Analysis on Implementation Effect of Groundwater Over-exploitation Comprehensive Control Water Conservancy Project——Taking Linzhang County as an Example

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Abstract. In order to effectively solve the problem of over-exploitation of groundwater in Hebei Province and achieve the balance of groundwater recovery, Hebei Province began to conduct pilot research on comprehensive management of groundwater over-exploitation in 2014. Taking Linyi County in the south of Hebei Province as an example, this paper studies the effect of pressure extraction on groundwater over-exploitation comprehensive treatment of water conservancy projects in 2015, analyzes and summarizes the experience, deficiencies and improvement measures of groundwater pressure mining work, in order to follow the groundwater pressure mining work. Provide guidance for reference. The results show that: Linyi County's 2015 water conservancy project achieved a pressure recovery capacity of 4.02 million m³, and the water-saving pressure mining effect was remarkable. Among them, the sprinkler irrigation water-saving facilities have an average water saving capacity of 105 m³/mu, and the water-saving efficiency is obvious. In addition, the next stage of work should pay attention to the study of water-saving measures based on water-saving management and regional agriculture represented by crop planting structure adjustment. Irrigation pattern, implementation of field engineering work, to form a regional scale, intensive water-saving irrigation pattern, promote the promotion and application of groundwater over-exploitation comprehensive treatment in Hebei Province.

1. Foreword
The North China Plain is an important production area for vegetable and grain in China[1], and it has an important contribution to China's agricultural production. However, agricultural irrigation technology continues the traditional irrigation method, the water utilization coefficient is very low, and Hebei Province has a serious shortage of water resources. According to statistics[2], the amount of groundwater exploitation in Hebei Province accounts for more than half of the total water supply per year, reaching more than 16 billion cubic metres. Among them, deep groundwater exploitation accounts for about 1/4, and it continues to grow every year. It is a region with serious groundwater
over-exploitation problems in China[3]. In order to maintain the development of agricultural production, a large amount of over-exploitation of groundwater has to be carried out for a long time, which has led to a series of shallow deep groundwater level falling funnels, ground settlement cracks, seawater intrusion and other water environment and geological problems[4]. In addition, as the groundwater level continues to decline, the cost of pumping water for farmers is increasing, bringing some potential economic risks. Therefore, it is urgent to explore new agricultural water-saving modes to curb groundwater over-exploitation in Hebei Province.

The work of over-exploitation of groundwater has attracted the attention of relevant state ministries and commissions. The 2011 Central Document No. 1 proposes the overall goal of groundwater over-exploitation by 2020. In 2014, the pilot project of groundwater over-exploitation comprehensive control in Hebei Province selected 49 counties (prefecture-level cities and districts) in Cangzhou, Hengshui, Xingtai and Handan as pilot areas. In 2015, 14 counties (prefecture-level cities and districts) in Shijiazhuang City were added. On the basis of 2015, in 2015, 52 counties (prefecture-level cities and districts) in Baoding, Tangshan, Zhangjiakou and Langfang were added to the pilot areas of 115 counties (cities, districts) in 9 cities, and continued to be implemented. We will continue to implement water-saving and stable production technologies for winter wheat, integration of water and fertilizer for wheat and maize, conversion of farmland to forests, replacement of groundwater by surface water, and efficient water-saving measures in well irrigation areas. And We will vigorously promote the pilot study of groundwater pressure recovery.

Taking Linzhang County, the southernmost part of Hebei Province, as an example, this paper analyzes and studies the groundwater pressure effect of the 2015 groundwater over-exploitation comprehensive treatment water conservancy project (high-efficiency water-saving irrigation project and surface water replacement groundwater project in well irrigation area). The experience, deficiencies and improvement measures of mining work, in order to better achieve the expected goal of comprehensive treatment of groundwater over-exploitation in Hebei Province, improve management level, and provide decision-making basis for groundwater pressure mining in the next stage.

2. Hydraulic engineering measures

2.1. High-efficiency water-saving irrigation project in well irrigation area
The high-efficiency water-saving irrigation project in the well irrigation area is for the shallow and deep groundwater over-exploitation areas far away from the surface water irrigation canal system. Combined with the specific conditions of crop types, lengths, and well types in the project area, the promotion and application of high-standard pipe irrigation, micro-irrigation, small pipe outflow, sprinkler irrigation, drip irrigation and other water-saving irrigation facilities can improve the water resource utilization coefficient and reduce the traditional flood irrigation. Water wastage caused by irrigation to save groundwater.

