Research and Assessment of the Impact of New Quality Productivity (NQP) on Land and Space Utilization in Chinese Hebei Province

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Abstract: Advanced production that is a strategic-driven process, emerging with the passage of time is called new quality productivity (NQP). It is an example of how the meaning of traditional productivity has evolved. The creation of NQP is advantageous for the preservation, development, use, and restoration of provincial land space under the significant strategic viewpoint of Beijing-Tianjin-Hebei integration in Hebei Province. It also expedites the development of a robust economic province and a stunning Hebei, embodying the principles of Chinese's president version of Socialism for the emerging era. This ensures strong writing and offers spatial assistance. Provide spatial support and guarantee on Hebei's Chinese-style modernization, this article builds a NQP indicator system for various prefectural cities in Hebei Province, then combines the NQP development level and other data with the PLUS model to simulate the land and space utilization scenario in Hebei Province in 2030. This study on the role of the development of NQP in the evolution of land use change found that the development of NQP is feasible and efficient for changes affecting land use in Hebei Province, and has a vital effect on the development of the overall land and space use pattern.

1. Introduction

The NQP is the core theme that Chinese government has been approaching that integrate with Marx theory based on the concrete development situation in China, and essential for sustainable development, Sinicization and modernization of Marxism. The proposal of NQP forces represents a new historical stage in the development of China's productive forces. It is in line with the historical law of continuous leapfrogging of the development of human historical development and productive forces from low to high, and also meets the historical needs of China in the context of the great changes in the world and the modernization drive. Hebei Province is an important part of the Beijing-Tianjin-Hebei city group. The study of the NQP is of positive implications to the development of Hebei Province's land use and predicting the changes in the development situation.

Research on the topic of NQP has a major effect on China's development. Zhang Sen, Wen Jun (2024)[1]made a judgment on the topic of NQP: "The NQP have a clear problem orientation, a practical orientation, and an effect orientation, and why promoting and developing the NQP is an urgent subject to study in the theoretical and business circles." However, various scholars in China have defined the concept and characteristics of the NQP differently: Du Chuanzhong *et al.* (2023)[2]believe that the development of the digital economy can effectively promote the development of the NQP, and is "making the NQP become a sustained intrinsic driving force for the promotion of high-quality economic development." Zhou Wen *et al.* (2023)[3]believe that the development of the NQP relies on the guidance of the Sinicization of Marxist political economics; Song Ziang *et al.* (2024)[4]believe that the key to the development of NQP lies in promoting scientific and technological innovation; Liao Xiaoming *et al.* (2024)[5]believe that "under the guidance of the goal of high-quality development, the development of NQP and the building of ecological civilization are intrinsically consistent." Wang Jue and Wang Rongji (2024)[6] believe that the study of the connotation and statistics of the NQP has not yet reached the level of development and passing through its early inception stages. Two core challenges that need to be addressed; first is that there is

little research on the critical features and rich connotations of NQP; and second there is no unified framework for existing research. Ding Shichao *et al.* (2024)[7] have that at present Chinese scholars on the NQP research mainly focus on qualitative research, less quantitative research, generally mainly for the theoretical basis of the development of the NQP, the construction and measurement of the NQP system and the analysis of the action path of the NQP.

This research contributes to the literature as it combines the analysis of NQP with land use change, which is a positive attempt to apply the theory of NQP. From the perspective of the NQP, this paper combines the measurement of the NQP with the change in land use in Hebei Province for research. The objectives are achieved by firstly defining the content of the NQP structure and constructs the NQP index evaluation system according to its scope. Second, according to the evaluation index system, the level of development of NQP in various prefectures of Hebei Province in 2010 and 2022 is evaluated using the entropy method. Third, using plaque to generate land use change simulation (PLUS) model combined with the level of development of NQP to predict the development of land in various prefectural cities in Hebei Province from the perspective of NQP. Finally, policy implications are derived from the analysis of the conclusions.

