Adapting to Water Scarcity: Improving water sources and use in urban agriculture in Beijing

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SWITCH supports Huairou Cooperative in improving rainwater use
Photo: René van Veenhuizen

Beijing is facing a shortage of water. Because of a downward trend in rainfall, surface water is gradually drying up and the level of groundwater is declining. This decline in availability of water is affecting urban agriculture in the city. Innovations are being sought by both the government and farmers focusing on the use of new water sources, like reuse of wastewater and rainwater harvesting, and improved water management.

Although groundwater is still the main water source for urban agriculture in Beijing (90 percent in 2003), in some areas groundwater is not accessible anymore. In April 2007 the Beijing municipal government started to charge a fee for agricultural use exceeding a certain quota. Thus farmers are confronted with a rising cost of agricultural production. On the other hand, water use efficiency in agriculture is still comparatively very low.

The available surface water in Beijing decreased from 1.743 billion m^3 in 1980 to 0.447 billion m3 in 1995 and to 0.142 billion m^3 in 2003. The average water table of groundwater is more than 20 metres deep, and in some places more than 30, making it impossible for the farmers to use it.

The SWITCH programme supports the demonstration of multiple uses of rainwater, including an agro-tourism component, and by conducting research into water flows, water quality and the cost-benefit ratio of collecting rainwater (see UA-Magazine 19 for more details). This article puts the SWITCH activity in Beijing into a broader context.

Wastewater use

The use of wastewater has a long history in China. But not until 2000 did farmers around Beijing start to use treated water from the central wastewater treatment plants, which was initiated by the municipal government in an attempt to reduce depletion of groundwater. In 2004, only 70 million m3 of treated water was used for urban agriculture in Beijing. This amount increased to

In a SWITCH visioning workshop in Beijing in 2008, the Water Vision 2030 for Beijing was summarised by the SWITCH team as:

By 2030, the city of Beijing will have reached a higher level of sustainable urban water management. Balanced availability, supply and consumption of water will avoid depletion of groundwater levels, which will be restored to 1960s levels, and pollution will be minimised. Rivers and lakes will be protected or rehabilitated to meet Surface Water Quality Standards grade III and above, and rivers will flow all year round. Water quality at the tap will meet international drinking water standards.

There will be a high degree of equity and efficiency in water use, and different quality water will be used in different sectors as appropriate. Harmonised regional water use will be achieved through fair spatial allocation of water resources; conflicts between upstream and downstream areas will be avoided through negotiation and appropriate compensation. Good water governance, open public access to information, and participation of stakeholders in decision making will ensure a water-conscious society; and adequate planning will mitigate disaster damage.

230 million m3 in 2007 and accounted for about 20 percent of total water used for irrigation. The 11th five-year plan states that 400 million m3 treated water will be available for more than 0.66 million ha of croplands in Beijing in 2010, which is less than one quarter of agricultural land in Beijing municipality. Almost all kinds of crops and fruit trees are suitable for the use of treated wastewater. However, not all the farmers can access treated wastewater because they are located too far from the wastewater treatment plants.

Rainwater harvesting

In addition to the use of (treated) wastewater, the use of rainwater is an important (potential) source for the water needs of parks, gardens and agriculture in Beijing municipality. Rainwater harvesting systems are currently being promoted in residential areas in Beijing and in periurban agriculture.

Wastewater in Beijing usually receives up to the secondary level of treatment. The primary level removes the floating and suspended material, and the secondary level neutralises and disposes the wastes using biological matter. After the secondary treatment, the water can be used for agricultural purposes. Beijing discharges about 1.35 billion m³ of wastewater every year. One billion m3 of this is treated, of which 0.23 billion is used by agriculture, 0.1 billion by industry, and 0.05 by urban public utilities; whatever is not used is discharged. Clearly there is a big potential for using more treated wastewater for agricultural purposes. This is now promoted by all levels of government, and is reflected in the 11th five-year plan.

Capturing rainwater in residential areas of the city has been promoted since 2000. This includes techniques like porous pavement and roadside gutter collection of stormwater (rainwater from the roof and road) and storage in local deposit pools, after which this water is transferred to larger water-saving ponds for primary treatment (sedimentation). This water can be used for many purposes, such as irrigation of parks and gardens, aquifer recharge, maintaining water levels at small ponds and lakes in the city, and other uses like car washing (after some simple treatments). The number of projects introducing these uses has been increasing in Beijing, especially in the last two years. For example, in the Beijing National Stadium for the Olympics captured rainwater will be used for toilet cleaning, cooling towers, fire fighting, and irrigation of green areas (Scholes and Shutes, 2008). In 2006 more than 300 rainwater-collecting projects were implemented, and the capacity for collecting water In Beijing has consequently increased to 40 million cubic metres.