2.2. Surface water replacement groundwater project
The surface water replacement groundwater project is mainly to make full use of the newly added water intake and local water volume, and to restore the expansion of surface water irrigation coverage area, including transportation, water storage projects and field projects. Field engineering is a high standard pipe irrigation project. The specific engineering measures include the expansion of surface water irrigation canal system, the construction of supporting facilities such as water pumping stations and gates, the construction of pit ponds and field projects, and the establishment of an irrigation system integrating introduction, extraction, storage, transportation and irrigation to maximize the use of surface water. Resources irrigate farmland and protect groundwater.
3. Overview of the implementation of Linzhang County Water Conservancy Project

3.1 High-efficiency water-saving irrigation project in well irrigation area

The implementation scale of the high-efficiency water-saving irrigation project in Linzhang County in 2015 is 24869 mu. Among them, 8837 mu of high-standard pipe irrigation project was added; 16032 mu of micro-irrigation and sprinkler irrigation projects were added. The supporting facilities include 323 submersible pumps and 323 smart wells. The specific implementation is shown in Table 1.

Table 1. Overview of implementation of high-efficiency water-saving irrigation project in Linzhang County 2015 well irrigation area

|                         | High standard pipe irrigation / mu | Micro irrigation, sprinkler irrigation |
|-------------------------|-----------------------------------|---------------------------------------|
|                         | Fixed / mu                        | Semi-fixed / mu                       | Center pivot / acre | Translating / mu | Drip irrigation / mu | Tubule outflow / acre | Total / mu |
| 8837                    | 10552                             | 3259                                  | 278                 | 247              | 202                 | 1494                 | 24869     |

3.2 Surface water replacement groundwater project

Linzhang County's 2015 groundwater over-exploitation comprehensive treatment of surface water replacement groundwater project involves 4 channels. And they includ 4 channels for dredging and remediation, with a total length of 18.65 km, with 26 supporting culverts, 54 pumping stations, and 15 eyes for power outages, develop 15,000 acres of field irrigation project.

3.2.1. River channel project. The river channel project has a total of 18.65 km of dredging and remediation and new channels, involving 4 channels. See Table 2 for the various pipeline projects.

Table 2. Summary of the implementation of the Linzhang County River Channel Project in 2015

| River channel name               | Water source | Remediation length (km) | Control irrigation area (mu) |
|----------------------------------|--------------|-------------------------|-----------------------------|
| Mahuang branch channel in the Minyou main canal | Zhang River | 4.95 | 3000 |
| Yougeliu branch channel in the Minyou main canal | Zhang River | 1.90 | 2100 |
| North two branch channel in the Minyou main canal | Zhang River | 2.40 | 2100 |
| South four branch channel in the Minyou main canal | Zhang River | 9.40 | 7800 |
| Total                            |              | 18.65                   | 15000                       |

3.2.2 Sluice and culvert engineering. The sluice and culvert project involves two control sluices and two box culverts on Mahuang branch canal, one intake sluice, two control sluices and eight box culverts on Yougeliu branch canal, one control sluice and one box culvert on the North Two branch canal, and four control sluices and five box culverts on the South four branch canal.

3.2.3 Pumping Station Project. According to the layout of field projects, 54 new pumping stations were built along Mahuang branch canal, Yougeliu branch canal, North two branch canal and South four branch canal in Linzhang County. Among them, there are 11 diversion channels in Mahuang, 7 diversion channels in Yougeliu, 7 diversion channels in North two and 29 diversion channels in South four.

3.2.4 Field Engineering. Field engineering is canal irrigation field engineering. Field plots are arranged along both sides of the canal, and each plot has its own water distribution system. The irrigation area covers a total area of 15,000 mu, consisting of Mahuang branch canal, Yougeliu branch canal, North two branch canal and South four branch canal. Among them, there are 3000 mu along
Mahuang branch canal, 2100 Mu along Yougeliu branch canal, 2100 Mu along North two branch canal and 7800 Mu along South Four branch canal.

4. Analysis of mining pressure effect of Linzhang hydraulic project

4.1 Determining irrigation quotas under different irrigation modes

Based on the current annual irrigation level, the irrigation experiments were conducted by using the ultrasonic flow method and volume method. We can determine the irrigation quotas of different crops under different water-saving irrigation modes in the project area and the corresponding irrigation quotas of different crops under the traditional irrigation modes in the non-project area. Comparing the irrigation quota before and after the implementation of Engineering measures, the average water saving per mu is determined, as shown in Table 3. Among them, the average water-saving per mu of sprinkler irrigation is obviously higher than other water-saving measures, and the water-saving benefit is remarkable, which is worth popularizing.

