

# Evaluation of the comprehensive measures and their effect for groundwater over-extraction in Beijing

Professor Binghua Li  
Beijing Water Science and Technology Institute

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In 2019, Beijing released an Action Plan for Groundwater Overextraction.

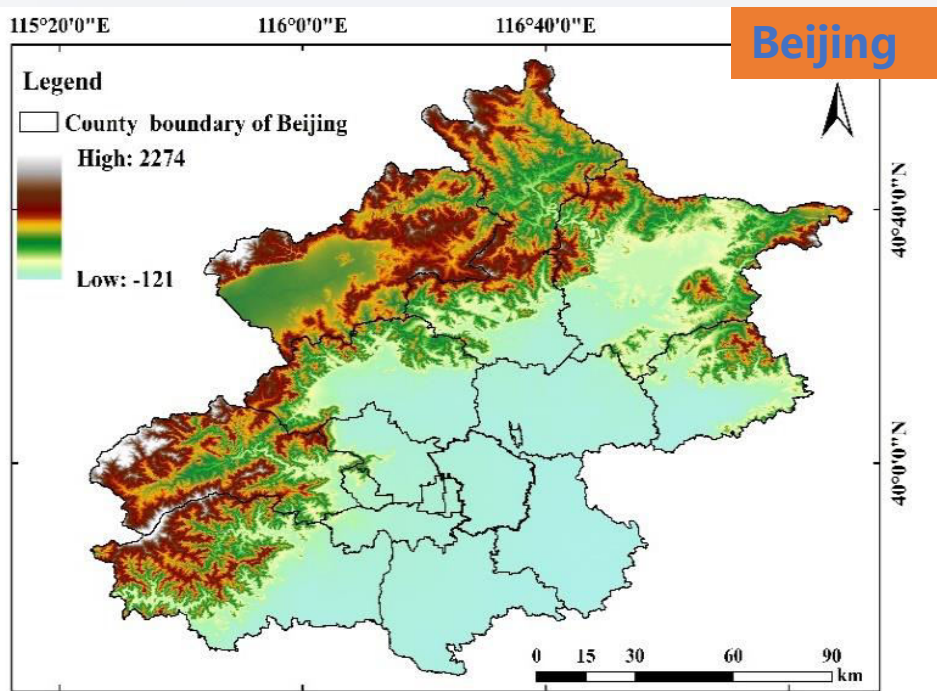
In 2022 and 2023, Beijing was preparing for formulating the next plan for groundwater overextraction.



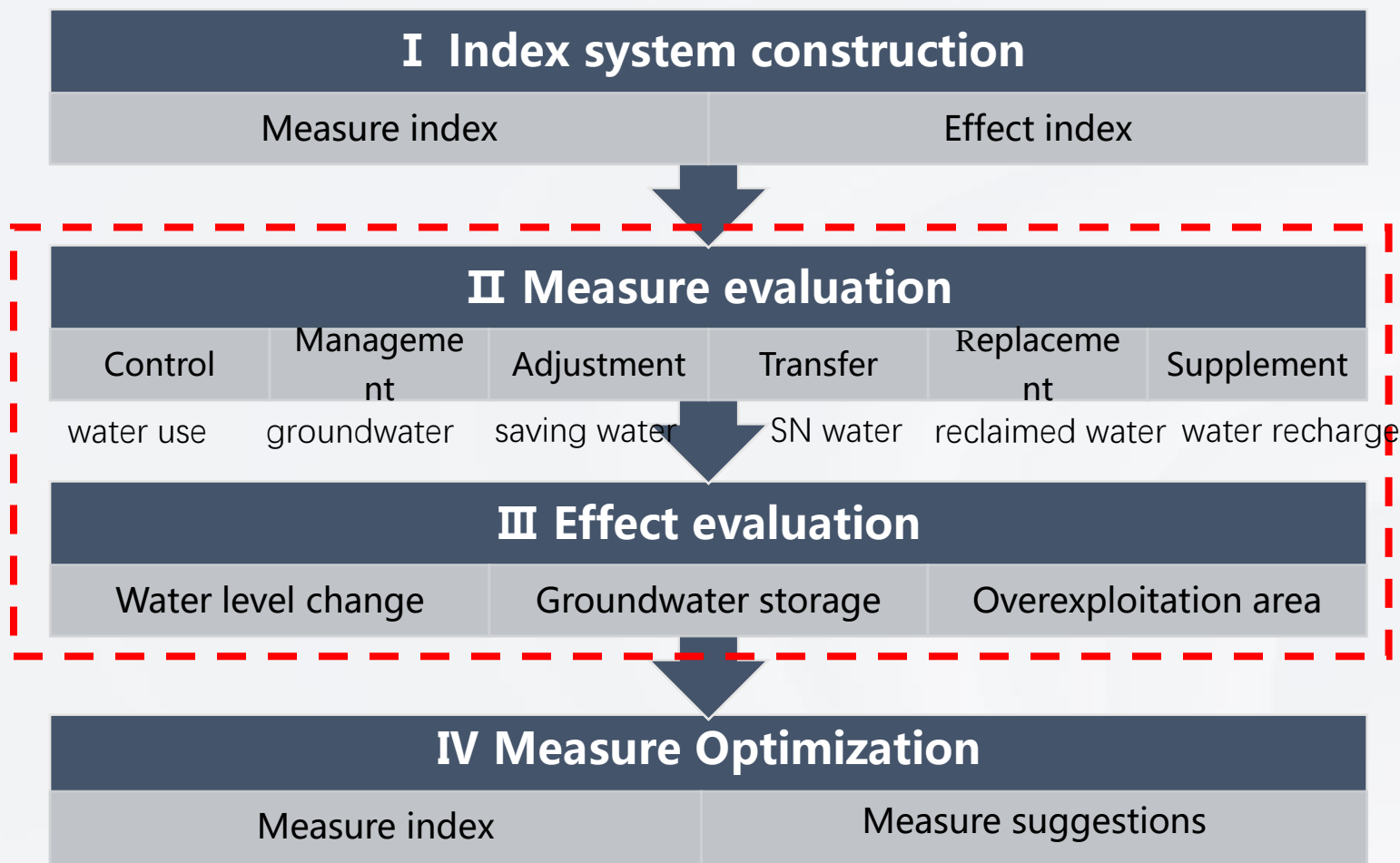
We should know the implementation of those measures and their effect.

