

## Summary of water resources allocation in Linfen City

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**Abstract:** In this paper, the allocation of water resources index and the current situation of project construction in Linfen City, as well as the water extraction project of the main stream of the Yellow River are reviewed. Through the analysis, it is found that the main reasons for the insufficient use of the Yellow River main stream index in Linfen City include the need to improve the water supply engineering system, the need to improve the water supply security mechanism and the need to implement the agricultural water price subsidy. To solve these problems, this paper puts forward three suggestions: accelerate the construction of county small water network, accelerate the establishment of the Yellow River main stream water supply guarantee mechanism, accelerate the improvement of the Yellow River water price mechanism. These suggestions are expected to help Linfen solve the problem of insufficient use of indicators for the main stream of the Yellow River.

### 1. Introduction

Water resources are the basic natural resources for the survival and development of human society, and its rational allocation and efficient utilization are of great significance to the sustainable development of the region. Linfen City, located in the southwest of Shanxi Province, is a typical resource-based city. Water resources play an irreplaceable role in the stability and development of its social economy. However, with the rapid development of economy and the continuous growth of population, the contradiction between supply and demand of water resources in Linfen City has become increasingly prominent. How to allocate and utilize water resources scientifically and reasonably has become an urgent problem to be solved. The purpose of this paper is to comprehensively review the water resources allocation of Linfen City, deeply analyze the reasons for the insufficient use of the water extraction project index of the Yellow River main stream, and put forward the corresponding improvement suggestions. This study not only helps to deepen the understanding of water resources allocation in Linfen, but also provides useful reference for water resources management and utilization in Linfen and similar areas.

### 2. Summary of the basic situation of Linfen City

#### 2.1 Water resource index allocation and project construction status in Linfen City

First, Linfen city water resources index allocation. The surface water index of Linfen City is 699 million m<sup>3</sup> and the groundwater index is 240 million m<sup>3</sup>. During the "14th Five-Year Plan" period, the total water use control target of the city is 875 million m<sup>3</sup>, of which the minimum utilization of unconventional water is 57 million m<sup>3</sup>, and the water use efficiency control target index of the city is 12.5% and 8% lower than that of 2020 for 10,000 yuan of GDP and 10,000 yuan of industrial added value, respectively. In 2021, Linfen City has a total water supply of 719 million m<sup>3</sup> and a water consumption of 551 million m<sup>3</sup>, with an average water consumption rate of 77%. The water supply of surface water projects is 425 million m<sup>3</sup>, accounting for 59.1%; Groundwater extraction capacity was 242 million m<sup>3</sup>, accounting for 33.6%; The water supply from unconventional sources is 52 million m<sup>3</sup>, accounting for 7.3%. According to the basin area, the water consumption of the Yellow River main stream is 28.46 million m<sup>3</sup>, and the water consumption of the inflow into Fen is 20.44 million m<sup>3</sup>. The water consumption of Fenhe River system is 345 million m<sup>3</sup>, the water

consumption of Qinhe River system is 4.23 million m<sup>3</sup>, and the water consumption along the Yellow tributary is 27.63 million m<sup>3</sup>. According to water type, urban and rural domestic water consumption was 116.25 million m<sup>3</sup>, primary, secondary and tertiary water consumption was 569.63 million m<sup>3</sup>, and ecological water consumption was 36.13 million m<sup>3</sup>.

Compared with the control index, Linfen City still has a certain space in the total water consumption, but there are shortcomings in the water consumption by type and basin. Surface water: Linfen Fen River basin and along the Yellow tributary water withdrawal has basically reached the control index, Xiangfen County, Quwo County, Yicheng county surface water overload; The Qinhe River basin still has certain potential for development and utilization, and the lower reaches of Qinhe River in Anze County have large water space. The utilization rate of water in the main stream of the Yellow River is at a low level, and all counties in the receiving area have large utilization space. In terms of groundwater, Linfen City has slightly overextraction, and the overextraction is mainly distributed in six counties of Pingchuan, and Houma City has a large overextraction; In terms of unconventional water: the total utilization has not reached the minimum control target, except Yaodu and Hongdong due to more water use in the ecological landscape, the rest of the counties have not reached the control target. In terms of water structure, agricultural water accounts for 64%, while ecological water accounts for only 5%, and the water structure still needs to be optimized[1].