Table 3. Average water saving per mu of water-saving measures for high-efficiency water-saving irrigation project in Linzhang County Well Irrigation District

| Water-saving Measures                        | Before Implementation | After Implementation |
|---------------------------------------------|-----------------------|----------------------|
| High standard low pressure tube irrigation  | Winter wheat and      | Winter wheat and     |
|                                             | summer maize          | summer maize         |
| Sprinkler irrigation                        | 70                    | 70                   |
| Tubular outflow                             | 4                     | 4                    |
| Drip irrigation                             | 280                   | 280                  |
| Average water saving per mu                 | 28                    | 105                  |

4.2 Analysis of mining capacity

4.2.1 High Efficiency Water-saving Irrigation Project in Well Irrigation Area. According to the average water saving per mu under different crop irrigation modes and the implementation area of water saving measures in Linzhang County, the pressure extraction capacity of water saving measures in high efficiency water saving irrigation project in well irrigation area is determined, as shown in Table 4. The groundwater pressure recovery capacity of the high-efficiency water-saving irrigation project in the well irrigation area is 1.79 million m³. Among them, the high standard pipe irrigation project is 0.25 million m³, and the micro irrigation and sprinkler irrigation project is 1.54 million m³.

Table 4. Pressure-saving capacity of various water-saving measures for high-efficiency water-saving irrigation project in well irrigation area

| Water-saving Measures                        | Pressue mining capacity |
|---------------------------------------------|-------------------------|
| High standard low pressure pipe irrigation  | 24.7436                 |
| Sprinkler irrigation, micro irrigation      | 150.528                 |
| Sprinkler irrigation                        | 2.988                   |
| Tubular outflow                             | 0.707                   |
| Drip irrigation                             | 178.97                  |
4.2.2. Surface water replacement groundwater project. Before the implementation of the surface water replacement groundwater project in Linzhang County, the well and canal double Irrigation irrigation method was adopted, in which the surface water supply was 2.12 million m³. After the implementation of the water-saving engineering measures, the total water volume of the Luanhe River was 2.57 million m³, and the drainage irrigation area had the main canal, the Mayao Canal, the Liuliu Canal, the North Branch and the South 4, covering an area of 15,000 mu. The water requirement for irrigation is 4.2 million m³, and the water requirement for wool irrigation is 5.09 million m³. After the implementation of the water-saving engineering measures, the surface water supply cannot completely replace the groundwater. The newly-added water intake in Linzhang County was 2.57 million m³. After deducting the water loss from the irrigation channel, the surface water volume reached 2.12 million m³. According to the relevant technical specifications, the surface water volume in the field was converted to the wellhead water volume of 2.24 million m³, and the surface water replacement groundwater project was completed. The pressure-collecting capacity is 2.24 million m³.

4.3 Implementation effect
Conduct on-the-spot investigation on the implementation effect of the 2015 water conservancy project in Linyi County. The survey found that compared with the traditional irrigation method, the improvement of high standard low pressure pipe irrigation loss is not significant, and the improvement effect is about 10%; The water-saving effect of sprinkler irrigation is obviously higher than other water-saving measures, which is 3~5 times of other water-saving effects, saving time and effort, and being recognized by the majority of farmers; The effect of small tube outflow and drip irrigation on water saving is not obvious. In addition, farmers are accustomed to the traditional irrigation method, which is considered to increase production, is discarded after using one birth cycle, and has poor sustainability, which seriously affects groundwater pressure recovery effect.

The comprehensive management of groundwater over-exploitation not only pays attention to engineering measures to save water during the implementation process, but also pays attention to management measures to save water, and studies water-saving measures based on water-saving management and regional agricultural irrigation patterns represented by crop planting structure adjustment. Pay attention to the concept of agricultural water saving and the promotion and use of water-saving facilities, fully mobilize the peasants to participate in the field management work, gradually establish a new mode of field irrigation area for self-management management, and implement the field engineering work to ensure the groundwater pressure Effective implementation of work.

5. Conclusion
In 2015, Linzhang County achieved a comprehensive mining and water control project for groundwater over-exploitation, which achieved an oil-collecting capacity of 4.02 million m³. The high-efficiency water-saving irrigation project and the surface water displacement groundwater engineering in the well irrigation area are respectively 1.79 million m³ and 2.23 million m³, and the water-saving pressure mining effect is remarkable. Among them, the sprinkler irrigation water-saving facilities have an average water saving capacity of 105 m³/mu, and the water-saving benefit is obvious, which is worthy of promotion and application according to local conditions.

In the next stage, groundwater pressure mining should pay attention to research on water-saving measures based on water-saving management and regional agricultural irrigation patterns represented by crop planting structure adjustment, and implement field engineering work to form regional scale and intensive water-saving. The irrigation pattern, on the basis of abundance of abundance and groundwater dynamic balance, achieves a balance between supply and demand of water resources, minimizes the contradiction between regional water supply and demand, and achieves sustainable use of water resources and sustainable development of social economy.
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