Theme: Finance, Food & Agriculture

CHINA HEBEI: DEVELOPMENT AND MANAGEMENT OF GROUNDWATER IRRIGATION IN HENGSHUI #312

The Taocheng District of Hengshui City is in extreme water shortage. The local government guides the farmers to participate in the management of irrigation and popularises water saving technologies.

Abstract

Description:

Water resources per capita in the Taocheng District of Hengshui City are only 120m^3. Surface water in the district is in extreme shortage and most of shallow groundwater in the district is saline water. Water demand has been maintained by overdraft from deep groundwater for many years. This resulted in a deep groundwater table descending by 2m per year, and the formation of a groundwater overdraft depression funnel area of more than 6300km^2 where the maximum ground depth reaches to 98m. This has been accompanied by serious problems such as ground settlement and saline water intrusion. The water administrative department took measures to implement integrated water resources management (IWRM) by setting up farmers Water User Associations (WUA); by applying measures of total quantity control, quota management, measuring water use at each family and encouraging economised users and penalising over-users; by distributing Water Use Certificates to each farmer family and water user; and by guiding the water users in water saving. The application of these measures has served to reduce groundwater overdraft.

The case has shown that: 1) the establishment of farmers WUA promoted the participation of stakeholders; 2) by approaches of integrated management combined with government unified management and water users' water saving self-management, the water-using relationship was improved and the water use efficiency was improved.

Lessons Learned

- It is ineffective to pay attention only technical measures while ignoring administrative measures.
- Establishing WUA, distributing Water Use Certificates and carrying out water saving self-management is a good way of mobilising stakeholders.

Importance of Case for IWRM

This case illustrates the scientific relevance and rationality of IWRM principles. It also demonstrates the important role of integration in water management.

Tools used

A1.2 Policies with relation to water resources
B2.1 Enforcement of the capability and right of participancy among civil associations;
C3.1 Improvement of water-using efficiency
C4.2 Communication with stakeholders

Key Words

Water Shortage, Groundwater Management, Public Participation, Water Saving.

MAIN TEXT

1. Problems

The Taocheng District of Hengshui City covers a total area of 590km2 (including urban and suburb areas), of which 31,127 hectares are farmland. The total population reaches 470,000, of which 200,000 are farmers. The annual rainfall of the total region is 513 mm, and the available water resources are less than 60,000,000 m3. Water resources per capita in the district are 120 m3, which is 1/18 of the national average; however, the practical average annual water use reaches to 145,000,000 m3 (of which 69% for agricultural irrigation). It is a region of extreme water scarcity in south-east plain of Hebei Province of China.

Although there are four rivers running through this region, the situation is described as "wherever a river, it is dry out; wherever water, it is polluted". The surface water is in extreme shortage, most of shallow groundwater is saline water, and the domestic and industrial water use has been narrowly maintained by the overdraft of deep groundwater in many years.

The District is one of the old well irrigation districts, with 2206 pumping wells supporting an effective irrigation area of 26620 hectares. In the past decade the average annual agricultural irrigation water is 100,000,000 m3, of which 75% depends on groundwater overdraft. This has led to a deep groundwater table descending at 2m per year, and formation of a groundwater overdraft depression funnel area of more than 6300km2, of which the maximum ground depth reaches to 98m. Meanwhile, many serious problems occurred such as ground settlement, shallow saline water intrusion to deep fresh water. This led to deeper and deeper well digging (from 30m to above 300m), and the cost of irrigation was increasing constantly (the electricity was charged from 0.1RMB/ m3 to 0.55RMB /m3).

Many disputes occurred because of water using and the comparative benefit of agriculture was descending. These problems were caused by many reasons. Objectively, it's in extreme water scarcity (only 1/60 of the water per capita of the world average). Subjectively, there are two reasons. Firstly, scientific knowledge is insufficient; the awareness of water saving is poor. Many farmers bear the wrong concept that more irrigation will yield more production. Therefore, they consume water without measurement, and the water use is doubled compare to better irrigation. Secondly, it is only focused on engineering water-saving measures while ignoring managerial methods concerning institutional and mechanism aspects and public participation, and this resulted in unclear responsibilities, rights and benefits, ineffective management, and the efficiency of water saving was not obvious.