Second, water resources allocation project construction status. At present, Linfen City is continuing to promote the water network water supply system with Qinqin into Fen, Yumen Yellow River eastward expansion (long-term Guxian Shanxi water supply project replacement) and central Yellow River diversion and other key water transfer projects as the backbone, with storage reservoir and supporting pipe network and other nodal water source projects as the auxiliary. One is to introduce Qin into Fen water supply system. With Hechuan Reservoir in Anze County as the water source, the key project has been completed and put into operation to supply water to Linfen Basin, with a designed annual water diversion of 59 million m<sup>3</sup>. At present, the supporting projects: the main project of the water supply project and Chennan River reservoir has been completed; The water quality improvement project of Yinqin into Fenyadu special line is implemented in PPP mode. The project company has been established, the preliminary design has been approved, and the construction will start within the year. The second is to expand the water supply system of Yumen estuary. From Yuncheng Yumen pumping station, through the already built Yumen east expansion project to the south of the city Xiangfen, Houma, Quwo, Yicheng four counties and cities water supply, designed water supply capacity of 125 million m<sup>3</sup>. At present, the backbone project has been built, has achieved water supply to Yicheng County west Liang reservoir, Quwo County Huihe reservoir, Houma City two reservoir and Xiangfen County, Houma City county water supply, Quwo County agricultural water, Yicheng county industrial water pipe network project has not yet been implemented. The long term Guxian Shanxi water supply project can realize the artefact diversion water cover. The third is the central Yinhuang county water supply system. From Baode County Tianqiao Hydropower Station Yellow River to Xi County, Pu County, Daning and Fenxi County, Linfen City, the designed annual water supply capacity of 150 million m<sup>3</sup>. At present, the East main line, West main line and Puda branch tunnel of the central Yellow River diversion backbone project in Linfen City have been all through, but the Luliang section has not been completed. County-level supporting projects are planned to build 12 storage reservoirs, 26 pumping stations, and 422km water supply pipelines. Of the 14 projects planned for construction recently, 5 storage reservoirs and the central pumping station of Fenxi County small water network and the main body of the connection project have been completed, and 2 projects such as the connection section of Bangou Reservoir and Shenjiazhuang reservoir and urban water supply project are under construction, and the rest have not started. After the completion of the 14 projects, 75.84 million m<sup>3</sup> of water can be diverted to the four counties of Xi County, Pu County, Daning and Fenxi, effectively alleviating the local water difficulties.

At present, Linfen City has initially formed a "three vertical and three horizontal" water network system with Fenhe River, Qinhe River and Yellow River as the longitudinal line, and the three

major projects of drawing Qin into Fen River, east expansion of Yumen Estuary and central Yellow River as the horizontal line, but the county small water network supporting project is not perfect, affecting the benefit. At present, the city's external water transfer is only 0.8 million m<sup>3</sup>, which has a big gap with the total water supply capacity of the three major backbone projects.

To sum up, the comprehensive status of water resource index allocation and water use project construction in Linfen City is described above. It is found that although the total water use in Linfen City has reached a certain level, there are still some shortcomings in the water use by types and basins. For example, there are still many areas that need to be improved in surface water, groundwater and water use structure in Linfen City. In terms of water resources allocation, although the projects such as Qin into Fen water supply system, Yumen Yellow East water supply system, and Central Yellow county water supply system are still continuing to advance, which can alleviate the water difficulties of local residents to a certain extent, but due to the imperfect supporting projects of county small water network, these projects are still in progress. There is still much ground to be made up[2].

## **2.2 Water extraction project of the main stream of the Yellow River in Linfen City**

There are three types of projects in Linfen city that can make use of the water consumption index of the main stream of the Yellow River, which are the east expansion of Yumen water supply project of the Big water network, the middle yellow water diversion project of the big water network, and the irrigation project along the Yellow River.

