Managing evapotranspiration using quotas

Hai Basin, China

water scarcity impact

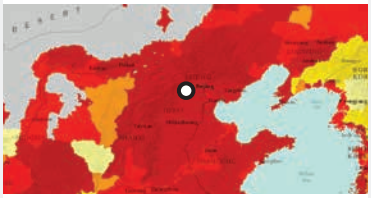
Reduced withdrawal	●
Reduced consumption	●
Improved water quality	
Increased productivity	●
Net basin benefit	●

volumetric impact
265 000 000 m^3/yr

programme cost
$14 800 000

estimated unit cost of water
<5 ¢/m^3

Water Stress
Hai Basin, China



Arid & low water use
Low (<10%)
Low to med (10-20%)
Med to high (20-40%)
High (40-80%)
Extremely high (>80%)
No data available

Water Stress Map:
Gassert, F., M. Landis, M. Luck, P. Reig, and T. Shiao. 2013. "Aqueduct Global Maps 2.0."

Confidence level
Low Medium High

Water Scarcity Impact Key
Main Minor

Credits
We wish to acknowledge the input of The World Bank in the preparation of this case study.

Project Overview

The Hai Basin is home to over 120 million people and is spread over four provinces and the municipalities of Beijing and Tianjin and accounts for some 15% of China's GDP. Water has played a pivotal role in the development of the Basin which is now facing serious water-related problems, including water pollution, water scarcity, diminishing water supplies and flooding. Water availability per capita in the Hai Basin is only 14% of the national average and about 4% of the global average. Over-exploitation of groundwater across the basin is estimated to be 9 billion cubic meters annually. The programme was developed to address the supply demand balance within the river basin, recognising the impacts downstream of the basin in the Bohai Sea ecosystem. The programme commenced in July 2004 and was completed in June 2011 and it involved the implementation of an integrated water and environmental management strategy in 16 counties. The pilot has proved successful in implementing reduced water quotas against improved water management practices, whilst supporting growth in farm incomes.

Key Elements

- Targeted reduction of consumptive water use, using water quotas supported by remote sensing (evapotranspiration).
- Institutional reform to improve co-operation across local administrations.
- Introduction of basin wide data management to improve data on water resources and to share data more effectively.
- Engagement of local communities including the use of incentives and support to farmers.
- Metering of irrigation systems to influence behaviour and to support more reliable collection of water charges.
- Legislative process to enforce irrigation quotas.

Key Outcomes

- At one location (village) water quotas reduced usage by approximately 40% (from 570 000m^3/year to 350 000m^3/year), whilst continuing to meet farmers' requirements for irrigation water.
- Reductions in water use were achieved alongside increased crop productivity within the pilot areas, with associated increases in income. This was achieved by diversification and adjustment of cropping patterns.
- Falling levels of groundwater over the last 30 years have been mostly reversed, ceased or in a few cases much reduced.
- Increased understanding of water issues within local decision making.

Hai Basin, China

Intervention Features

- Irrigation metering
- Remote monitoring and sensing
- Replacement of channels with pipes
- Enforcement of quotas
- Institutional reform
- Stakeholder engagement

Project Levers

(1) Consumptive Use Quotas:

Introduction of a new concept of real water savings which targeted a reduction in consumptive use or evapotranspiration (ET). This was targeted on the basis that experience in China has shown that improvements to physical infrastructure alone can increase irrigation efficiency but can also reduce groundwater recharge by increasing the proportion of rainfall or irrigation water consumed by crops through ET.

The project introduced ET quotas or targets, which were based on the actual ET measured with remote sensing technology and models of surface water and groundwater systems. As well as setting quotas this also acted to raise understanding of real water savings and sustainable water use.

(2) Institutional measures:

Institutional mechanisms were introduced to increase cooperation among government departments. This integrated institutional management proposed horizontal (cross-sectoral) cooperation between national, provincial and county equivalent agencies. The approach also included vertical cooperation between administrative levels, within the participating organisations.