Thus to give optimization measures for groundwater overextraction in the future, then promote the sustainable use of groundwater.

The evaluation was carried out from two aspects, one for those measures and the other for their effect. At each aspect, quantify was conducted by different indexes respectively.



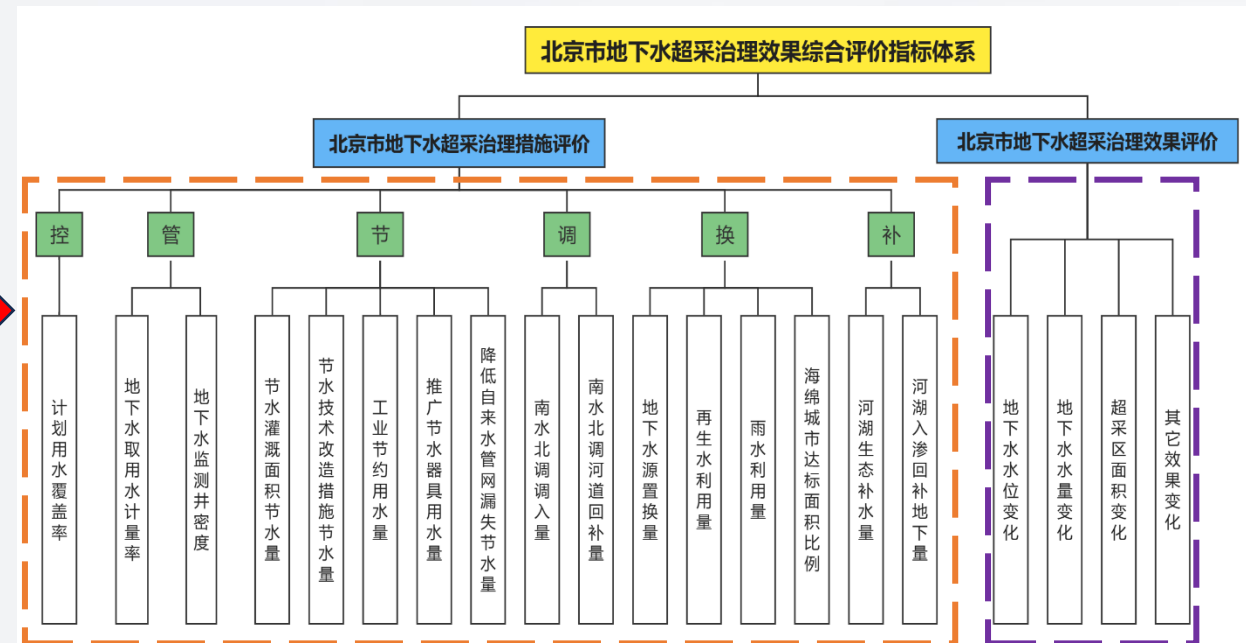
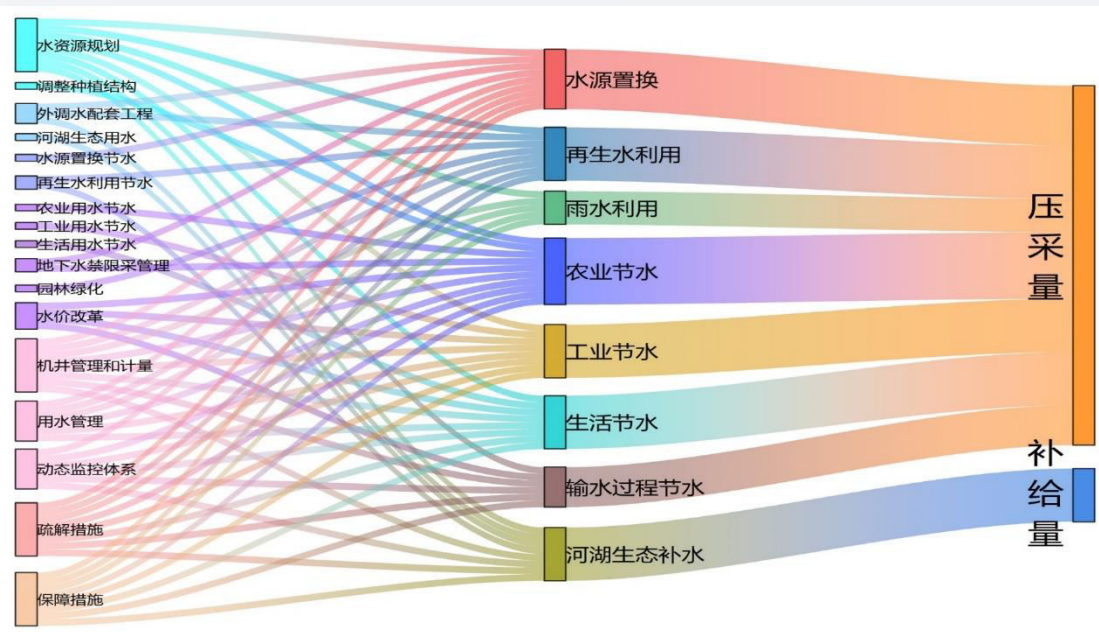
**Study Area**



**Evaluation Technology Route**



- Based on the measures in Action plan of groundwater overextraction in Beijing.
- Index system was given, including 16 indexes for the implementation of measures and 4 indexes for their effect.



**The relationship between measures and tasks**

**Multi-theme, multi-dimensional, multi-level measures and effect indexes**

# II Method

## Comprehensive Index of Groundwater Overextraction Control Measures

$$X = C_n / C_{2018}$$

$$Z_j = \sum_{i=1}^n W_i X_{ij}$$

Change of groundwater storage

$$\Delta Q = \mu V = \mu A \Delta H$$

Task	measures	measures weight	index	index weight
Evaluation of Groundwater Overextraction Control Measures	water use	0.04	计划用水覆盖率 (%)	0.043
	groundwater management	0.06	地下水取用水计量率 (%)	0.049
			地下水监测井密度 (10 <sup>-3</sup> 眼/km <sup>2</sup> )	0.016
	saving	0.09	节水灌溉面积节水量 (万 m <sup>3</sup> )	0.047
			节水技术改造措施节水量 (万 m <sup>3</sup> )	0.008
			工业节约用水量 (万 m <sup>3</sup> )	0.014
			推广节水器具节水量 (万 m <sup>3</sup> )	0.004
			自来水管网漏失节水量 (万 m <sup>3</sup> )	0.019
	transfer water	0.25	南水北调调入量 (万 m <sup>3</sup> )	0.043
			南水北调河道回补量 (万 m <sup>3</sup> )	0.206
	replacement groundwater	0.17	地下水源置换量 (万 m <sup>3</sup> )	0.073
			再生水利用量 (亿 m <sup>3</sup> )	0.059
			雨水利用量 (万 m <sup>3</sup> )	0.021
	recharge	0.39	海绵城市达标面积比例 (%)	0.012
			河湖生态补水量 (亿 m <sup>3</sup> )	0.148
			河湖入渗回补地下水量 (万 m <sup>3</sup> )	0.240