A wider diversity of crops can be grown in the greenhouse
Photo: René van Veenhuizen

Rainwater harvesting using roofs of houses in rural China has been practiced for thousands of years. Using the roofs of greenhouses to capture rainwater for irrigation of crops has been promoted since June 2005. Experiences with this were reported in UA-Magazine no. 19. These projects became popular because they are relatively simple to use and maintain, and because they are subsidised by the government. So far, twenty of these rainwater harvesting systems have been installed. On average, 200-300 m3 of rainwater can be collected per greenhouse (with a roof of 667 m2) each year, which can irrigate 2-3 times the same area with efficient irrigation (drip irrigation). The demonstration project of SWITCH in Beijing supports this work by analysing water flows, adding the use of wastewater, by conducting cost/benefit analyses of typical farming systems, and by linking other productive activities, like mushroom production and agro-tourism.

Challenges remain in terms of financial sustainability

So the potential of this technique is high, and given that there were some 20,000 ha of agriculture land under glasshouses in 2005 in Beijing, the current proportion of irrigation using rainwater harvesting is very low, accounting for less than 1 percent.

Improving water management

The Beijing Municipal Water Authority was founded in 2004, illustrating the beginning of reforms in the water management system of urban and periurban Beijing. Integrated urban-rural water management is being developed at four levels: municipality, districts and counties, water stations and at user (farmer) level. At the latter level, the Beijing Water Authority has village water managers and stimulates the organisation of farmers' water use associations or cooperatives. These village level associations manage issues such as access to water (and developing alternatives, like using wastewater and building rainwater harvesting structures), water pricing, irrigation practices, and quota management. By the end of 2006, Beijing had established more than 3,339 of these farmers' water use associations. Every villager (except the village leaders in order to prevent power from becoming too concentrated in the hands of few people) has the right to apply for the position of water manager, and selected villagers will receive capacity building training from the Water Authority. In December 2006, 10,800 farmers were appointed as water managers of their villages in Beijing (the total number of periurban villages in Beijing is 3,954).

Future perspective

Integrated reuse of wastewater, rainwater harvesting, and more

In December 2006, 10,800 farmers were appointed as water managers of their villages in Beijing
Photo: IGSNRR

efficient water use (e.g. by village water managers and farmers' water use cooperatives) are important technological and institutional innovations in Beijing. Challenges remain, especially in terms of financial sustainability. Farmers in Beijing municipality are used to having free access to all kinds of water for agricultural purposes. If a fee is charged, higher returns will also need to be established. But this also opens new opportunities to improve current farming systems. The SWITCH programme in Beijing, together with the RUAF-CFF programme, seeks to demonstrate a model of urban agriculture which incorporates multiple sources and efficient use of water and delivers higher returns by diversifying production and services. These higher returns not only compensate for water fees, but also enable farmers to pay for the relatively high investment in rainwater harvesting facilities.

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An example is the Caijiandian farmers' water use association, located in Xincheng Town of Miyun County. The association has 233 households. Its director, vice director and secretary were elected by members. Each household has an account number for its drinking water quota, which is published regularly. Farmers who want to use this water need to apply to the association 3 days in advance. The cost of drinking water is 1.48 RMB Yuan per ton, but farmers only pay 1 Yuan if their consumption quantity is within the quota. The Caijiadian farmers produce apples. By using more efficient methods and rational water distribution as promoted by the association, the farmers have substantially improved their quality and quantity of apples without consuming extra water. In addition, each household earned 1,800 Yuan (180 USD), which was higher than the previous year's average (Jinhuai Yang and Cailin Cui, 2005).

References
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The SWITCH programme collaborates with the Huairou Fruit and Vegetable Cooperative. The cooperative is located in An ge zhuang village, Beifang town, in Huairou district of Beijing, and was initiated in March 2004. The cooperative specialises in the production of vegetables, grapes and Chinese dates. At present, there are 1108 households in the cooperative who participate voluntarily. In an interview, the cooperative's chairperson, Ms Zan, discussed the importance of rainwater harvesting:
(..) The farmers of the cooperative used to use groundwater for irrigation, but in recent years, the water table has been drying up very quickly, and some wells cannot be used anymore. Digging deeper and pumping up water increases cost. (..)
Rainwater harvesting is therefore very important to the cooperative. A problem is the funding for the building of the rain harvesting systems. Despite the subsidies, not all farmers have access to it. SWITCH helps us improve the rain harvesting system. (..)

We are now using the underground space to plant mushrooms. The environment of the basement by the side of the water storage pool is quite good for growing mushrooms in terms of temperature and humidity conditions. Using the ground space can save us lots of money by making it easier to control growth conditions and it allow us to gain more benefits. (..) Agro-tourism is another opportunity to raise the value of our products. (..)
In addition, opportunities and constraints experienced by our cooperative as a result of rapid urbanisation need to be tackled by involving several institutions and stakeholders in the development of our cooperative and our search for sustainable use of the water. We are collaborating with RUAF on this. (..)