Study on the Green Development for the Optimization of Soil and Water Resources in Tianjin City

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Abstract: Based on the theory of optimal allocation of soil and water resources, and the status and role of Tianjin in the coordinated development of Beijing-Tianjin-Hebei region, this paper studies the relationship between optimal allocation of soil and water resources in Tianjin. On the basis of analyzing the situation of land and water resources utilization in Tianjin, the paper proposes the green development strategy and implementation path of Tianjin, mainly focused on functional zoning, comprehensive planning, management mode, reserved space, structure optimization, and the price, in order to promote the green development of Tianjin in the process of Beijing-Tianjin-Hebei coordination.

Keywords: water and soil resources; optimal allocation; Tianjin

1. Introduction

The optimal allocation of water and soil resources is proposed for the shortage of water resources, including the optimal arrangement, design, combination and distribution of resources in different spaces, different time periods and different departments. It is reasonable to adjust the industrial structure and urban layout. Allocating land and water resources to various user units enables the limited resources to produce the greatest environmental and economic benefits, thus achieving the goal of unifying economic, social and ecological benefits. In the past, most of the related researches have carried out research on water and soil resources separately, and there are few studies on organically combining them; and most of them are model-based quantitative optimization studies, and there are few studies on how to allocate spatially. For example, Zhang Han and others [1] used the analytic hierarchy process, entropy method, variable weight analysis method, game combination weight method and projection pursuit method to obtain the evaluation plan of Yan'an soil and water resources carrying capacity, and then statistically analyzed different evaluation results. Wang Zhixin [2] used gray correlation analysis method and TOPSIS method improved by entropy method to evaluate the utilization efficiency of water and soil resources. Based on the DPSIR model, Zhao Ziyang [3] constructed a safety evaluation index system for agricultural water and soil resources, and quantitatively evaluated the safety of agricultural water and soil resources in Ningxia. Some scholars have proposed methods to solve soil and water resources problems from the technical and management levels. For example, Wang Jin and others [4] have analyzed the resistance surface and summarized the protection methods for water and soil resources in the mine area under severe damage; Shi Zhihua [5] studied the evolution law of regional soil erosion and its key driving factors, developed the technical system of soil erosion control, and formed a comprehensive management model of soil erosion; Liu Guobin [6] proposed a comprehensive treatment technology for soil erosion in the Loess Plateau.

As a traditional industrial base in China, the coordinated development of Beijing-Tianjin-Hebei is the biggest, most valuable and most realistic opportunity facing Tianjin. You Zhen [7] established a water and soil resource limit model to evaluate the water and soil resources limitation and spatial pattern of Beijing-Tianjin-Hebei based on population distribution. The results show that the Beijing-Tianjin-Hebei urban agglomeration is the most restricted by water and soil resources, and the water resources are the main constraints. Therefore, this paper analyzes the status of water and soil resources in Tianjin, finds the problems of water and soil resources utilization, and implements the most stringent joint management system for land and water resources from the perspectives of red line, development and space. Relying on resource conservation and joint configuration to restore and expand the ecological space, and then put forward a preliminary plan to promote industrial restructuring and progressive price reform.

2. Status of land and water resources utilization in Tianjin

2.1. Social Development and Population Increase Leading to the Pressure on Land and Water Resources

Tianjin faces a good international and domestic environment, especially the development of Binhai New Area into the national development strategy. With the construction of development zones, demonstration industrial parks, new towns and central towns, population growth, economic growth and rapid urbanization on land and water resources Demand is increasing. In recent years, Tianjin's economic development has been rapid "Figure 1," the overall economic operation has remained stable, the quality and efficiency have been steadily improved, the market vitality has been continuously enhanced, and high-quality development is taking shape. In 2018, Tianjin's GDP was 1,880.9 billion yuan, an increase of 3.6% over the previous year.