(3) Water Data Capture:

A basin-wide Knowledge Management (KM) System (including application of remote sensing ET measuring technology) was installed at the Hai Basin Commission and local governments. This included decentralised knowledge hubs that made it possible to share and allocate data at both basin and county levels by local governments and water use sectors within the basin.

(4) Integrated Water Management Plans:

Development and implementation of sub-basin and county-level Integrated Water and Environmental Plans (IWEMPs) to return surface and groundwater use to sustainable levels consistent with the project's goals. This was achieved through ET quotas and targets for Water Function Zones (WFZ).

(5) Public Engagement:

Public participation was encouraged by establishing Water Users Associations (WUAs) and promoting Community Driven Development (CDD). The core value of the CDD/WUA approach was to mobilise farmers' incentives to participate in the project design, implementation, operation and management. The communities made their own decisions on cropping pattern adjustments to ensure that water was used for higher value crops to increase farmer incomes and the water saved was allocated to restoration of ecosystems.

Above: Nightscape of CCTV tower, Beijing (© Lizu Zhao | Dreamstime.com)

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Outcomes and Challenges

One of the key indicators for the success of the project was the reduction of groundwater overdraft used for irrigation. Falling levels of groundwater of the last 30 years have been mostly reversed, ceased or in a few cases much reduced.

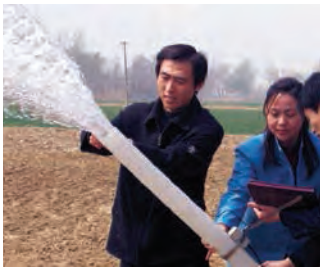
The project has also had a profound impact on the understanding of sustainable water resources management and the need to control water consumption (evapotranspiration) rather than supply.

Other impacts of the project on WUAs and farmer water users in Beijing and Tianjin include:

- Water use quotas have been much reduced, for example, in Beiguo village from 570 000m^3 in 1999 to 350 000m^3 in 2010. However, crop adjustments and water savings have more than compensated for this reduction. Farmers' requirements for irrigation water have been met and time and labour inputs have been reduced.
- As a result of improved infrastructure and management, the area of irrigated crops and proportion of cash crops, use of water saving crops and varieties, yields, water productivity and incomes have all increased. For example, farmers' income has increased from around 110 yuan/day to 220 yuan/day. In addition, labour hours for irrigation have also been reduced by around 35%.
- Water usage in Zhanglan village was reduced by 20-30% per annum after water supply was piped and power costs reduced by 25% by replacing worn out pumps. The replacement of irrigation channels with pipes has reduced the time for 1 irrigation cycle from 20-30 days to 7 days.
- The problem and difficulty of collecting water charges has been resolved through metering. Accessing funds for large scale infrastructure repairs or replacement became feasible through negotiation and making financing arrangements with village collectives.
- Women have been engaged in irrigation management. WUAs now require that women occupy more irrigation-related jobs.
- Elimination of the conflicts and disputes between users and between village leaders and villagers. As a result, the relationships have improved and, in particular, the rights and demand of the marginalised groups for water use has been satisfied.
- The skills and development of the people involved in WUAs is having wider and beneficial society impacts. It is also resulting in decision makers with water management backgrounds who appreciate the importance of water and its good management. Recent village level elections have resulted in many (about 600 of 10 000) water management agents being elected to Village Committees.

Some WUAs are still facing difficulties in implementing elements of the project. There is a need to:

- Continue to strengthen the WUA approach to water allocation, water planning, metering, water fee collection, cropping pattern adjustment, and water saving measures.
- Allow local flexibility and decision making in deciding cropping patterns within the overall water allocation so that higher water efficiency varieties of wheat and maize, which have low labour requirements, can be used.
- Involve water bureaus and township governments in ratifying the selection of water agents to reduce the negative impacts and loss of continuity that can result when village committees are changed.



"The project has also had a profound impact on the understanding of sustainable water resources management and the need to control water consumption rather than supply."

Above: Better water use and pollution controls in the Hai Basin has restored the environment and improved residents' health and living conditions. (© World Bank)