## Measure Evaluation

- The groundwater extraction was decreased from **1.626 billion m<sup>3</sup>** in 2018 to **1.392 billion m<sup>3</sup>** in 2021, a decrease of 14.4%.
- A total of **3.118 billion m<sup>3</sup>** of Southern to North Water have been transferred to Beijing, of which **1.96 billion m<sup>3</sup>** have been allocated to various centralized **water supply plants**, **176 million m<sup>3</sup>** have been stored in reservoirs, **504 million m<sup>3</sup>** was used to recharge undergroundwater.
- The water consumption for **industrial added value of 10000 yuan** has decreased from **7.97 m<sup>3</sup>** in 2018 to **5.17 m<sup>3</sup>** in 2021.



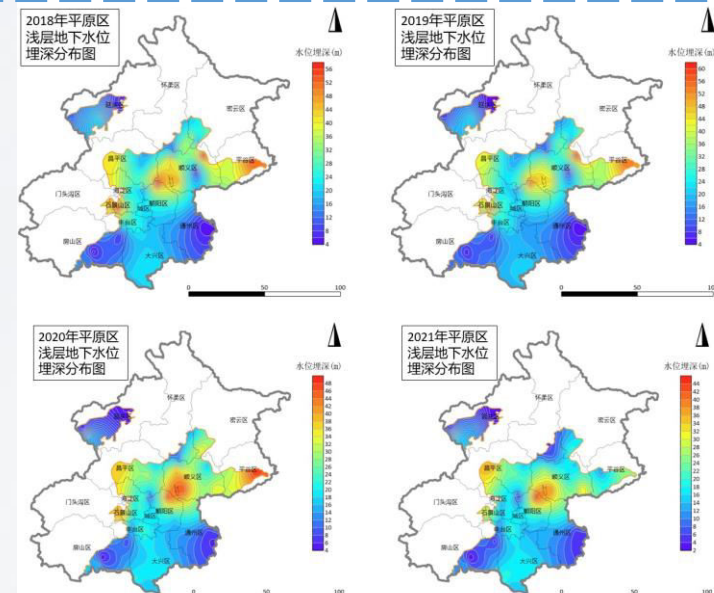
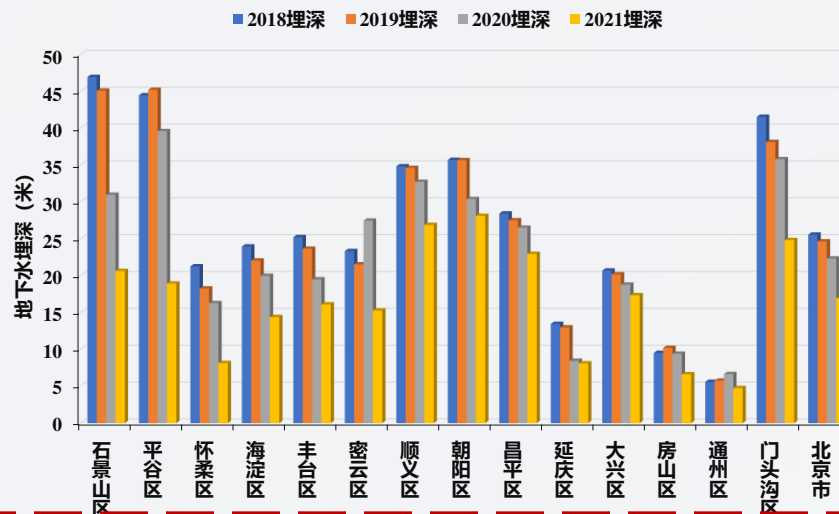
South-to-North Water Transfer Project