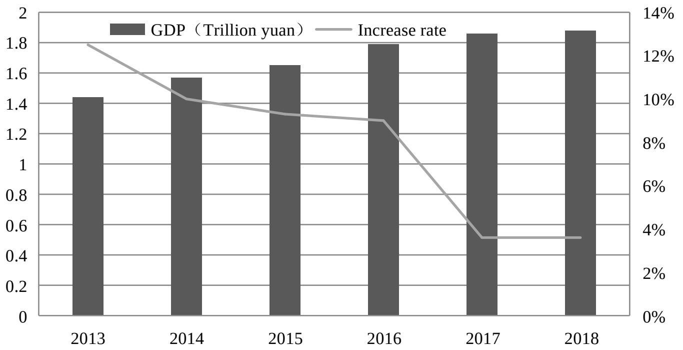

Figure 1. Change of GDP for Tianjin in 2013-2018.

The resident population of Tianjin has grown rapidly [8], the total amount of continuous growth has been increasing, and the population doubling time has been shortened. The population density is very different due to the different administrative regions and geographical regions. The population of the six districts in the city is the most densely populated.

2.2. The Total Amount of Resources is Short, and the Utilization Efficiency has Room for Further Improvement

Tianjin's land resources are very tight. According to the 2016 and 2017 Tianjin Statistical Yearbooks [9], the total land area of the city is 1.19 million hectares. From 2016 to 2017, the area of agricultural land decreased from 58.3% to 57.8%, the construction land increased from 34.8% to 34.9%, and the unused land area decreased from 7.0% to 7.3%. The cultivated land area did not change much; from 2016 to 2017, the cultivated land area decreased by about 17,000 square kilometers, from 36.7% to 36.5% of the total land area; the land used for residential and mining areas increased by 235,900 square kilometers, from 27.8% to 27.9%; the land used for transportation facilities increased by 31,500 square kilometers, and the unused land decreased by 9800 square kilometers. At the same time, the land use structure is not reasonable, the proportion of land for transportation, forestry and urban and rural construction is low; the degree of land use is not high, and the unused land is mainly grassland and saline-alkali land, and there is a trend of increasing year by year; The level needs to be improved. The low-yield fields in agricultural production and management account for a higher proportion of all cultivated land, and there are still idle places in industrial storage and land; the total land supply increases, and the newly-built construction land occupies a large amount of high-quality land in the suburbs, and the situation of cultivated land and basic farmland protection severe.

Tianjin is prosperous because of water, but after the 21st century it has become a typical resource-based water-deficient city. On the one hand, Tianjin has a poor natural resource endowment [10]. Tianjin is a city suffering from severe water shortage. Its annual average water resources amount is 1.82 billion m^3, and per capita water resources is 180 m^3, less than half of the national average and one quarter of the international water shortage index. Due to the scarcity of surface water resources, the amount of groundwater that can be mined is small, and the high cost of seawater and urban sewage treatment and utilization, a large amount of water for production and living needs to be supplemented by water diversion and extraction of deep groundwater that is difficult to regenerate, and highly dependent on external water diversion. In 2017, the amount of water entering Tianjin reached 1.88 billion m^3. On the other hand, despite the economic development, there is still a gap between resource utilization efficiency and large domestic cities. There is a serious problem of high quality and low use of water. Under the background of coordinated development of Beijing-Tianjin-Hebei, resource and environmental constraints have become increasingly tight, and there is still a gap between the development and utilization of unconventional water and major cities such as Beijing. In 2017, the surface water source accounted for 70.43% of the total water supply, the per capita comprehensive water consumption was 185 m^3, the water consumption per 10,000 yuan of GDP was 18 m^3, the industrial added value of the 10,000 yuan (the current year price) was 6.90 m^3, and the water use efficiency was at the national leading level, but further water saving. The potential of the water resources is small; there are still some degrees of waste in water resource utilization, such as high industrial water quotas in some industries and low efficiency of urban water pipeline networks.

2.3. The Matching Degree between Water Resources and Land Resources is not High

Due to the shortage of total land and water resources and the irrational use of resources, the degree of matching between different land use types and water resources affects urban safety. Relevant research indicates that the ratio of effective irrigation area to planting area can reflect the degree of agricultural water conservancy support and the matching of water and soil resources [11]. In 2017, the planting area of Tianjin's crops was 439,500 hectares, and the effective irrigation area of farmland was 305,300 hectares, of which 179,300 hectares of water-saving irrigation area, and the effective irrigation area of farmland accounted for 69.47% of the planted area, higher than the national average. However, the use of cultivated land should be considered for the cultivation of economic crops with relatively small water requirements, giving full play to the marginal effects of water resources.

