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Construction of an assessment method for the effect of water resource scheduling in Beijing oriented to Smart Water

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Introduction

In order to respond to the requirements of the Ministry of Water Resources, which issued the document "Notice of the Ministry of Water Resources on the Issuance of Water Resources Scheduling Management Measures" (No. 314, 2021), and to further improve the refined scheduling of water resources under the demand of Beijing's smart water construction, and to support the city's water resources scheduling under new situations such as "five water transfers", cross-basin, and multi-target. This study aims to explore the construction of a technical method to evaluate the scheduling effect with practical significance and to support the optimization of water resources scheduling.

Based on the massive data, related information and key parameters, the research utilizes GIS, knowledge mapping and other technical methods, and on the basis of systematic analysis of water resources dispatch management business processes, it clarifies the feedback mechanism of the whole chain of "generation-conduction-execution-feedback" around water resources dispatch business flow, and builds a whole chain of water resources dispatch management business chain that covers the whole object and focuses on the whole link. We have built a closed-loop management business chain for water resources dispatching, and completed the construction of a knowledge map covering all objects of water resources dispatching management. The "six-dimensional" scheduling effect evaluation index system (plan implementation, water supply security, water system connectivity, water conservation, ecological restoration, water quality improvement) has been constructed from the actual needs of water resources scheduling management, and the technical methods such as Topsis and barrier degree model have been used to complete the evaluation of the effect of water replenishment in the Yongding River since 2019. The evaluation of the effect of the Yongding River water replenishment implementation was completed, and the key factors affecting the ecological scheduling water replenishment effect were identified as groundwater level rebound, submerged plants and algae diversity. The project results supported the release of the "Beijing Water Resources Scheduling Implementation Management Rules".

Method

The evaluation index system includes three levels: target layer, criterion layer and index layer. The target layer is a comprehensive and scientific evaluation of the comprehensive effect of Beijing's ecological dispatching of "bringing in water, keeping water, making more water, making the water moving and making the water clear". Specifically, the five-dimensional criterion layer of "strong implementation, promoting connectivity, conservation, ecological protection and water quality" can be constructed, and specifically dismantled into the index layer.

Tab. 1 Evaluation index system of water resources scheduling

Goal Layer	Criterion Layer	Indicator Layer
Implementation effect of water resources scheduling	Strong implementation	Scheduling instruction execution degree
		Key objectives of scheduling
	Promote connectivity	Water duration
		Water surface area
		River chief
		Outflow
	Preservation conservation	Groundwater depth
		Groundwater recharge water
		Reservoir water storage (Storage variable)
	Protect the ecology	Algae diversity index
		Submerged plant diversity index
	Water quality	Water quality compliance rate

Results & Discussion

Tab. 2 The index weight system under the analytic hierarchy process

Criterion Layer	Weight	Indicator Layer	Weight
Strong implementation	0.1126	Scheduling instruction execution degree	0.0563
		Key objectives of scheduling	0.0563
Promote connectivity	0.2572	Water duration	0.0953
		Water surface area	0.0282
		River chief	0.0886
		Outflow	0.0451
Preservation conservation	0.2975	Groundwater depth	0.0348
		Groundwater recharge water	0.2033
		Reservoir water storage (Storage variable)	0.0595
Protect the ecology	0.133	Algae diversity index	0.0665
		Submerged plant diversity index	0.0665
Water quality	0.1996	Water quality compliance rate	0.1996

Tab. 3 Entropy weight method to calculate the weight value

Criterion Layer	Indicator Layer	Information entropy	Value of utility	Weight
Strong implementation	Scheduling instruction execution degree	0.4004	0.5996	0.0118
	Key objectives of scheduling	0.2995	0.7005	0.0138
Promote connectivity	Water duration	-4.9553	5.9553	0.1174
	Water surface area	-5.2292	6.2292	0.1228
	River chief	-4.9753	5.9753	0.1178
	Outflow	-5.1484	6.1484	0.1212
Preservation conservation	Groundwater depth	-5.1085	6.1085	0.1204
	Groundwater recharge water	-4.9798	5.9798	0.1179
	Reservoir water storage (Storage variable)	-5.2338	6.2338	0.1229
Protect the ecology	Algae diversity index	0.6771	0.3229	0.0064
	Submerged plant diversity index	0.6628	0.3372	0.0066
Water quality	Water quality compliance rate	-5.1414	6.1414	0.1211

When the water diversion scheme focuses on ecology, the weights of the five criteria layers are first set to protect the ecology and improve the water quality. At the same time, the criteria layers of conservation, strong implementation and promotion are considered. The highest weight of ecological protection and water quality improvement is set to 0.3, followed by the weight of the conservation criterion layer is set to 0.2, and the weight of strong implementation and promotion of connectivity is set to 0.1. The weight of the specific index layer is shown in the following table.

Tab. 4 The weight of each index of ecological water replenishment scheme

Criterion Layer	Weight	Indicator Layer	Weight
Strong implementation	0.1	Scheduling instruction execution degree	0.05
		Key objectives of scheduling	0.05
Promote connectivity	0.1	Water duration	0.025
		Water surface area	0.025
		River chief	0.025
		Outflow	0.025
Preservation conservation	0.2	Groundwater depth	0.067
		Groundwater recharge water	0.067
		Reservoir water storage (Storage variable)	0.067
Protect the ecology	0.3	Algae diversity index	0.15
		Submerged plant diversity index	0.15
Water quality	0.3	Water quality compliance rate	0.3

Conclusion

The quantitative evaluation of the relative implementation effect of multiple schemes and multiple objectives is realized, and the evaluation criteria are established, and then the main factors affecting the scheduling effect are determined.

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