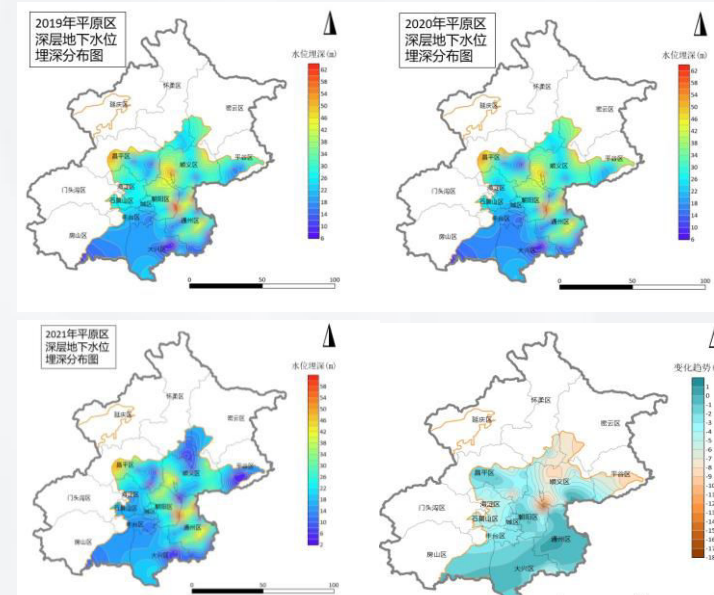
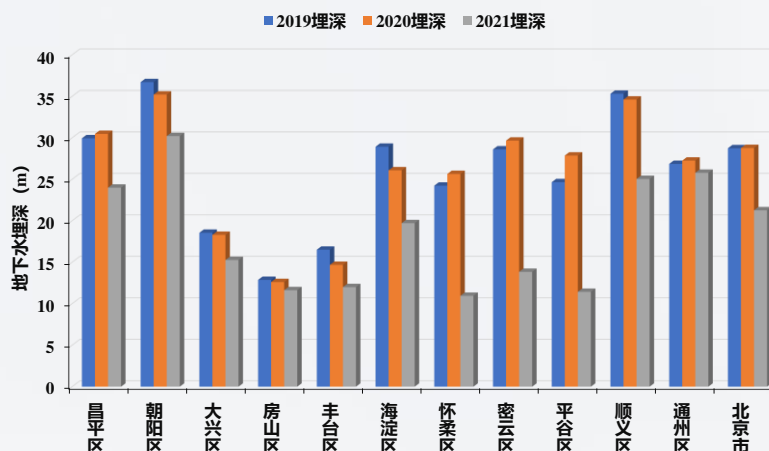
## Effect Evaluation

- The shallow groundwater level in the plain area have increased by **6.64 meters** from 2019 to 2021.
- The deep groundwater level **have increased by 7.48 meters** from 2019 to 2021.
- The rising of shallow groundwater level in **Shijingshan District** was the highest, 26.33m.
- While the average recovery rate of that in **Tongzhou District** was the lowest, 0.84m.