At the same time, water consumption per unit area can also be used as the basis for quantitative calculation of water and soil resources matching. From 2015 to 2017, domestic water consumption was 382 million tons, 3910.4 million tons and 408.94 million tons, while production water consumption was 309.83 million tons, 309.89 million tons and 267.45 million tons. According to the Tianjin Water Resources Bulletin, the water consumption of various industries in Tianjin is relatively large. In 2017, the city's water consumption was 1.824 billion m^3, and the average water consumption rate was 63%. The production water consumption is 1.114 billion m^3, accounting for 61.6% of the total water consumption; the domestic water consumption is 253 million m^3, accounting for 13.8% of the total water consumption; the ecological water consumption is 448 million m^3, accounting for 24.6% of the total water consumption.

2.4. The Role of Price in Regulating Resources Needs to be Further Developed

As a super-large city that is short of water resources, Tianjin insisted on water conservation first, and the unit price of industrial water tap water was adjusted in 2005, 2007, 2009, 2010 and 2011. At present, the unit price of industrial water tap water remains unchanged at 6.65 yuan/m^3. At the same time, the water consumption per unit of GDP in the high-water consumption industry in Tianjin is quite different, and the emission characteristics are not the same. On the whole, the output value of the thermoelectric industry is the largest, but the discharge per unit of output value is not the highest. The COD emissions per unit of output and ammonia nitrogen emissions are also relatively small, and the pollutant content of tons of wastewater is also relatively low. The water consumption per unit of output value of the steel industry, wastewater discharge, COD emissions and ammonia nitrogen emissions are relatively low, and the content of tons of wastewater pollutants is relatively high. The water consumption per unit of output value of the paper industry and the discharge of wastewater per unit of output value are in the middle, but the COD emissions and ammonia nitrogen emissions per unit of output value are relatively high, and the pollutant content of tons of wastewater is also relatively high. The water consumption per unit of output value of the textile industry, wastewater discharge, COD emissions and ammonia nitrogen emissions are high, and the pollutant content of tons of wastewater is also high. The petrochemical industry's output water consumption, wastewater discharge, COD emissions and ammonia nitrogen emissions are very low, and the pollutant content of tons of wastewater is also relatively low. The characteristics of chemical industry and textile industry are similar. The water consumption per unit of output value, the discharge of waste water, the discharge of COD and ammonia nitrogen are very high. The water consumption and waste water discharge per unit output value of the chemical industry are slightly lower than that of the textile industry, but the COD and ammonia nitrogen emissions per unit output value are higher than that of the textile industry, and the pollutant content per ton of waste water is also higher than that of the textile industry. Although the water consumption per unit of output value and wastewater discharge are close to the lowest in the food manufacturing industry, COD emissions per unit of output value and ammonia nitrogen emissions are relatively high, and the pollutant content of tons of wastewater even reaches the highest level.

3. The green development based on the optimal allocation of water and soil resources in Tianjin

Based on the development philosophy of environment-friendly, functional division of labor, industrial optimization, institutional innovation, complementary advantages and price regulation, it focuses on industrial structure optimization, takes overall planning of resource space as the main line and price reform as the starting point. Aiming at the problem of spatial mismatch between water and soil resources, explore a new path of functional deconstruction and space optimization; focus on the new model mechanism of differentiated price adjustment for price problems; focus on the prominent contradiction between rapid economic and social development and severe resource and environmental situation, and focus on implementation. The most stringent new mode of joint management of land and water resources, reserved enough ecological land and ecological water.