2. Decisions and Actions Taken

To solve the problem of groundwater overdraft, since 1985, the Provincial Department of Water Resources started to popularise the rational irrigation system and the techniques of pipe water supply and border irrigation. Another technique of irrigation with mixed saline water and fresh water was popularised after 1998. In 2002, the Ministry of Water Resources began to set up some pilot water-saving districts. The provincial government selected the Taocheng District as one of the provincial pilots, and worked out an implementation plan together with the local government and local water resources bureau. The plan including setting up a water management mechanism of government regulation, a market guidance and public participation, and the water resources bureau of the district conducting the macro regulation and control and unified management of water resources. Furthermore, it also included farmers' water user associations (WUAs) for the democratic water resources management for the allocated water; applying measures of total quantity

control and quota management, as well as measuring water use at each family and encouraging economised users and penalising over-users.

In 2004, the district government selected the Zhonggao Village as the pilot village (with a population of 473 from 146 families and a total farmland of 94.3 hectares). By 2005 this piloting practice has been popularised in 21 villages of three towns and was proving to be very effective. For example, in 2005 water use reduced by 20% or above compare to 2004.

2.1 To popularise Water-Saving Technology

In the 1990s, after scientific experiments, the irrigation times of wheat was reduced from 5-6 to 3-4 times, by which 2400 m3 water was saved per hectare on average. Meanwhile, subsidies to the investment of the fixed pump well pipelines were supplied by the government – 750-1500 RMB for each hectare to stimulate farmers' motivation to popularise water-saving irrigation. Farmers were assisted in the program of pipe water supply and border irrigation.

In the program, after the levelling off of farmland, more than 300 pieces of borders were made in each hectare. The water from pumping the wells is transferred to farmland by hard plastic underground pipelines, and then poured into borders using soft-plastic pipes. An alternative approach is the re-shaping of wheat land belonging to each family into long smooth pieces of farmland after levelling off and then irrigating each piece land by soft-plastic pipe (see figure 1).

Compared with trench irrigation, much water and electricity were saved, and irrigating efficiency was improved by 20-30% while about 10% of farmland occupation by trenches was saved. At the end of 1990s, another technology of irrigation with mixed saline water and fresh water was popularised. The deep fresh water and irrigating cost were saved by exploiting the local shallow brackish water. A total of 50% of the shallow-well construction cost was subsided by the government (generally 5000RMB for each well). Each deep pumping well was matched with 1-2 shallow pumping wells, which made a group of mixed irrigating wells. The brackish water (materialised degree is 3g/L or less) from the shallow wells was mixed with fresh water (materialisation degree is controlled at 2g/L or less) from deep wells. The mixed water in the mixing tank (see figure 2) was supplied by underground pipelines and connected by soft plastic pipes for watering. In each well group, 1/3 of deep fresh water and electricity were saved, and the irrigating times and cost were saved at the same rate. Consequently, this method was well received by farmers.

As shown from data of 40 years' observation in Nanpi experimentation station of Hebei Province, and together with the many years' practice of mixed water irrigation in the Taocheng District, it is confirmed that no side effect will be produced to crops and soils, as long as the materialisation degree was controlled below a salinity of 2g/L.