2. Study Design

2.1. The system of indicators of the development level of NQP is constructed

The construction of the NQP measurement system in this paper is mainly based on the three elements of workers, labor data and labor objects together to construct the indicator system. The NQP forces requires the laborers to be highly qualified knowledge-based workers, and more importantly, from the motivation of the laborers themselves, to create better wealth to realize value and contribute to social development. This paper will measure the factors of laborers from human resources, per capita income, employment philosophy, entrepreneurial activity. Among them, talent resources are limited by data availability, measured by the total number of employees of strategic emerging industries and future industry listed companies; The per capita income is measured by the average wage of the employed; The employment concept is measured using the tertiary sector employment weightings, using the methods of Wang Yu and Wang Wing Kee (2024) [6]; The concept of entrepreneurship is also measured by the approach of Wang Yu and Wang Rong-ki (2024)[6] using the entrepreneurial activity of the number of new enterprises in the year as compared to the total population (100 people).

The NQP require the target of labor to face the future, the constant development of the needs of the face-to-face era, and the development of better service NQP. This article will be from future industry, industrial rationalization, industrial advanced, infrastructure, Ecological protection to measure the target of labor element, in which future industries use the stock of AI enterprises to measure AI level; Infrastructure is measured by the number of Internet broadband access subscribers and the total volume of telecommunications services; Ecological protection refers to the selection of indicators of the strength of environmental protection by Wang Yu and Wang Rongji (2024) [6] and is measured by investment in environmental pollution control.

The NQP forces requires that labor materials meet the development needs of the times and reflect China's development strategy. This paper will measure labor data from energy consumption, digital level, scientific and technological innovation, in which the overall energy consumption ratio uses the total energy consumption ratio and carbon trading. Measurement of energy and emissions trading, in which the overall energy consumption ratio is based on the measurement method of Wang Jue and Wang Rongji (2024) [6]; Science and technology innovation is measured by the number of green patent applications.

Among the NQP systems constructed above, the data are derived from the Hebei Statistical Yearbook, Hebei Economic Yearbook, and China Urban Statistics Yearbook. Public data such as enterprise inspection, data on Chinese industrial and commercial enterprises, etc.

2.2. Overview of the study area and data preparation

This article focuses on Hebei Province (Figure 1).

Figure 1: Hebei Province

The capital of Hebei Province is located in Shijiazhuang. Hebei Province is strategically located, and it occupies Xiongan New Area, shouldering the heavy responsibility of carrying on the non-capital functions of Beijing, covering the entire Beijing-Tianjin-Hebei urban agglomeration. It also has abundant mineral resources, which provides a guarantee for the secondary industry to boost the economic growth of the whole province. Under the development potential brought about by the coordinated development of Beijing, Tianjin, and Hebei, and the planning and construction of Xiongan New Area, the economy is stable and good, which is an important economic pillar of the northern region. Hebei's economic development is dominated by the secondary and tertiary industries. The core industries of the region include Biomedicine Health, high-end equipment manufacturing, New Energy, information, intelligence, New Materials, Steel, and agriculture sector thus emerged as the eighth major sector.

The PLUS model[8]used in this paper is based on existing geo-cell automata (CA) models. Based on the availability and rationality of data, data are collected and loaded into the model, so as to better explore the causes of various land-use changes, and to better simulate multiple types of land-use plaque-level changes. Coupling with multi-target optimization algorithms can better support policies to achieve sustainability.

3. Research methods

The entropy method can avoid the drawbacks of subjective empowerment in the measurement of NQP level. The weight of each indicator is calculated through data. If the degree of dispersion is greater, the higher the weight is assigned. And this method can be used to calculate between the indicators of different scales, so the entropy method can be used to obtain a relatively objective measurement.

In this paper, based on the calculation of the NQP level of each prefecture-level city, the ArcGis divided the NQP level of each prefecture-level city into three types of elements and made three raster charts. The Land Expansion Analysis Strategy (LEAS) analysis in the PLUS model first captures the probability of development of various types of land and the contribution of each driver, and then uses the Markov chain to predict various types of land use data. and get data on projected land use in development scenarios, On this basis, the land use data of Hebei Province from 2010-2020, combined with the "Hebei Land and Space Plan (2021-2035)" of the Hebei Province land use data for 2030 of various prefectures of Hebei Province, CA based on Multiple Random Seeds (CARS) analysis, and using the land use data of Hebei Province from 2000 to 2010 to predict and compare the land use data for 2020 with the real situation to verify the correctness of the Kappa coefficient test land simulation results. The resulting land expansion projections for the provinces of Hebei Province by 2030 were

made.