3.1. Compiling Water and Soil Resources Functional Zoning

Firstly, an integrated water and soil resource utilization plan is worked out to define the functional positioning of each region. According to the spatial strategy of urban function optimization, coastal key development, coordinated development of the west and ecological conservation of the north, the utilization of water and soil resources plays a guiding role in the comprehensive zoning, gradually forming an overall pattern of one axis, two belts and the north-south ecology. Among them, the central city focuses on the development of the tertiary industry, and gradually forms a service-oriented industrial structure; the peripheral urban areas focus on the development of technology-intensive, high-value-added, non-polluting industries; the large-scale tidal flats in the eastern coastal areas are in an unutilized state. Urban industrial development should be transferred to the eastern region in a timely manner.

Second, implement the regulation of land and water use according to the plan. Comprehensive consideration of quantitative and spatial uncertainties, reserve a certain number of new construction land and water use indicators, to arrange land use for major infrastructure construction projects beyond the planned expectations; second, further improve land acquisition compensation, ecology Compensation, formulate comprehensive price of districts, and strengthen dynamic supervision of the implementation process; third, improve and standardize the pre-examination system for water use for construction, strengthen the pre-examination system for land use and water resources argumentation system, and strengthen the punishment measures for violation of planning.

Finally, actively develop new land and water sources. The amount of water used for construction purposes shall be strictly controlled. While actively developing unused land and new water sources, the amount of land used and the amount of water used for construction purposes shall be strictly controlled. Then, the transformation of water and land saving to alleviate the pressure of resources shall be strengthened "Figure 2".

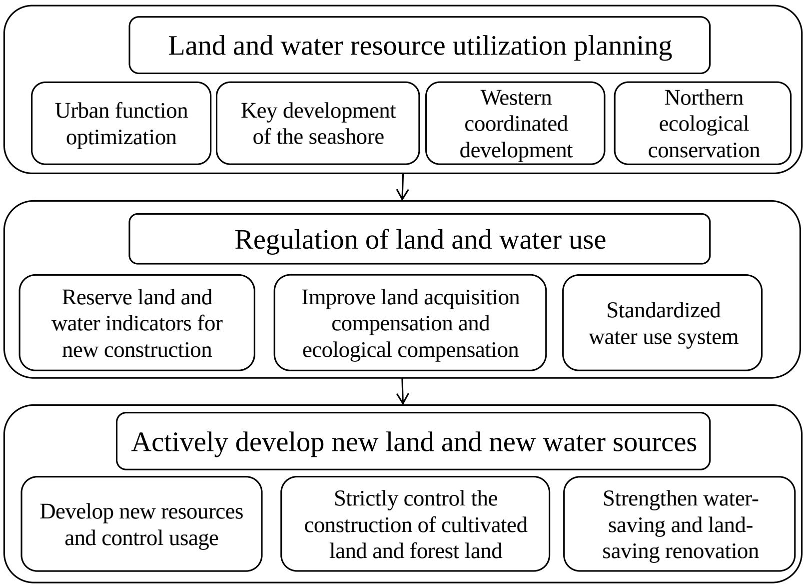

Figure 2. Soil and Water Resources Planning.

3.2. Implement the Most Stringent Joint Management System for Land and Water Resources

Implement the most stringent joint management system for land and water resources, and promote the transformation of limited land and water resources from extensive use to intensive use. The intensive use of water and soil resources is related to the structure and efficiency of resource utilization. The implementation of the most stringent water and soil resources management system is a necessary means. The overall idea is to guide demand, strictly control the total amount, revitalize the stock, increase the quality, and intensively, that is, fully tap the potential. Stocks, control inefficient increase, use good increments, ensure the dynamic balance of totals, adhere to economical and intensive use, realize the use of various types of land use water from extension to connotation, and from high-efficiency to intensive, and build ecology, production and life. Coordinated spatial pattern. Specifically, it focuses on three aspects:

First, protect the red line--strictly protect basic farmland, farmland and basic water demand, and ensure the red line of land and total water resources, which is the lifeline to maintain basic human survival. The total amount of good soil and water resources should be controlled to ensure that the amount of cultivated land and the protected area of basic farmland are no less than the target of the responsibility for protection, and the total amount of water used should not be higher than the binding targets set by the state. Then, ensure the development of both quantity and quality of cultivated land and water resources, that is, the total amount of cultivated land does not decrease, the use does not change, the quality does not decrease, the total amount of water is controlled and the quality of water is improved. The scale of water use for construction land should be rationally arranged, the total amount of water used and land used for construction should be controlled, and the total amount of groundwater exploitation needed to maintain a good ecosystem should be determined to achieve a dynamic balance between use and compensation.

