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Original Research Article

Evaluation of Sustainable Utilization of Water Resources Based on Synthesized Integration Weight and Grey Target Model ---A Case Study of Beijing -Tianjin-Hebei

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Abstract

Water resources are a favorable guarantee for the economic and social development of a region. Utilization efficiency of water resources is of great significance for formulating rational water resources strategy. In this paper, a gray target model is weighted by the synthesized integration weight method which combines the order relation and the entropy weight. Through the construction of evaluation index system for sustainable utilization of regional water resources, the comprehensive evaluation of water resources utilization in Beijing-Tianjin-Hebei region in 2016 was carried out. The results show that: (1) the water consumption structure of Beijing and Tianjin is relatively balanced, while Hebei Province shows typical characteristics of agricultural cities. The agricultural water footprint accounts for more than 90% of the total water footprint, followed by residential water, industrial water and ecological water. (2) In 2016, the total water footprint of Beijing-Tianjin-Hebei region showed a distribution pattern with Beijing as the center, surrounded by all sides, and the distribution pattern of the center was high and low. The sustainable utilization level of water resources concentrates on the middle and poor grades, and there is still room for improvement.

Keywords: Water footprint; sustainable utilization of water resources; grey target model.

INTRODUCTION

Water resource is an important restricting factor for economic and social development, and also essential natural resources to maintain ecosystem balance. With the growth of population and the rapid development of economy, the demand for water resources is also increasing. Water resources are very limited, and their spatial-temporal distribution is not uniform. In addition, the lack of attention to water conservation makes the situation of water shortage has become the main bottleneck restricting the sustainable development of economy and society. The Beijing-Tianjin-Hebei region is the "capital economic circle" of China and has an important strategic position. However, due to the characteristics of regional water resources and industrial development, water shortage is gradually becoming one of the main reasons that restrict regional economic development and ecological security in Beijing, Tianjin and Hebei. The per capita water resources in this area is only 1/9 of the national average level. In view of this, it is necessary to calculate the water resources utilization efficiency in Beijing, Tianjin and Hebei. Through scientific evaluation of water resources sustainability, the efficient allocation of water resources can be realized. Thus, it contributes to the sustainable development of Beijing, Tianjin and Hebei, which is the region with the most acute contradiction between supply and demand of water resources.

In recent years, domestic and foreign scholars have been increasingly active in the quantitative evaluation of water resources under the framework of water footprint theory [1, 2, 5, 13, 16, 18, 21]. In terms of sustainable evaluation of water resources, it is mainly through the construction of a conventional water resources index system to evaluate the impact of human activities on the sustainability [14, 15, 20]. Fuzzy comprehensive evaluation method [19], analytic hierarchy process [12], TOPSIS method [17], grey correlation model [9], principal component analysis method [10] and neural network [3] are often used for quantitative calculation and analysis. However, the utilization of water resources is a complex system, which is restricted by many factors such as population, economy, ecological environment, natural space-time distribution, etc. The existing evaluation methods do not consider the impact of human activities on interregional water resources flow in practical application. Lacking the analysis and judgment of the utilization benefits of water resources in different regions and the consideration of comparability of water resources among different evaluation units. Therefore, the evaluation result of the model is not perfect. The grey target is a grey correlation analysis theory for processing pattern sequences, which can enhance the comparability between different research units in the evaluation area, and the method is easy to understand with strong applicability [7]. At present, grey target model is widely used in model evaluation, among which the problem evaluation using improved weighting grey target model is a relatively new field in recent years [6, 11, 4], but it is rarely used in water resources evaluation. The existing literatures are mainly focused on using entropy weight method with objective weight to give weight to the degree of target center. Although the entropy weight method is supported by mathematical theory and method, it ignores the subjective understanding of the evaluator and does not reflect the actual situation.

In summary, this paper firstly calculates the relevant water footprint index based on the water footprint theory, analyzes the water footprint of Beijing-Tianjin-Hebei, and constructs a comprehensive evaluation index system of water resources utilization from three aspects: pressure, state and response according to the PSR model. The synthesized integration weight method is used to evaluate the indicators based on subjective and objective aspects, and the grey target model is introduced to evaluate the water resources utilization in Beijing-Tianjin-Hebei in 2016. The aim is to explore the spatial differences in the sustainable use of water resources in the Beijing-Tianjin-Hebei region from a more comprehensive scientific perspective, so as to provide direction and theoretical support for the rational development and efficient allocation of water resources in this region.