Based on the directive of "Hebei Province Land and Space Planning (2021-2035)" ⓘ, this paper is formulated in conjunction with the perspective of NQP as the development scenario of "government land planning from the perspective of NQP", and revised the transfer matrix setting to predict the type of land use distribution in Hebei Province in 2030.

Kappa, for which the specific calculation formula of the coefficient is as follows. Where T_0 is to simulate the ratio of the grid to match, T_p to set the correct ratio to simulate in the environment, and to T_c simulate the correct ratio in the random state. The Kappa coefficient value is between 0 and 1, if the Kappa coefficient is between 0.8 and 1, the model simulation accuracy is high; Between 0.6 and 0.8, the model simulation accuracy is high; Between 0.4 and 0.6, the model simulation accuracy is medium; Between 0.2 and 0.4, the model simulation accuracy is poor; Between 0 and 0.2, the model simulation accuracy is low.

$$Kappa = \frac{T_0 - T_c}{T_p - T_c} \tag{1}$$

4. Findings and Analysis

4.1. NQP level measurement

Based on the data collection and calculation steps above, the NQP level of 2010-2022, first calculated for various prefectural cities in Hebei Province, is shown in Table 1.

Table 1 NQP level from 2010 to 2022

Region	2010	2013	2016	2019	2022	Mean
Mean	1.1691	1.2424	1.3500	1.4763	1.5497	1.3575
Shijiazhuang	1.3214	1.4402	1.5463	1.7461	1.8856	1.5879
Tangshan	1.1979	1.2631	1.3595	1.4864	1.5175	1.3649
Qinhuangdao	1.1970	1.2551	1.3634	1.4551	1.4703	1.3482
Handan	1.1361	1.1941	1.3412	1.3832	1.4546	1.3019
Xingtai	1.1044	1.1851	1.2898	1.3969	1.4785	1.2910
Guaranteed	1.1738	1.2563	1.3881	1.5183	1.6845	1.4042
Zhangjiakou	1.1474	1.2251	1.3287	1.4285	1.4827	1.3225
Zen	1.1372	1.1966	1.2657	1.4045	1.4615	1.2931
Cangzhou	1.1635	1.2135	1.3015	1.4733	1.5094	1.3322
Langfang	1.1519	1.2370	1.3678	1.5091	1.6107	1.3753
Water	1.1297	1.1999	1.2977	1.4373	1.4912	1.3112

4.2 LEAS-based study of land expansion in Hebei Province

This paper will introduce the 2020 level of NQP workers, labor data and labor objects in Hebei province's prefectural cities into the raster map of Hebei province as a projection, based on the LEAS model (default parameter) to study the influence of various drivers on the various development changes in the region, proportion and extent of influence.

As shown Table 2, through the LEAS model (default parameter) study found: Hebei arable land, the area of grassland decreased between 2010 and 2020, while woodland, water, shoals, there has been an increase in land for construction and unused land. Among them, the overall contribution of labor factors in the process of the degradation of arable land ranks fourth, and the socio-economic factors rank second, showing a clear spatial association with it; In the growth of forested land area, the total contribution of the labor target factor is fourth and the socio-economic factor is second, with clear spatial correlation; The overall contribution of factors of NQP is middle in the degradation of grassland area and third in socio-economic factors, showing a more pronounced spatial correlation; In the increase of the area of water area, the total contribution of the working target factors ranked third and the socio-economic factors ranked first, showing a clear spatial correlation; In the growth

of wetland area, the total contribution of the working target factor is the first, the social and economic factor is the fourth, and the socio-economic factor is the second, with obvious spatial correlation; In the growth of the area of construction land, the contribution of the working target is ranked seventh overall, the socio-economic factors are third, showing a medium spatial correlation; In the growth of unutilized land area, the contribution of the labor-object factor is ranked sixth overall and the socio-economic factors fourth, showing a low spatial correlation.