## Shallow Groundwater



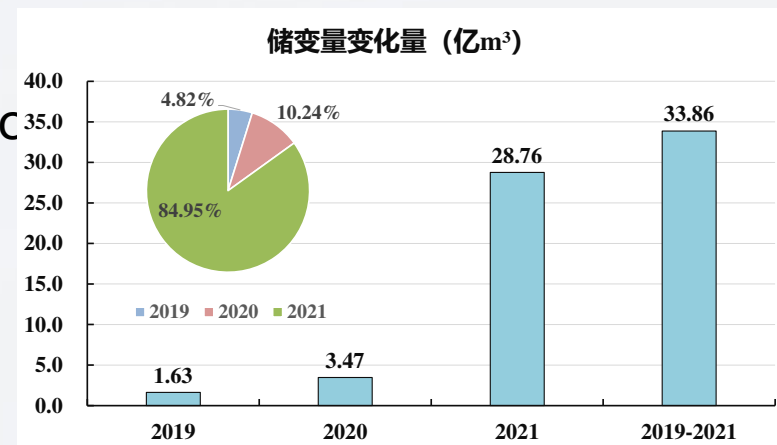
## Deep Groundwater



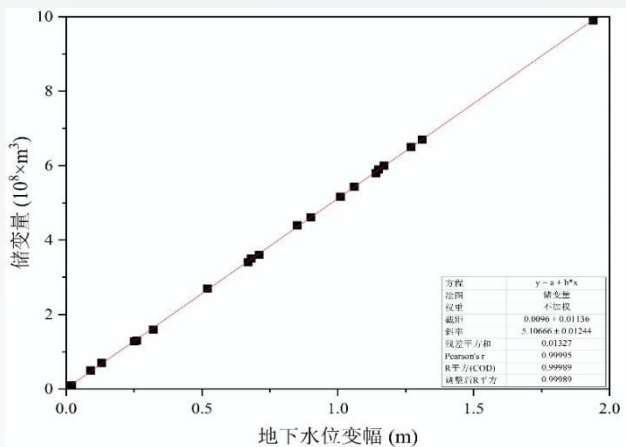


## Effect Evaluation

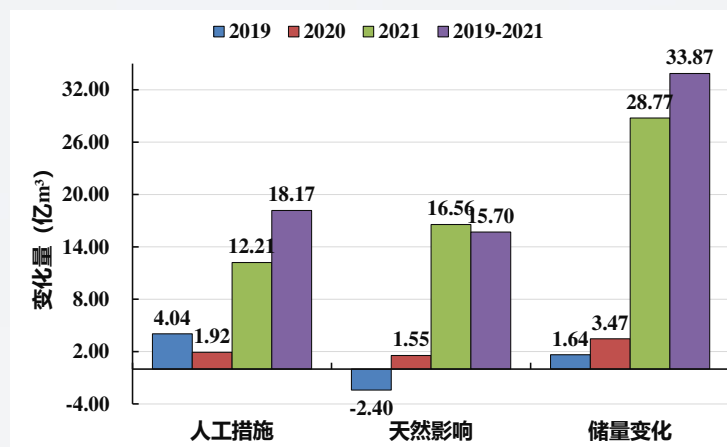
- The groundwater storage increased by **3.386** billion m<sup>3</sup> from 2019 to 2021.
- Artificial measures** accounted for **1.817** billion m<sup>3</sup>, while **natural factors** (mainly