First, the big water network Yu men mouth east expansion water supply project. Yumen East Expansion project is an important part of Shanxi's big water network, and it is a guaranteed water supply project for industrial, agricultural and rural life in Linfen and Yuncheng. The designed annual water supply capacity is 124.76 million m<sup>3</sup> (including adding 15 million m<sup>3</sup>/a industrial water supply in Xiangfen County). Xiangfen, Houma, Quwo and Yicheng counties in Linfen City are beneficiary areas. At present, the backbone water supply project has been supplied to the west beam reservoir of Yicheng County, Quwo County, Houma city, the second reservoir of the Huihe river, Xiangfen County, which is managed by Shanxi Huanghe Yumen Water Group Co., LTD., a subsidiary of Wanjiashai Water control Group. In terms of small water network, Quwo County has the conditions for industrial and agricultural water supply, Yicheng County has the conditions for water supply to Xiaohekou reservoir and industrial park, and Xiangfen County water source replacement project has been completed.

Second, the Yellow River diversion project in the middle of the big water network. The Central Yellow River Diversion Project is one of the backbone projects of Shanxi's big water network. It draws water from Tianqiao Hydropower Station of the main stream of the Yellow River in Bade County. The water transmission project includes the main trunk line, the West trunk line and the East trunk line as well as various branches, and Xi County, Pu County, Daning and Fenxi County in Linfen City benefit from the design annual water supply of 149.8 million m<sup>3</sup>, solving the shortage of local industrial and agricultural production and domestic water. At present, the Linfen section of the central Yellow River diversion backbone project has all been through, but the Luliang section has not yet been through. In terms of small water network, Fenxi, Xi County, Daning, Pu County four counties have basically implemented and completed the four storage reservoirs in Pu County Diao, Sigou, Fen Northwest Palm, Xi County Nanyu and Fenxi County small water network center pumping station and connection line project, and other county small water network projects, because the backbone project has not been transferred, it is currently unable to play a role.

Third, irrigation project along the Yellow River. It refers to three irrigation projects along the Yellow River in Xiangning County, Dongcheng in Ji County and Gechiyuan in Yonghe County respectively, which are constructed and managed by each county, with a designed total water withdrawal of 9 million m<sup>3</sup> /a, of which 3.6 million m<sup>3</sup> /a in Xiangning County, 2.4 million m<sup>3</sup> /a in Jixian County and 3 million m<sup>3</sup> /a in Yonghe County. At present, the project has been completed.

To sum up, after analyzing and summarizing the Yellow River main stream water extraction engineering field in Linfen City, it is found that among the Yellow River main stream water

consumption index projects in Linfen City, the east expansion water supply project of Yumen Estuary of the big water network has been completed well, and its conditions in industrial and agricultural water supply are mature. However, in the Yellow River diversion project in the middle of the large water network, because the backbone project has not been used, so that the county small water network project cannot play a beneficial role. In the irrigation project along the Yellow River, the project has been completed, but the procedures such as water intake permit have not been completed, and its benefits cannot be fully utilized for the time being. To sum up, the water use project of the main stream of the Yellow River in Linfen City has not yet brought into full play its overall benefits, and there are still many aspects that need to be further improved[3].

### **3. Reasons of insufficient use of main stream index of the Yellow River in Linfen City**

#### **3.1 Water supply engineering system still needs to be improved**

The water supply project of Linfen City still needs to be continuously improved, which is mainly reflected in the two projects of the east expansion of Yumen Estuary and the Yellow River diversion in the middle. In the east expansion of Yumen, Xiangfen County has no regulating reservoir, only rely on the water source replacement project of 152,000 m<sup>3</sup> regulating reservoir and industrial enterprise self-built regulating reservoir adjustment, Houma city no.2 reservoir supporting projects have not yet been built; In the central yellow diversion, although the Linfen section of the tunnel is all through, but the Luliang section has not yet been through, does not have the conditions to supply water to Linfen, the county small water network Fenxi, Xi County, Daning, Pu County have not all completed supporting projects, the size of the water network synchronous completion of the task is still difficult. Therefore, in the face of the major reality that the water supply engineering system needs to be improved, there are still many places that need to be constantly followed up in the construction and improvement of the large and small water networks.