Table 2 Changes in the number of lands lots of various types of land, 2010 and 2020 (units: Units)

Type of land	Arable land	Forest land	Grass	Water	Beach	Land for construction	Unutilized
2010	9319994	3719268	3275754	278728	91825	1923545	127670
2020	9027827	3744121	3240461	373574	102982	2110357	137462

The above data show that the NQP factors can be related to the distribution of land use development, to a certain extent the feasibility of promoting changes in land use development through the development of NQP, and the predictability of land use development planning from the perspective of NQP. On the whole, the development of NQP has had a clear effect on promoting changes in the land use of Hebei Province.

4.3 Land Use Forecast for Hebei Province 2030 based on CARS

The calculated Kappa coefficient value is 0.86778> 0.85, indicating a high confidence level in using the PLUS model in this scenario. After completing the confidence evidence, this article uses Markov Chain (the default parameter) to predict changes in land use in 2030 for all types of land based on the 2010 and 2020 Hebei Province land use data to correct the conversion probability according to the specified development scenario (Table 3). According to the requirements of the development scenario of "government land planning from the perspective of NQP", it is assumed that through the development of NQP, the conversion rate of arable land to construction land will be set to promote -30%, forest land. The conversion rate from grassland to cropland +30% is used to protect cultivated land and the number of permanent basic farmland; the conversion rate of construction land to cultivated land, woodland and grassland -30% is used to prevent urban sprawl and improve ecology; To improve the efficiency of land use by converting farmland, woodland, grassland, construction land to unused land - 60%.In addition, Arable land shall not be converted to Water bodies, Beach, Land for construction and Unutilized; Forest land and Beach shall not be converted into Land for construction and Unutilized; Grass shall not be converted to Water bodies and Unutilized; Water bodies can only be converted to Beach and Land for construction; Land for construction can only be converted to Land for construction and Unutilized.

In particular, neighborhood weights are calculated by reference to Wang Baosheng et al. (2019)[9], which determines neighborhood weights based on the normalized value assignment of land expansion in the previous phase. Where,W_i represents the class i land type field weight,TA_i represents the class i land use expansion area,TA_{min} represents the minimum expansion area of the various types of land use, TA_{max}Indicates the maximum area of expansion for each type of land use. The specific formula is as follows:

$$W_i = \frac{TA_i - TA_{min}}{TA_{max} - TA_{min}} \qquad (2)$$

Table 3. The weight of the adjacent areas of land types

	Arable land	Forest land	Grass	Water	Beach	Land for construction	Unutilized
Modified Neighbor Weight	0.99	0.024537652	0.4433628	0.616683	0.049839	0.8384763	0.01

Modelled projections of land use data in Hebei Province for 2030 based on the parameter variables set above, as shown in Figure 2:
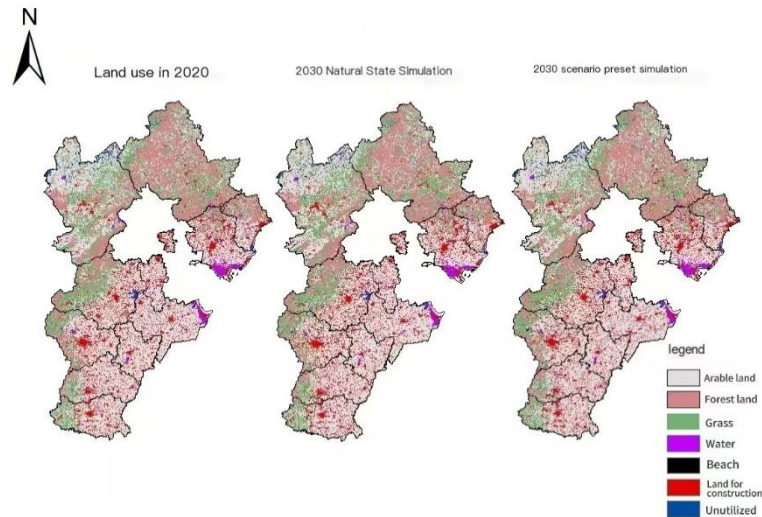
Figure 2: Comparison of land use in Hebei Province