Secondly, leave space--pay attention to the construction of ecological space, reserve enough ecological land and ecological water, which is the premise to realize the harmonious development between human and nature. First, leave enough space for ecological adjustment from the perspective of planning. On the basis of ensuring the security of water use and land in the central urban area, focus on serving the development and opening up of binhai new area, and gradually increase the proportion of ecological land. Especially after the south-to-north water diversion, how to reserve enough water resources for ecological land; Second, promote the construction of ecological corridors, gradually increase the ecological space, and promote the construction of soil and water loss control in mountainous areas and the construction of soil and water conservation in the desertified plain around cities and towns. For soil erosion control in mountainous areas, terraces can be renovated and various water conservation facilities built. For plain areas, repair the field irrigation and drainage canals and river ecological protection, restore vegetation; Third, abundant wetland resources and great potential for ecological construction. Focusing on the construction of Haihe river and coastal ecological corridor, along the river course and the sheltering forest belt along the traffic, the ecological service function of coastal wetland resources will be brought into play, and the ecological system integrating water, city, land and sea will be built to improve the overall service function of the ecological system.

Finally, the development of insurance - on the basis of guaranteeing the red line of basic water use, improve the efficiency of water and soil use, and provide the necessary construction land and water for social and economic development, which is the necessary material basis for improving the quality of human life. First, the implementation of subdivision management, implementation of quality classification of water supply for land. That is to coordinate the various types of land use in various industries, strengthen the control of the direction, structure and layout, and initially limit the functions and uses of land and water resources; second, adhere to the high quality and excellent use of water and soil resources, low quality and low use. The implementation of the newly renovated and expanded thermal power plant project will use the reclaimed water and seawater policies. All projects that use reclaimed water, seawater and rainwater will not approve conventional water. Third, make full use of inefficient water and soil resources and explore the potential of multi-channel water and soil resources utilization. For the phased objectives, the indicators to be controlled include the water consumption of industrial added value of 10,000 yuan, the effective utilization coefficient of farmland irrigation water, the water quality compliance rate, the gross production value of construction land, and the per capita urban industrial.

3.3. Promote Industrial Restructuring

The continuous adjustment of the utilization structure of water and soil resources is the driving force for industrial adjustment. It starts from the two aspects of the total amount of water used for land use and layout, including the geographical optimization of structure and time series optimization, and improves the level of industrial development.

First, optimize the regional structure of the industry and improve the city's functions. The development of the tertiary industry in the central area will require high-quality conditions for commercial and service industries, and industries that require high-quality water and low-quality land will be placed in the city center; industries with low-quality water and low-quality water should be placed in cities. On the edge; agriculture needs low-quality water, high-quality water, and the development of agricultural and sideline products in the suburbs, so that the urban industrial structure is in a zonal circle distribution pattern.

Secondly, the industrial timing structure should be optimized to accelerate the upgrading of industrial structure and the adjustment and optimization of the internal structure of the tertiary industry. The optimization of industrial timing structure requires rational allocation of resources in various industries according to the law of industrial evolution and maximization of comprehensive utilization efficiency, so as to promote the optimization of industrial structure.

Finally, reduce the overall scale of land use for the industry, accelerate the industrial docking, and build upstream and downstream resource chains. Promote the transfer, agglomeration and integration of industries, rationalize the industrial development chain, promote industrial division of labor, avoid isomorphism and homogenization between industries in different regions, and form a rational distribution of industries and comprehensive utilization of upstream and downstream resources between different regions. Linkage mechanism.

3.4. Implement Differentiated Pricing in the Production Industry

Due to the scarcity of water and soil resources, the direction and scale of resource utilization can be effectively regulated by adjusting the consumption structure and seeking the price reflecting the value of resources through market means, taking water resources as an example.