increased rainfall infiltration recharge and piedmont lateral recharge) amounted to **1.57** billion m<sup>3</sup>.



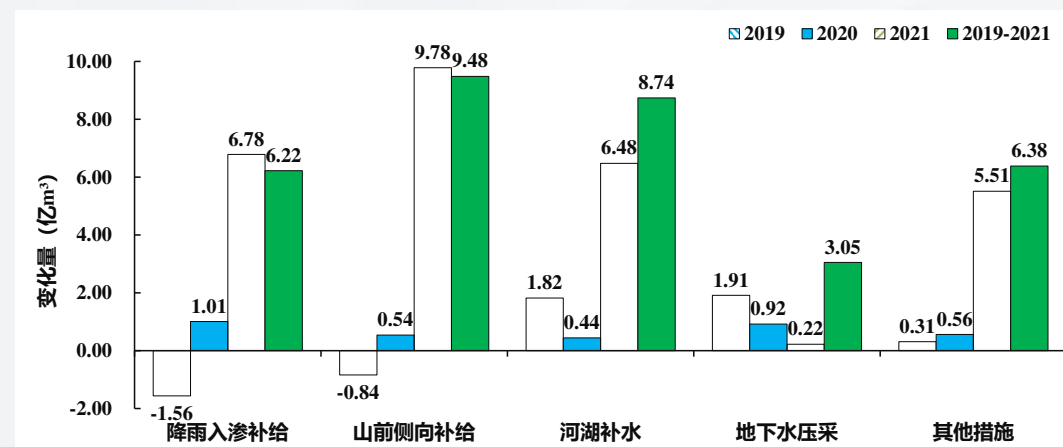
**Change of groundwater storage in 2019-2021**



**Groundwater storage variable linear fitting graph**



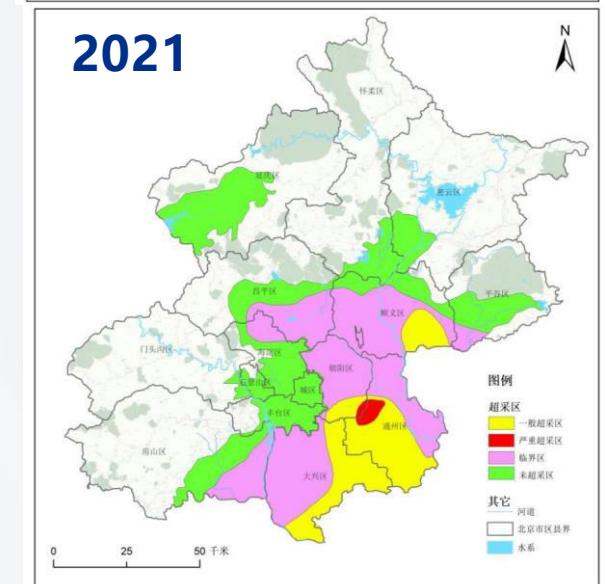
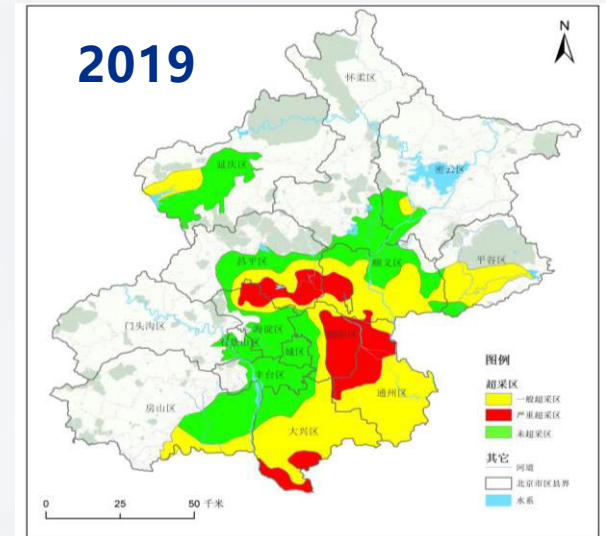
**Chart of artificial and natural impacts**