Figure 1. Pipe Water Supply and Border Irrigation Site

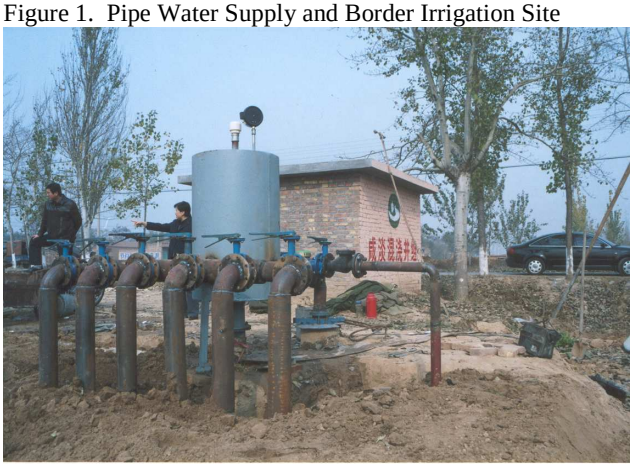

Figure 2. Irrigation with Mixed Saline Water and Fresh Water

2.2 To set up farmers' Water Using Associations (WUAs)

WUAs in the Taocheng District are civil organisations guided by government and established voluntarily by farmers. In rural areas they are set up by villages, while other water user organisations were established by units. The composition of the association and its management system must be passed through by people's plenary meeting with democratic voting. The association tries to strive for the rights and interests of water users. Meanwhile, it also manages and supervises water users practically.

The associations carry out three steps in management. Firstly, apply the method of water use measurement. The principles are total quantity control, quota management, measuring water use at each family and encouraging economised users while penalising over-users. It could be measured by water used, or by electricity consuming for pumping.

Secondly, there is the establishment of a management system. The management is conducted at an administrative level and self-management level. At the administrative level, many regulations and rules were formulated in the Taocheng District. For example, water resources allocation plans, regulations and rules for water use certificates; regulations for the organisation of water users; statutes for the organisation of water users; regulations for water use checking; and the rewards and punishment systems. At the self-management level, the association formulates the statutes of the WUA; regulations of domestic water management; the Water Allocation Plan; regulations of irrigation management; rules for water charge collection: rules of reward and punishment; as well as a responsibility system of pumping well management.

Thirdly, the association distributes water use certificates. The total volume of allocated water of each family and the actual water consumption volume in irrigation were recorded in the Water Use Certificate. With this method, farmers were clearly informed about their allocated volume and their actual consuming as well as their electricity fees. The water saved or a lower quantity used, can be traded freely.

2.3 Implementation of the principles of total quantity control, quota management, measuring water use at each family and encouraging economised users and penalising over-users

Total quantity control means to control the source of water use. The control period is an irrigating year (from September 1st to August 31st of the following year). The available total water quantity of the whole year is initially calculated by the County Water Resources Bureau. Based on this calculation, 90% of the total quantity is allocated as total quantity. It is then broken down level by level: Firstly to each town, then to each village or water user association, which will be allocated to water users by distributing the water user certificate. If the allocated quantity is insufficient, the consumer can buy water at 20-30% above the standard price. Another way to get more water can be free trade between water users.

Quota management is to control the water use process (irrigating rotation). Each pumping well is equipped with a water meter. The irrigation quota of each time is set by the calculation of a weighted average water use by each hectare after each irrigating. Based on this quota, the consumer will be rewarded (more than 5% below the quota) or punished (more than 5% above the quota). The one who use water within ±5% of the quota will not be rewarded or punished. See the following table:

Water use less or more than the quota	Water-Saving Rewarding Amount (RMB)	Overuse Penalty (RMB)
<10 m^3	0.03	0.03
10-20 m^3	0.07	0.07
>20 m^3	0.1	0.1

2.4 Enhancing the government guidance and promoting farmers self-discipline

After the founding of the farmers Water User Associations, the main tasks of the local government and the water resources bureau are:

- To strictly control the overdraft of deep groundwater;
- To implement the water saving self-management mode, including controlling the total quantity and quota of water use, measuring each family's water use, rewarding water saving and penalising over-users, carrying out self-governance of the association, and increasing marketing motivation and public participation;
- To guide the farmers and other water users to make self-management;
- To cultivate a water-valued, water-protected and water-saving environment;
- To construct a water-saving and pollution prevention society.