The study found that in the natural state of Hebei Province's land use situation in 2030, arable land area decreased by about 2.8% compared with 2020, and forested area decreased by 0.5% compared with 2020. (a) A reduction of about 1 per cent in grassland area compared to 2020; At the same time, the area of water areas increased by about 21.5%, the area of shoals increased by about 10.3%, the area of construction land increased by about 7.5%, and the area of unused land increased by about 7.6%. From the land use map, there is a relatively obvious spread of the construction land in Tangshan, the construction land in Xingtai City and Handan City show a trend of concentration, and the construction land in Shijiazhuang City has expanded around the concentrated area. The amount of arable land occupied by construction land in Baoding and the south of Hebei Province has increased significantly. The land use situation of Hebei Province in 2030 under the scenario would only decrease by about 1.5% compared to 2020 cultivated area, forest area by only about 0.2%, grassland area by about 1.9%, and water area by about 22.1%. The area of shoals increased by about 10.7%, the area of land for construction decreased by about 5.3%, and the area of unused land achieved negative growth. About 3%. The "Hebei Province Land and Space Plan (2021-2035)" has initially achieved the planning tasks of protecting farmland, improving ecology, limiting urban sprawl and increasing land utilization; The distribution of large tracts of arable land and construction land south of Baoding City and Baoding City in Hebei Province is more reasonable than the natural state of 2030, the construction land shown by the pre-set state of the 2030 scenario is distributed in Baoding City, Shijiazhuang City, Xingtai City, The western part of Handan City is more concentrated, while Cangzhou City, Langfang City and Hengshui City have less arable land. The more concentrated and spatial distribution further reflects the implementation of the 2030 land use scenario for the task of "Hebei Province Land and Space Planning (2021-2035)".

In general, under this scenario, the land use simulation results of 2030 in Hebei Province can significantly change the natural state of low land utilization and rapid reduction of cultivated land. Urban sprawl, the gradual deterioration of the natural environment and other problems, can achieve the development goals planned by the "Hebei Province Land and Space Plan (2021-2035)" in a high quality overall, and has made a meaningful attempt to combine NQP with land use and regional development planning.

5. Conclusions

5.1 Summary of the Findings

Based on research, this paper believes that the NQP have a high correlation with changes in the land use of Hebei Province and can play a leading role in its spatial development pattern. Although natural conditions have a major constraining role in the development of various types of land, the role

of NQP factors in land-use development change in the vast majority of cases is among the highest among socio-economic factors, playing an important role in land-use development change.

At the same time, in the pre-set simulation of the 2030 scenario of the government land planning from the perspective of NQP, the optimization of the overall environmental protection, the limitation of urban sprawl and the protection of the amount of cultivated land can better reflect the policy objectives of the "Hebei Province Land and Space Plan (2021-2035)".

5.2 Policy recommendations

First, to improve the quality of matching among NQP factors, to form an optimal allocation of NQP factors between regions, and to improve the utilization of resources. We should complete the new quality of the development of productive forces. The study found that the development contribution of each NQP factor of productivity varies from place to place, and the NQP has a greater driving effect is relatively homogeneous, and in most cases, it fails to form a synergy with other NQP factors of productivity. In order to solve this problem, it is necessary to open up barriers to the movement of workers between regions, promote the interregional allocation of the policy-oriented workforce, and speed up the regional industrial adjustment and upgrading. We should optimize the optimal distribution of labor materials between regions and promote the NQP forces to play a greater role in economic and social development.

Second, the purpose of developing NQP is to achieve high-quality development, while a good ecological environment is the inevitable requirement for achieving high-quality development. In the past, Hebei Province was dominated by the secondary industry, the situation of environmental pollution was relatively serious, and the development and utilization of land resources was unreasonable. In recent years, Hebei Province has imposed restrictions on the high-pollution secondary industry, which is dominated by the steel industry.

Third, the development of new-quality productive forces should be adapted to local conditions, and the development of superior new-quality productive forces should be based on the resource conditions of different regions and the target of labor, so as to form a highly specialized division of labor with regional characteristics. It is necessary to encourage cities and counties that have advantages and NQP factors of productive forces to make bold innovations, strengthen policy guidance and support, and form a "first-come advantage." At the same time, we should draw on the development experience of the developed regions of new-quality productive forces, and make good use of the "advantage of late-onset development" to develop the short-term aspects.

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