MATERIAL AND METHODS

Calculation Method of Water Footprint

The water footprint measurement method used in this paper is the bottom-up method. The water footprint is calculated by summing the water resources consumed by products or services in the research area. The specific formula is as follows (all physical quantities contained in the formula are $10^8 m^3$ in units):

$$WFP = WU_A + WU_I + WU_D + WU_E - VWE_{DOM} + EWFP \qquad (1)$$

Where WFP is the total water footprint of a country or region; WU_A is the amount of water used for agricultural production in the study area(excluding the amount of loss in agricultural irrigation); WU_I indicates the water consumption for industrial production in the study area; WU_D represents the domestic water consumption of residents in the study area; WU_E indicates the ecological environment water consumption of the study area; VWE_{DOM} represents the virtual water output from the research area to other areas (numerically equal to the ratio of import trade value to GDP, multiplied by the total production water consumption); $EWFP$ is the external water footprint, that is, the total amount of virtual water input from the external area to this area.

$$WU_A = WU_{A1} + WU_{A2} \qquad (2)$$

In formula (2), WU_{A1} represents the water consumption of crop products; WU_{A2} represents water consumption of animal products.

$$EWFP = VWI - VW_{i-e} \qquad (3)$$

VWI represents the virtual water quantity input into the study area from other regions (the value is equal to the ratio of export trade value to GDP, and then multiplied by the total water consumption). The value of VW_{i-e} is ignored and is assumed to be 0.

Calculation of Index Weight

In order to reflect the mutual restriction relationship between resources and environment and human activities, this paper constructed an evaluation system including pressure index, state index and response index based on PSR model. The synthesized integration weight method respectively adopt the order relation analysis (G1) method and entropy weight method as the methods to determine the weights of these indexes, giving the results more objective value. According to the selected index, relevant experts from the water conservancy department and the environmental protection department are employed to score the importance. Referring to the literature [22], the method of order relation analysis and the method of entropy weight calculation are not listed in detail in this paper.

Establishment of Grey Target Evaluation Model

The calculation steps of grey target model are as follows:

First, the evaluation matrix is standardized and the standard model is constructed as follows:

$$X_0 = \{X_0(U_1), X_0(U_2), X_0(U_3), \ldots\ldots, X_0(U_n)\} \quad (4)$$

In the formula (4), X_0 is the standard pattern sequence, U_n is the nth evaluation index, $X_0(U_n)$ is the standard value of the evaluation index U_n. When U_n is the positive index, $X_0(U_n)$ takes the maximum value and vice versa. Next step is to carry out grey target transformation:

$$x_0 = TX_0 = (\underbrace{1,1,1,\ldots\ldots1,1,1}_{m}) \quad (5)$$

In the formula (5), x_0 is the bull's-eye and m is the number of evaluation units, the grey target transformation formula for evaluation index U_K in evaluation unit X_i is as follows:

$$x_i(U_k) = TX_i(U_k) = \frac{\min\{X_i(U_k), X_0(U_k)\}}{\max\{X_i(U_k), X_0(U_k)\}} \quad (6)$$

Then, the gray correlation difference information space is:

$$\Delta = \{\Delta_{0i}(U_k)\} = |x_0(U_k) - x_i(U_k)| \quad (7)$$

In the formula (7) , Δ represents a set of difference information. According to formula (5), the value of is 1, so the above equation is equivalent to:

$$\Delta = \{\Delta_{0i}(U_k)\} = |1 - x_i(U_k)| \quad (8)$$

The calculation formula of the bull's-eye coefficient is as follows:

$$\gamma[x_0(U_k), x_i(U_k)] = \frac{\min_i \min_k \Delta_{0i}(U_k) + 0.5 \max_i \max_k \Delta_{0i}(U_k)}{\Delta_{0i}(U_k) + 0.5 \max_i \max_k \Delta_{0i}(U_k)} \quad (9)$$

Given the bull's - eye coefficient, the bull's - eye degree can be calculated as follows:

$$\gamma[x_0, x_i] = \sum_{k=1}^{n} w_k \gamma[x_0(U_k), x_i(U_k)] \quad (10)$$

$\gamma[x_0, x_i]$ is the bull's eye degree of evaluation unit X_i, and w_k represents the weight of the kth index.