**Effect of different measures**

## Effect Evaluation

- From 2019 to 2021, the **total groundwater overextraction area** in Beijing plain was reduced **2934 square kilometers**, a decrease of **71%**.
- Of which the **severe groundwater overextraction** area was reduced **1037 square kilometers**.
- and the **light groundwater overextraction area** was reduced **1897 square kilometers**.
- The number of administrative districts involved in overextraction areas decreased **from 8 to 3**.

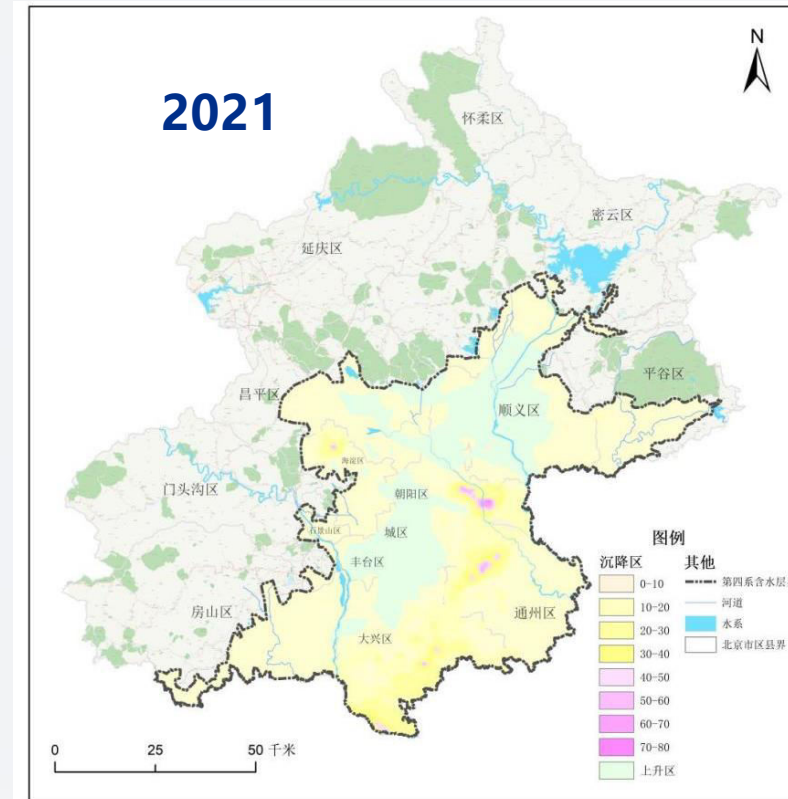
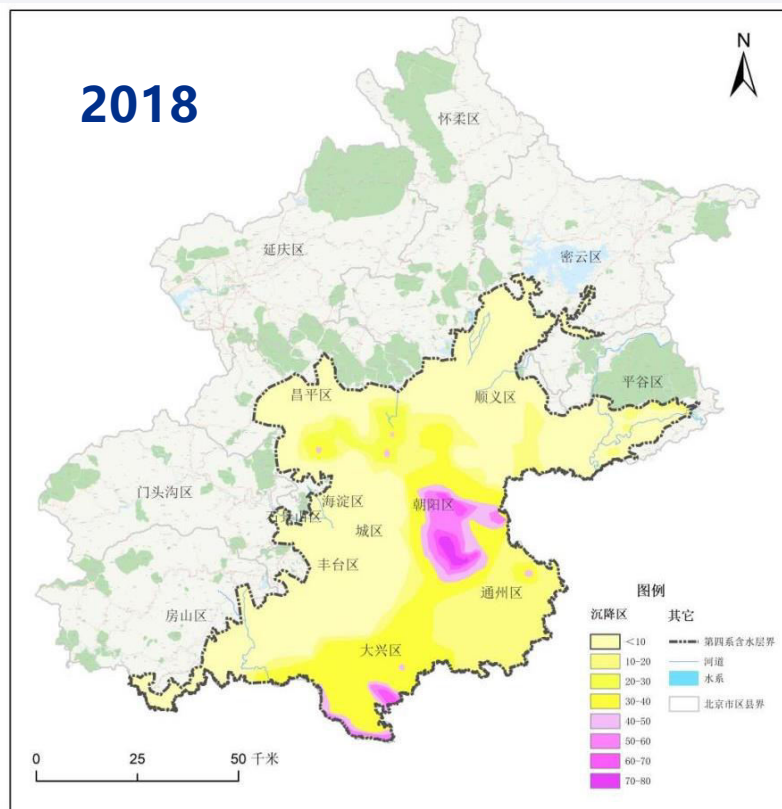