#### **3.2 The water supply security mechanism still needs to be improved**

At present, all the water backbone projects of the Yellow River are constructed and managed by the subordinate enterprises of Wanjiashai Water Control Group, and a stable and reliable water supply mechanism has not yet been formed between local governments and water conservancy departments and water supply enterprises. With high industrial water prices, low agricultural water prices and some industries not yet ready for production (mainly the Yicheng County iron and steel industrial park), water supply companies cannot be motivated to supply water to agriculture, to a certain extent, the water has affected the benefits of the project play. Therefore, the sound of water supply security mechanism is still an important aspect that needs to be continuously strengthened.

#### **3.3 Agricultural water price subsidies still need to be implemented**

According to the "Shanxi Province large and medium-sized pumping station irrigation electricity price subsidy management Measures" (Jin Government Office (2009) No. 138), the east expansion of Yumen project to implement 0.06 yuan/KWH electricity price, irrigation charging water price shall not exceed 0.25 yuan /m<sup>3</sup>, the approved water price of more than 0.25 yuan /m<sup>3</sup> part of the provincial financial water conservancy fund subsidies. From the current situation, as the cost of water supply from the east expansion of Yumen Mouth to Linfen is about 0.6 yuan /m<sup>3</sup>, the subsidy funds cannot be fully in place, and the approved water price cannot be implemented. In addition, the water price cost of the county small water network does not bear the main body, and the agricultural irrigation water price is high, affecting the agricultural water utilization. In addition, because the irrigation project along the Yellow River has not been completed and accepted, has not obtained the water intake permit, has not been included in the list of agricultural water price subsidy pump stations, and has not yet enjoyed the subsidized electricity price of 0.06 yuan/KWH. Therefore, the improvement of agricultural water price subsidy is still an important issue that cannot be ignored.

## **4. Suggestions on improving the use of the Yellow River main stream index in Linfen City**

### **4.1 We will accelerate the construction of small water networks at county level**

The problem of insufficient use of the Yellow River main stream index in Linfen city has been troubling the local government and residents, so some measures need to be taken to improve it. In view of this problem, I think it can be solved by speeding up the construction of county small water network. Specific measures include vigorously promoting the preliminary work of the project, actively docking with large-scale state-owned water enterprises such as Wanjiazhai Water Control Group, and studying and determining the project investment, construction and management mode as soon as possible. This move can help speed up the start of projects and thus accelerate the construction schedule.

In the process of promoting the construction of small water networks, we can also seize the favorable opportunity of "moderately advanced infrastructure investment" proposed by the Central Economic Work Conference, and declare for investment in government special bonds. In this way, more financial support can be obtained, thus further promoting the landing and start of the project. Government special bond investment, as a long-term debt instrument, can provide a reliable financial guarantee for the construction of small water networks and help ensure the smooth progress of the construction [4].

At the same time, attention should be paid to the construction of small water networks, but also to ensure that the size of the water network synchronously completed and play a good role. This requires comprehensive consideration of various factors, such as financial support, technical equipment, staffing, etc., to ensure the comprehensiveness and effectiveness of the construction. Only when the large and small water networks can be built simultaneously and give full play to the benefits, can the problem of insufficient use of the main stream indicators of the Yellow River really be solved.

In general, by speeding up the construction of county small water network, we can effectively solve the problem of insufficient use of Yellow River main stream indicators in Linfen City. This requires the joint efforts of government departments, enterprises and all social parties to actively promote the preliminary work of the project, win financial support, and ensure the comprehensive and smooth implementation of the project. Only in this way can the improvement proposals truly bear fruit and provide better living security and environmental protection for local residents.

### **4.2 We will accelerate the establishment of a mechanism for ensuring water supply for the main stream of the Yellow River**

Linfen City is located in the middle reaches of the Yellow River, the whole territory basically belongs to the Yellow River basin. However, in recent years, due to the impact of climate change and human activities, the shortage of water resources in the main stream of the Yellow River has become increasingly serious, which has brought many difficulties to the life and production of local residents. In view of this problem, the paper puts forward some suggestions to speed up the establishment of water supply guarantee mechanism for the main stream of the Yellow River, in order to solve the current water supply dilemma effectively.