Data Sources

In calculating the virtual water content of crop products, this paper selects seven kinds of food crops such as wheat, rice and corn in the Beijing-Tianjin-Hebei region as the research object, and refers to the research results of Jiang Li *et al*., [8] in the calculation method. The calculation results are shown in Table-2. For the measurement of virtual water content of animal products, due to the data are usually difficult to obtain, so this paper directly adopts the estimation results of China part of the data provided by FAO and WTO. The virtual water quantity per unit quality is shown in Table-3. Data on industrial water, domestic water, ecological water and conventional environmental and economic indicators in the Beijing-Tianjin-Hebei region are respectively from the 2017 Beijing Statistical Yearbook, Tianjin Statistical Yearbook, Hebei Economic Yearbook, Hebei Rural Statistical Yearbook, Hebei Province Municipal Statistical Yearbook and Beijing-Tianjin-Hebei Municipal Water Resources Bulletin.

Table-2: Virtual water content of the main crops in the Beijing-Tianjin-Hebei region (m^3/kg)

Region	Wheat	Corn	Rice	Potato	Beans	Oil	Cotton
Beijing	1.23	0.84	1.4	0.7	2.24	1.5	5.24
Tianjin	1.25	0.85	1.19	1.07	3.73	1.71	4.6
Hebei	1.38	0.93	1.56	1.2	2.59	1.61	6.1

Table-3: Virtual water content of the main animal products in the Beijing-Tianjin-Hebei region (m^3 / kg)

Animal product	Pork	Beef	Mutton	Poultry eggs	Milk	Aquatic product
Content of virtual water	3.6	19.98	18.1	8.65	2.2	5.1

RESULTS AND DISCUSSION

Calculation of Water Footprint

This paper calculates the total water footprint of agricultural products by using the virtual water volume per unit area and the actual output per unit area. The results are shown in Table-4.

Table-4: Water Footprint of Agricultural Production in the Beijing - Tianjin - Hebei Region in 2016 （$10^8 m^3$）

City	Wheat	Corn	Rice	Beans	Potato	Oil	Cotton	Pork	Beef	Mutton	Poultry eggs	Milk	Aquatic product
Beijing	1.051	3.628	0.016	0.098	0.061	0.084	0.003	7.848	2.797	2.172	15.830	10.054	2.754
Tianjin	7.613	10.039	1.595	0.448	0.096	0.275	1.012	10.512	6.993	2.896	17.819	14.960	20.094
Shijiazhuang	23.228	39.520	0	0.703	1.180	3.882	0.484	16.452	17.782	3.982	97.120	25.726	1.592
Chengde	8.124	0	1.644	0.636	2.873	0.374	0	6.768	18.781	3.801	10.292	3.371	2.143
Zhangjiakou	8.055	0	0.132	0.894	5.336	1.118	0	10.361	14.246	8.869	22.107	29.322	0.663
Qinhuangdao	5.013	0.196	1.048	0.649	1.604	1.298	0.027	7.434	5.674	5.593	9.714	2.166	18.449
Tangshan	15.784	9.202	8.015	1.328	1.353	5.175	1.233	19.080	16.983	3.258	32.959	37.406	31.226
Langfang	10.543	5.335	0	0.808	0.429	0.647	0.886	5.472	9.990	4.525	13.541	3.747	1.781
Baoding	29.842	39.547	0.164	0.985	2.685	5.473	0.503	14.832	7.592	6.697	41.408	17.763	2.929
Cangzhou	22.193	28.657	0	0.789	0.530	1.395	3.227	7.481	14.366	6.100	28.762	2.510	8.293
Hengshui	17.426	23.347	0	0.428	0.251	1.945	4.741	8.568	9.590	3.801	25.921	2.852	0.456
Xingtai	19.682	30.969	0	0.953	0.469	2.944	9.459	6.912	6.593	3.077	47.049	6.575	0.447
Handan	24.600	36.216	0.119	0.575	0.601	2.469	4.727	14.616	9.191	9.231	99.117	5.086	1.855