**Different degrees of groundwater overextraction in Beijing Plain**

# III. Evaluation of measures and its effect

## Effect Evaluation

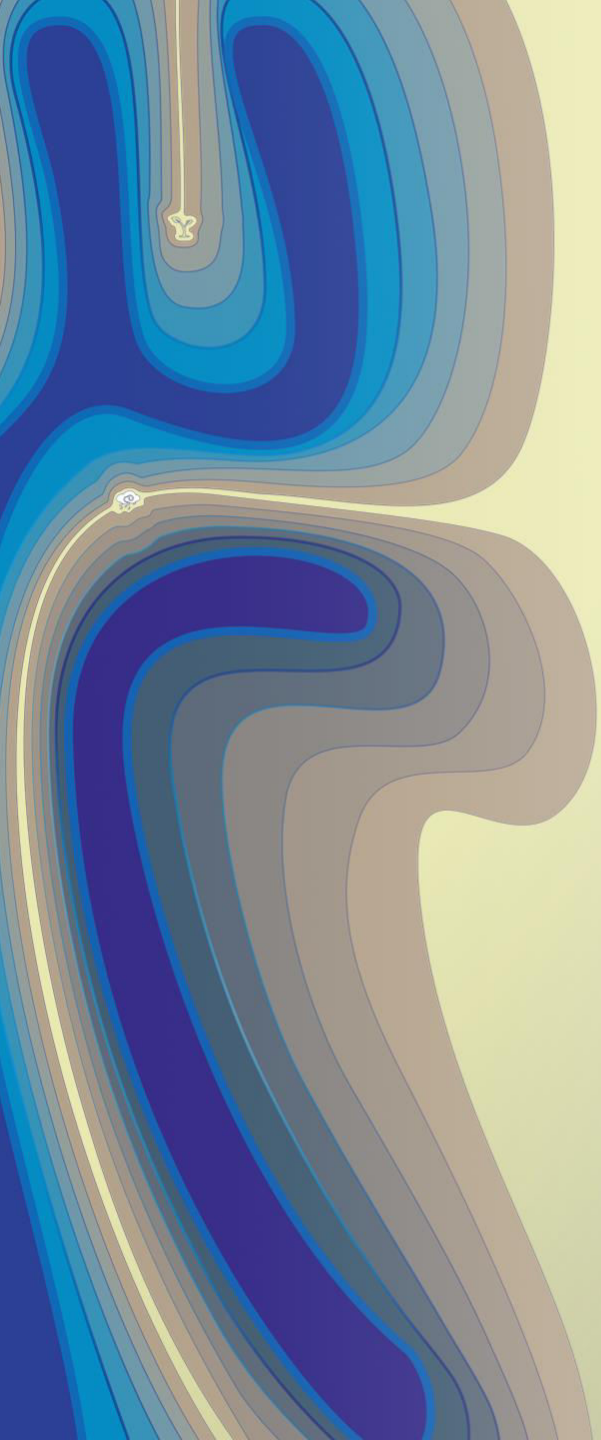
- The regional average land subsidence rate decreased from **13.32 mm/year** in 2018 to **8.73 mm/year** in 2021.
- The area of severe subsidence areas with annual rate greater than 50 mm decreased from **330 square kilometers** in 2018 to **16 square kilometers** in 2021.



**Map of land subsidence in Beijing**

- ◆ Comprehensive measures of Groundwater Overextraction were well done in Beijing.
- ◆ The groundwater level and storage were obviously restoration , and the regional average land subsidence rate decreased.
- ◆ There is still a significant deficit in groundwater reserves-over 2.5 billion m<sup>3</sup>, and it is necessary to continue to carry out groundwater recharge and management.





**Thank you!**