First, progressive price increases encourage water conservation. From the perspective of cost-benefit ratio, higher water price should be set for the wastewater production industry with higher concentration of pollutants. From the perspective of improving water use efficiency and environmental efficiency, a lower price should be given to industries that consume less water per unit output and discharge less waste water. In addition to price differences, on the premise of meeting the needs of sustainable economic development, advocate the development of low-consumption water industry; the admittance policies of high water-consuming industries should also be different. The admittance threshold of high water-consuming industries with low water efficiency can be appropriately raised to promote the optimization of regional economic water structure.

Secondly, the production water is subject to a system of excess progressive mark-up, which separates the price difference between enterprises with low water efficiency and other enterprises in the industry, and penalizes large users with low water efficiency to improve water-saving technology.

4. Conclusion

Through the analysis of the status of soil and water resources in Tianjin, it is found that the following problems exist in the utilization of land and water resources in Tianjin: First, the total amount of water and soil resources is scarce, the demand caused by social development and population growth is far more than the supply of land and water resources; the second is the structure of water and soil resources utilization. Unreasonable, low utilization efficiency, and water resources are highly dependent on other regions, there is waste; third, the price adjustment leverage is not obvious.

Based on the analysis results, this paper proposes the optimal allocation of land and water resources in Tianjin: (1) Determine the water and soil resources planning strategy for the whole region, implement the sustainable development of water and soil resources use system, and actively develop new land and water resources; (2) Implement strict water and soil Joint resource management system to improve the utilization efficiency of land and water resources, promote the transformation of extensive utilization mode of land and water resources to intensive use mode; (3) Promote industrial restructuring, build resource linkage and linkage mechanism; (4) Impose different fees for different industries standards, actively play the role of price adjustment leverage.

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References

[1] Zhang Han; Zhou Weibo; Song Yang; Ma Yaxin. Research on Evaluation of Soil and Water Resources Carrying Capacity Based on Optimal Weighting Method. *Journal of Irrigation and Drainage*, **2016**: 67-72.
[2] Wang Zhixin; He Juanshi. Benefit Evaluation of Water and Land Resources Utilization in Tongliao City Based on Improved TOPSIS Method. *Water Saving Irrigation*, **2016**: 68-72.
[3] Zhao Ziyang; Li Wangcheng; Zhang Yuzheng; Wang Xia. Safety Evaluation of Ningxia Agricultural Land and Water Resources Based on DPSIR Model. *Acta Agriculturae Zhejiangensis*, **2017**: 1336-1346.
[4] Wang Jin; Li Min; Bi Rutian. Evaluation of Soil and Water Resources Protection from the Perspective of Ecological Value: A Case Study of the Changhe River Basin. *Journal of Irrigation and Drainage*, **2018**: 117-123.
[5] Shi Zhihua; Yang Jie; Li Zhongwu; et al. Comprehensive Control of Soil and Water Loss in Low Mountain and Hilly Areas of Southern Red Soils. *Journal of Soil and Water Conservation*, **2018**: 6-9.
[6] Liu Guobin; Wang Bing; Wei Wei; et al. Comprehensive Control Technology and Demonstration of Soil and Water Loss on the Loess Plateau. *Acta Ecologica Sinica*, **2016**: 7074-7077.
[7] You Zhen; Yang Yanzhao. Study on the Conditions and Limitations of Soil and Water Resources in Major Urban Agglomerations in China—Taking Beijing-Tianjin-Hebei, Yangtze River Delta and Pearl River Delta as Examples. *Areal Research and Development*, **2018**: 138-143.
[8] Tianjin Net—Daily News. http://tj.focus.cn/news/2011-12-05/1634662.html, 2011.
[9] Tianjin Statistics Bureau. Tianjin Statistical Yearbook, 2018.
[10] Chen Linsheng; Li Gang. Resource Endowment, Comparative Advantage and Regional Economic Growth. Research on Financial and Economic Issues, 2004, pp.63-66.
[11] Liu Yansui; Gan Hong; Zhang Fugang. Matching pattern of agricultural land and water resources in Northeast China. *Acta Geographica Sinica*, **2006**, 847-854.