It can be seen from Table 4, among the crop water footprint in 2016, the grain crops in the Beijing-Tianjin-Hebei region are mainly wheat and corn with higher water consumption.Wheat, rice and corn are the main food crops in the Beijing-Tianjin-Hebei region. Rice consumes a high amount of water. In order to reduce water consumption, the planting area and output of wheat and corn increase, so the production water consumption increases. In terms of longitudinal comparison, although Tianjin is a municipality directly under the central government, its wheat and corn yield is obviously higher than that of Beijing.The cultivated land area in Beijing is in a state of continuous decrease with the influx of a large number of people and the rapid expansion of urban construction. Therefore, the grain yield in Beijing is obviously lower than that in Tianjin. Among animal products, poultry and egg products in Beijing and Hebei have high water consumption. The water consumption of aquatic products in Tianjin is much higher than that of other animal products, It is because that Tianjin is located in the east of Bohai Sea.Aquaculture is a high water consuming industry, so the water consumption of aquatic products in Tianjin is higher than that of other animal products. In contrast, most areas of Beijing and Hebei are located inland, with high egg production, so the water footprint of eggs is relatively high. According to the numerical results of Table 4, and according to the formula (1) - (3) to calculate the total water footprint of the Beijing-Tianjin-Hebei region, as shown in table 5.At the same time, in order to facilitate the horizontal comparison among cities, the differences in the total water footprint structure of different cities in Beijing-Tianjin-Hebei region are analyzed, according to the calculation results, the total water footprint of the Beijing-Tianjin-Hebei region and the water consumption of each industry are plotted according to the calculation results, as shown in Figure-1.

Table-5: Water Footprint of Beijing, Tianjin and Hebei in 2016 （$10^8 m^3$）

Evaluation unit	Total Water Footprint of Various Types								
	Agricultural production water	Industrial production water	Domestic water	Ecological water	Export virtual water	Import virtual water	Total water footprint	External water footprint	Internal water footprint
Beijing	3.800	17.800	11.100	46.396	0.786	3.483	81.792	3.483	78.309
Tianjin	5.530	5.590	4.070	94.351	0.674	0.889	109.755	0.889	108.866
Shijiazhuang	1.200	3.200	0.180	289.858	0.955	0.624	290.283	0.624	289.659
Chengde	0.120	1.320	0.004	70.226	0.037	0.003	70.367	0.003	70.364
Zhangjiakou	0.020	1.310	0.001	110.713	0.053	0.021	110.843	0.021	110.822
Qinhuangdao	0.820	1.040	0.060	77.093	0.434	0.211	77.263	0.211	77.052
Tangshan	3.430	3.990	0.068	231.626	1.299	1.056	232.350	1.056	231.294
Langfang	0.240	1.580	0.090	69.254	0.330	0.388	69.450	0.388	69.062
Baoding	0.600	2.490	0.060	221.669	0.173	0.071	221.974	0.071	221.903
Cangzhou	0.760	1.920	0.045	140.374	0.198	0.070	140.634	0.070	140.564
Hengshui	0.080	1.170	0.005	119.188	0.076	0.007	119.306	0.007	119.299
Xingtai	0.570	1.570	0.030	152.168	0.278	0.092	152.367	0.092	152.275
Handan	0.120	1.720	0.030	245.248	0.251	0.152	245.425	0.152	245.273

