Hebei region is an important support for building a new development pattern with domestic circulation as the main body and domestic and international dual circulation promoting each other, which not only occupies a high value-added position in the domestic value chain, but also plays a role as an external hub in transportation, commerce, and other fields. It is also necessary to deepen the division of labor and cooperation in functional coordination, governance cooperation, and interest coordination in the Beijing-Tianjin-Hebei region, break down administrative boundaries, further strengthen inter-city cooperation in industries, transportation, ecology, and other fields, and innovate regional interest coordination mechanisms, to further promote the coordinated development of the Beijing-Tianjin-Hebei region.

The third is to actively promote the co construction and sharing of basic public services in the Beijing-Tianjin-Hebei region, and continuously narrow the development gap between cities within the region. The inter-city differences in basic public services are an important influencing factor leading to uneven industrial layout. Facing the future, basic public services, especially high-quality public services, are the decisive factor in the formation of urban competitiveness. Promoting the equalization of basic public services will be conducive to facilitate the relaxation of non-capital functions in Beijing, promote the balance of industrial layout, and also help to reduce differences between cities, reflecting the basic concept of "people-centered".

The fourth is to improve the ecological collaborative governance mechanism in the Beijing-Tianjin-Hebei region. It is a must to practice the concept that "green mountains and clear waters are invaluable assets", continue to increase efforts in ecological and environmental joint construction, prevention and control, and accelerate the overall positioning of ecological restoration and environmental improvement demonstration zones. At present, there are problems with ecological compensation in the Beijing-

Tianjin-Hebei region, such as a single form of compensation, unclear compensation standards, unclear main responsibilities, and weak willingness to compensate. It is necessary to accelerate the improvement of the long-term ecological compensation mechanism in the Beijing-Tianjin-Hebei region, broaden compensation channels, enhance the autonomous development capacity of the compensated areas, and achieve sustainable economic and social development. At the same time, it is also necessary to reasonably define the property rights of natural resources and clarify the interests of various stakeholders in ecological protection, improve the ecological compensation standard system and establish a dynamic adjustment mechanism for compensation standards; there will be a necessity to intensify the promotion and education of ecological compensation, guide the public to actively participate in and supervise ecological compensation activities, form a good situation where all parties in the Beijing-Tianjin-Hebei region jointly participate in ecological environment governance, and promote the normal operation of ecological environment joint construction, prevention, and governance in the Beijing-Tianjin-Hebei region. There will also be a necessity to promote the collaborative legislation of environmental governance and ecological construction, as well as the preparation of regional ecological environment protection plans and related special plans, and explore the model of regional multi-party collaborative governance.

## ACKNOWLEDGMENTS

Fund projects: Supported By the Beijing Urban Governance Research Base of North China University of Technology (2023CSZL01); North China University of Technology National-level Project Supporting Special Project (110051360023XN217).

## REFERENCES

- [1] Wang Qingming, Urban Governance Transformation and Grassroots Power Restructuring: Taking the Reform of Shenyang Street Office as an Example [J]. *The Journal of Humanities*, 2015(08): 100-106. (in Chinese)
- [2] Wang Conghu, Qiao Weixing, Streamlining and Perfection of the “Stripe-Block Division” in Grassroots Governance — The “One Body with Two Wings” Mechanism of Beijing as an Example [J]. *Chinese Public Administration*, 2021(10): 49-56. (in Chinese)
- [3] Xu M, Chen C, Deng X. Systematic analysis of the coordination degree of China’s economy-ecological environment system and its influencing factor [J]. *Environmental science and pollution research*, 2019, 26(29): 29722-29735.
- [4] Yan N. Legal Guarantee of Smart City Pilot and Green and Low-Carbon Development [J]. *Journal of Environmental and Public Health*, 2022.
- [5] Wang Huizhi, Research on the Coordinated Development of Economic Society and the Eco-environment in Beijing-Tianjin-Hebei City Agglomeration [J]. *Economy and Management*, 2017, 31(05): 22-26. (in Chinese)
- [6] Jiang Yue, Hou Xianhui, Liu Guobin, etc., Research on Coordinated Development of Ecological-Economic-Social Coupling of Loess Plateau--Take Changwu County, Suide County, Shenmu City and Chunhua County as Examples [J]. *Bulletin of Soil and Water Conservation*, 2022, 42(04): 234-243. (in Chinese)
- [7] Gao Yan, Feng Qi, Li Zongxing, An assessment on the coordinated development of ecology, economy and society in Gansu section of Qilian Mountain National Park [J]. *Chinese Journal of Ecology*, 2022, 41(06): 1197-1204. (in Chinese)
- [8] Ruan Yuting, Xu Bin, Measurement and Evaluation of the Degree of Coordinated Development Between Urban and Rural Areas [J]. *Statistics & Decision*, 2017(19): 136-138. (in Chinese)
- [9] Wu Xinjing, Li Tongshan, A Study on the Spatial Agglomeration and Coupled Coordinated Development of Rural Population Economy Land under the Background of Rural Revitalization: A Case Study of Henan Province [J]. *Hubei Social Sciences*, 2019(06): 61-69. (in Chinese)
- [10] CHEN D R, LIU Y. Evaluation model of energy-economy-environment (3E) system coordinating degree: empirical analysis on China regionally [J]. *IOP Conference Series*:



Earth and Environmental Science, 2019,  
237(4): 042037.

- [11] YANG H R, YANG H L. Research on the coordinated development of energy-economy-environment (3E) system in Inner Mongolia [J]. International Journal of Education and Management, 2020, 5(1): 284-288.
- [12] Huang Renquan, Dong Juan, Research on Coupling Coordination Development of Economic Development, Technological Innovation and Ecological Environment in Shaanxi Province [J]. Operations Research and Management Science, 2022, 31(10): 161-168. (in Chinese)
- [13] Liu Qiong, Guo Junhua, The Coupling and Coordination Level and Obstacle Factors of Smart City Construction in China: Based on the Data of 15 Sub Provincial Cities [J]. Modern Urban Research, 2023(01): 83-88. (in Chinese)