3. Outcomes

The following outcomes have been achieved among the pilot villages and the villages implemented the experience:

(1) The atmosphere of water saving is getting better and better. With the help of the certificate of water use, farmers are well prepared in mind. The first issue they consider now is what they will cultivate and how they can cultivate in a way of water saving. The WUAs awaken the farmers' awareness of water saving. The concept of

quota, reward and penalty is gradually accepted by water users. In the pilot villages, the water user who saved most was rewarded 14.29 RMB and the one who consumed the most paid a penalty of 14.35 RMB. The economical instrument greatly motivated water saving activities of farmers, which has transferred the concept from being required to save water into, "I want to save water". People always discuss on how to save water wherever they meet. The hot topic now is about how much water certain family used and how much they saved. Some farmers who did flood irrigation before now pratice point irrigation; some have dug shallow wells to apply irrigation with mixed saline water and fresh water; some have reshaped their farmland into small borders, renewed the old pipes with hard pipes and purchased soft plastic pipes, while transferring water to small borders with trenches and implementing border irrigation.

(2) The water saving effect is obvious. In a pilot village, 339 m^3 of water was saved in 2004 from each hectare comparing to the same period of the previous year; 20% or above of water was saved among 20 villages implementing the pilot experience. 1,000,000 m^3 of water and 250,000RMB of electricity cost of pumping well were saved. After the popularising of the pilot experience, it is estimated that the annual water saving quantity will reach 20,000,000 m^3 and 5,000,000RMB worth of electricity will be saved.

(3) The trend of groundwater table descending in deep groundwater is relieved. From 2003 to 2005, the annual water level descending rate reduced from 2m to 1m. The agricultural water saving has effectively reduced the groundwater table's descent, and played an active role in improving water environment.

(4) Agricultural structure is hastened to adjust. Some farmers initiatively studied scientific agricultural knowledge and chose to cultivate some high yield anti-dry crops and spices.

4. Prospect

At present, the main source of water supply for Hengshui city is still rainfall and flood resources conserved by the Hengshui Lake which is in the south of the city. By 2010, the north and east part of the South to North Water Transfer Project will be completed. As a storage lake of the Project, the surface area of the Hengshui Lake will increase from 42km2 to 82km2, and water storage capacity from 80,000,000 m3 to 180,000,000 m3. Both industrial and domestic water will be supplied by the Hengshui Lake. By building water saving society, the industrial and domestic water demand will reduce so that shallow groundwater quantity will increase. The reuse of the urban treated polluted water can supply about 30,000,000 tons water per year for agriculture. Therefore, the exploitation of shallow fresh groundwater will be reduced by 60% or above, while the deep groundwater table will ascend gradually. The water environment in the Taocheng District of Hengshui City will be improved remarkably.

5. Lessons Learned and Replicability

1) By setting up farmers Water User Associations and distributing the Water Use Certificates, stakeholders are encouraged to participate in water management, which speeds up the agricultural water saving process.
2) With the comprehensive management of the combination of government unified management and water users' water saving self-management, the water use relationship is clarified, which improved the water use efficiency.
3) The pipe water supply and border irrigation techniques and the reasonable irrigation management system are the effective water saving measures in well irrigation regions; in brackish water regions, alternative irrigation with mixed saline water and fresh water can effectively reduce deep groundwater exploiting, which can bring a satisfied effect in saving of water, electricity, time and finance.
4) There is still a great potential for water saving. In the pilot villages, water use of each hectare for the users who consumed the most is doubled than those who consumed the least. Therefore, there is a room for making further improvements and popularisation of the pilot experience.

5) Lessons learned in this case can be referred to by the groundwater irrigation regions.

6. Contacts, references, organisations and people

Author: Mr.Wei Zhimin, GWP China Hebei;
Mr. Chang Baojun, Water Resources Bureau of Taocheng District, Hengshui City
Address: Hebei Provincial Water Resources Bureau, Fuqiang Street, Shijiazhuang City, Hebei, China
P.C.: 050011
Tel: 0311-85185960, 13513372050
Email: hbwfa@263.net

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Organisations and People

Hebei Provincial Hydraulic Engineering Society
Address: Hebei Provincial Water Resources Bureau, Fuqiang Street, Shijiazhuang City, Hebei, China
P.C.: 050011
Tel: 0311-86053194

Water Resources Bureau of the Taocheng District, Hengshui City
Address: No.65, Dongming Road, Taocheng District, Hengshui City,
P.C.: 053000
Tel: 0318-2124096