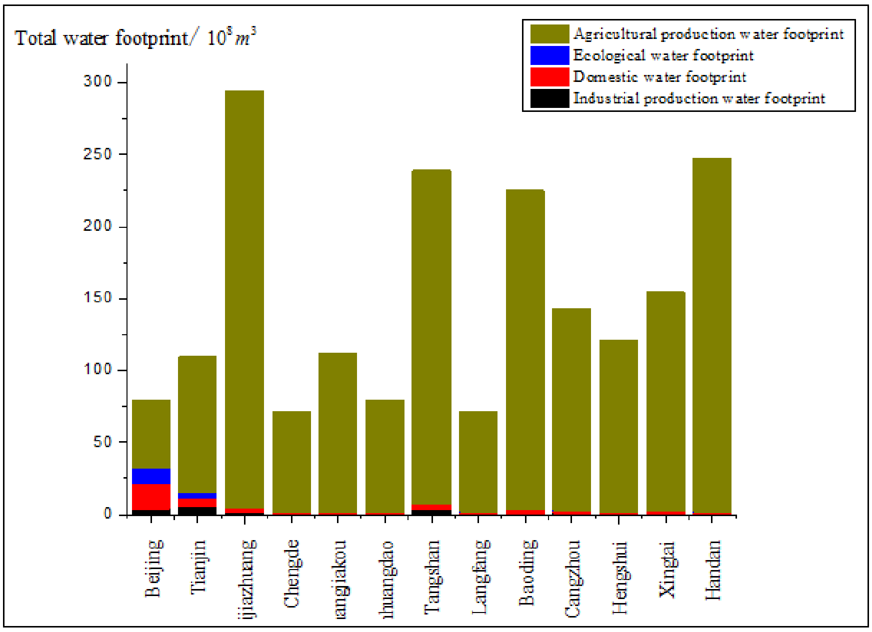

Fig-1: Total Water Footprint of Cities in the Beijing-Tianjin-Hebei Region in 2016

It can be seen from Table-5, Shijiazhuang has the highest water footprint in the Beijing-Tianjin-Hebei region in 2016. As the capital of a major agricultural province, Shijiazhuang is in a leading position in terms of grain output and sown area in the province. Animal products, milk and egg products are highly produced, making the water footprint of agricultural production much higher than other cities in Hebei province. The water footprints of Handan, Tangshan and Baoding are ranked second, third and fourth respectively. Comparatively speaking, Chengde, Qinhuangdao and Langfang have the lowest total water footprint, all less than $100 \times 10^8 m^3$. Among them, Chengde is surrounded by mountains and the terrain descends from northwest to southeast, with diversified climate, large temperature difference between day and night, crop planting conditions are affected to some extent, so the agricultural water footprint is low. Qinhuangdao has the lowest population in Hebei Province. The number of agricultural population is low, the area of cultivated land per capita is small, which lead to the low output of agricultural products. Langfang is the smallest prefecture-level city in Hebei Province. Due to its close proximity to Beijing and Tianjin, some high-tech industries have become the mainstay of its economic development. Crop cultivation is limited by geographical conditions, which is relatively low compared with other cities in Hebei Province. Combined with Table-4 and Figure-1, from the structure of water footprint, Beijing-Tianjin-Hebei region has the largest proportion of agricultural production water footprint, followed by residential water footprint, while the water footprint of industrial production and ecological water footprint account for a relatively small proportion. The footprint of ecological water in various cities in Hebei province is very small in the total water footprint, indicating that the structure of ecological water that can promote the recycling of water resources has not been paid much attention and the urban greening work is still not in place.

Comprehensive Evaluation of Sustainable Utilization of Water Resources in Beijing-Tianjin-Hebei Region

Based on the P-S-R model, this paper observes the changes and development of water resources sustainable utilization system in Beijing-Tianjin-Hebei region from the perspectives of pressure, state and response. Referring to the index selection and selection frequency of the existing documents, taking into account the availability and continuity of data, the comprehensive evaluation system is finally established by 16 indexes. Meanwhile, the indexes are calculated according to the comprehensive and integrated weighting method and the Evaluation Index System are shown in Table-6

Table-6: Comprehensive Evaluation Index System for Sustainable Utilization of Water Resources in Beijing-Tianjin-Hebei Region

Criterion layer	Criterion layer weight	Index	Index weight
Pressure layer P	0.5806	x_1 Ecological water index	0.1151
		x_2 Natural rate of population growth (‰)	0.0231
		x_3 Per capita water footprint (m^3 / person)	0.1075
		x_4 Agricultural water index	0.1039
		x_5 Industrial water index	0.0446
		x_6 Domestic water index	0.0595
		x_7 Urbanization rate (%)	0.0101
		x_8 Local water footprint pressure index	0.1168
State layer S	0.3427	x_9 External dependence of water footprint (%)	0.0809
		x_{10} Absolute value of water footprint growth rate (%)	0.0272
		x_{11} The effective irrigated area of farmland ($10^4 hm^2$)	0.0219
		x_{12} Indicators of water footprint deficiency	0.0853
		x_{13} Total water resources（$10^8 m^3$）	0.1274
Response layer R	0.0767	x_{14} Proportion of investment in environmental protection and water conservancy to GDP（%）	0.0279
		x_{15} Greening coverage rate in urban areas（%）	0.0230
		x_{16} Sewage treatment rate （%）	0.0258

The standard mode of research is x_0 = {0.14,0.18%,376.42,0.57,0.00018,0.007,48.89%, 96.7%,4.26%,-4.67%,657.13,233.03%,35.1,23.77%,48.4%,97.6%}.The bull's-eye coefficient of each evaluation index in each research unit and the same evaluation index corresponding to the standard model can be obtained through the formula(4)-(10). The bull's-eye degree of pressure layer, state layer and response layer can also be calculated according to the above process. The specific results are shown in Table-7.