First of all, adhere to the government market "two hands", led by the city, Houma, Quwo, Yicheng, Xiangfen and other cities along the Yellow River participation. The government should play a leading role in resource planning and integration, guide the market to play a role in water supply security, and form a joint force of government leadership and market regulation. On this basis, we can negotiate and sign a strategic agreement with the management unit of the east expansion of the Yellow River, clarify the responsibilities and cooperation mechanisms of all parties, and jointly promote the establishment and improvement of the water supply security mechanism.

Secondly, it is suggested to develop and improve the annual water supply plan to fully mobilize the enthusiasm of the east expansion of Yumen estuary. Through scientific and reasonable formulation of annual water use plan, reasonable allocation of water resources in the main stream of the Yellow River to ensure the smooth implementation of water supply security mechanism. At the

same time, market means can be used to effectively dispatch the water resources of the main stream of the Yellow River to ensure the normal water demand of urban and rural areas.

In addition, it is suggested to increase the utilization rate of the Yellow River water index of the completed project, and explore the experience of establishing the water supply mechanism of the central Yellow River diversion project in the next step. By improving the utilization rate of the Yellow River water index, the current water shortage situation can be effectively alleviated, and experience and technical reserve can be accumulated for the construction of major water conservancy projects such as the Yellow River diversion project in the future. This not only helps to solve the current water problem, but also lays a good foundation for the future water supply security mechanism.

In general, it is an urgent task for Linfen City to speed up the establishment of water supply guarantee mechanism for the main stream of the Yellow River. Through the cooperation mode led by the government and the participation of the market, the annual water use plan is formulated to increase the utilization rate of water resources, Linfen City can effectively alleviate the current water use difficulties and ensure the normal life and production needs of residents. At the same time, it will also accumulate experience for the construction of future large-scale water conservancy projects and the continuous improvement of water supply security mechanism, and lay a solid foundation for sustainable urban development[5].

#### **4.3 We will speed up the improvement of the Yellow River water pricing mechanism**

Linfen City is one of the important agricultural production bases in the Yellow River basin. However, due to the insufficient use of the main stream index of the Yellow River, the problem of agricultural irrigation and ecological water shortage is caused. In order to solve this problem, I think we can start from accelerating the improvement of the Yellow River water pricing mechanism.

First of all, the funding problem can be solved by actively fighting for provincial financial water conservancy special water price (electricity price) subsidy funds. In this way, the financial pressure of agricultural irrigation and ecological water can be alleviated, and the needs of agricultural production and ecological environment can be guaranteed. Moreover, special funds can be set up by the municipal and county finance for agricultural irrigation and ecological water fees, and further increase capital investment to ensure that the water resources of the main stream of the Yellow River are rationally utilized.

Secondly, we can explore the implementation of "basic water charge + metering water charge" two parts of the water price system to solve the problem of cost water price inversion. Basic water charges can be used to cover the basic operating costs of water resources management and water facilities, while metered water charges can be charged according to actual water consumption, which can be fairer to charge agricultural and ecological water, and also incentivize farmers and ecological water units to save water and improve water efficiency. This reform of the water pricing mechanism will help mobilize the enthusiasm of the east expansion of water supply and the masses, and promote the utilization rate of agricultural water indicators.

In general, we can solve the problem of insufficient use of the Yellow River main stream index by speeding up the improvement of the Yellow River water pricing mechanism. By introducing subsidy funds and adjusting water price mechanism, it can effectively improve the utilization rate of agricultural irrigation and ecological water, and then promote the sustainable development of agricultural production and ecological environment in Linfen City. It is hoped that the government departments can attach importance to this issue, intensify reform efforts, implement relevant policies as soon as possible, and make greater contributions to the rational utilization of water resources in the main stream of the Yellow River[6].

## **5. Conclusion**

In summary, Linfen City water resources allocation and project construction status is good, but the Yellow River main stream water extraction project has the problem of insufficient use of indicators. The reasons include the imperfect water supply engineering system, the imperfect water

supply security mechanism and the unimplemented agricultural water price subsidy. In order to improve this situation, it is suggested to accelerate the construction of county small water network, establish the Yellow River main stream water supply guarantee mechanism and perfect the Yellow River water price mechanism. Through these measures, we can solve the problem of insufficient use of the main stream index of the Yellow River in Linfen City and improve the efficiency of water resources utilization.

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