Table-7: The bull's-eye degree of evaluation units

City	γ_A	γ_P	γ_S	γ_R
Beijing	0.862	0.850	0.910	0.725
Tianjin	0.547	0.585	0.455	0.672
Shijiazhuang	0.563	0.535	0.570	0.733
Chengde	0.561	0.532	0.531	0.924
Zhangjiakou	0.544	0.587	0.432	0.725
Qinhuangdao	0.540	0.539	0.502	0.718
Tangshan	0.519	0.524	0.463	0.722
Langfang	0.492	0.526	0.382	0.725
Baoding	0.542	0.543	0.501	0.704
Cangzhou	0.491	0.534	0.380	0.655
Hengshui	0.502	0.550	0.381	0.675
Xingtai	0.560	0.543	0.563	0.674
Handan	0.549	0.586	0.437	0.757

Note: γ_P , γ_S and γ_R represent the bull 's-eye value of the three criterion layers respectively, and γ_A is the comprehensive value of bull 's-eye degree.

In Table-7, the value range of γ is mainly concentrated in 0.3~0.9. In Arcview3.3, the evaluation grade is divided into: $0.75 \le \gamma \le 0.95$, the rank is excellent; $0.6 \le \gamma \le 0.75$, the rank is good; $0.45 \le \gamma \le 0.6$, the rank is medium; $\gamma \le 0.45$, the rank is poor.The results of spatial differences in the sustainable utilization level of water resources in the Beijing-Tianjin-Hebei region are shown in Figure-2.

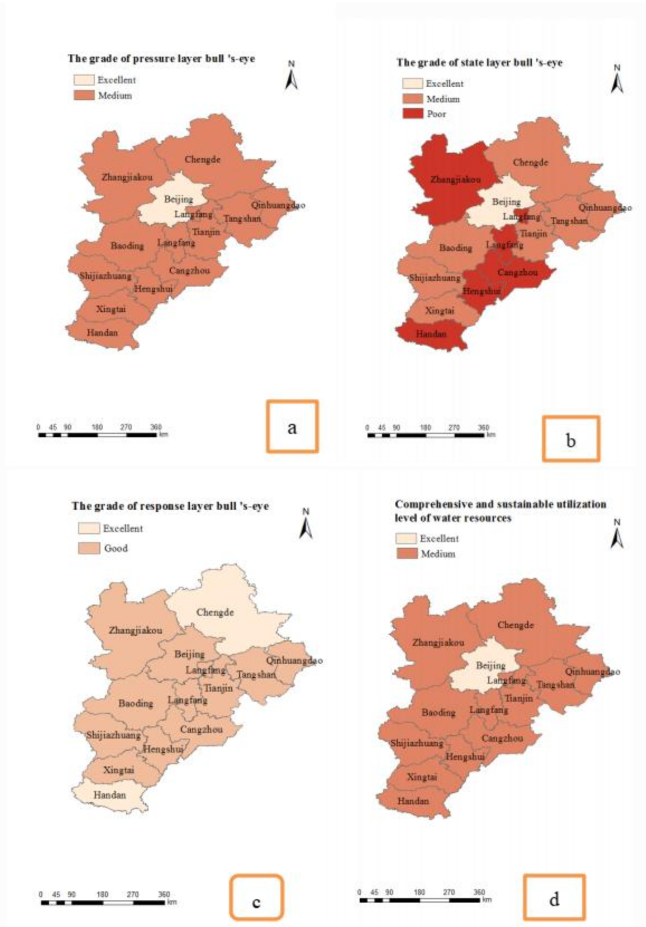

Fig-2: The bull's-eye degree of pressure layer (a), the bull's-eye degree of state layer (b), the bull's-eye degree of response layer (c) and comprehensive and sustainable utilization level (D) of water resources in Beijing-Tianjin-Hebei Region in 2016

It can be seen from Figure-2a that except for Beijing, the bull's-eye degree of the pressure layer in Tianjin and Hebei cities is relatively low in 2016. Most of the cities are at a medium level, surrounded by Beijing as the center, showing a distribution of high center and low periphery. As the capital, Beijing has played an exemplary role in economic development and sustainable use of resources by properly controlling its water footprint and environmental pressure growth. However, with the rapid development of social productive forces, the high density of population and other factors, other cities have exerted great pressure on the utilization of water resources, there is still a large room for improvement in the bull's eye degree. From Figure-2b, we can see that Beijing is still in the central area in terms of the bull's-eye degree of the state layer. Areas with low bull's-eye focus are concentrated in the southeast of Beijing-Tianjin-Hebei region. The total amount of water resources in these areas is relatively scarce. In addition, problems such as the city's geographical location and uneven economic development lead to excessive dependence on water resources within the city, which makes the water resources utilization situation grim. It can be seen from figure 2c that the cities in the Beijing-Tianjin-Hebei region have a high bull 's-eye degree in the response layer, the bull's - eye of each city is in an excellent or good level. This shows that with the increasing emphasis on environmental issues and the strengthening of awareness of sustainable development concepts, the investment in environmental protection in cities is increasing day by day. In addition, the efficient treatment of wastewater and active afforestation have also improved urban water use efficiency. It can be seen from figure 2d that the trend of sustainable utilization level of water resources in the Beijing-Tianjin-Hebei region is basically similar to the bull's - eye degree of the pressure layer, surrounded by Beijing as the center, showing a distribution of high center and low periphery. The three provinces and cities of Beijing, Tianjin and Hebei are located in the middle and lower reaches of the Haihe River. There is drought and little rain, the population is very dense. The diversification of production methods and industrial structure and the rapid economic development have brought great pressure. Except that Beijing's water resources utilization is in good agreement with various pressures and measures, Tianjin and other cities in Hebei have not reached a good balance, the situation of sustainable water resources utilization is not optimistic.

The evaluation model constructed in this paper has fully absorbed the advantages of the water footprint theory and the grey target model. Starting from the perspective of water footprint, it can reveal the influence of economic activities and changes in human production and consumption patterns on water resources according to the characteristics of water mobility. The results also show that the differences and status of different provinces and cities in the utilization and protection of water resources in the Beijing-Tianjin-Hebei region are very close to the reality. At the same time, the comprehensive and integrated weighting method is adopted to determine the index weight, which can combine the influence of subjectivity and objectivity on the index, which makes the evaluation result more scientific and enriches the research blank of grey target model in the field of water resources evaluation.

CONCLUSIONS

This paper calculates and analyzes the water footprint of the Beijing-Tianjin-Hebei region in 2016, constructs an indicator framework for PSR (pressure-state-response), combines some water footprint indicators with conventional water resources indicators, and constructs regional water resources sustainable utilization evaluation indicators. The system uses the synthesized integration weight method to empower the gray target model, and comprehensively evaluates the utilization of water resources in the Beijing-Tianjin-Hebei region in 2016. The research shows that:

- In the water footprint calculation of Beijing-Tianjin-Hebei region in 2016, Shijiazhuang ranked first.Handan, Tangshan and Baoding ranked second, third and fourth respectively. Chengde, Qinhuangdao and Langfang ranked last.Beijing and Tianjin, as the capital and municipality directly under the central government, have relatively perfect water structure, while the cities in Hebei province all show typical characteristics of agricultural cities, such as large total water consumption, high proportion of agricultural water consumption, low ecological water consumption and uneven distribution structure of water footprint.
- In 2016, the total water footprint of Beijing - Tianjin - Hebei region presents a distribution pattern with Beijing as the center surrounded by four sides, showing a distribution of high center and low periphery. The level of sustainable utilization of water resources is concentrated in medium and poor grades. It is necessary to deal with water resources pressures and current problems of low water resources and large growth trends actively, and take effective measures to improve the sustainable use of water resources.
- In the process of constructing the water resources evaluation model, this paper uses the water footprint index combined with the grey target model to study. At the same time, in the aspect of weight distribution, it introduces the method of combining the order relation method and entropy weight method to determine the weight, so as to optimize the index weight. The improved grey target model constructed in this paper is moderate in calculation difficulty and easy to understand. It is applicable to the evaluation of the sustainable utilization of water resources in comprehensive areas and other relevant evaluations. However, limited by data, methods and other factors, this paper fails to consider the correlation between indicators. In the future study, it is necessary to optimize and improve the weighting method according to the actual situation of each region and the selected indicators.

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