
Beijing: alternative water sources for peri-urban agriculture.

Building networks for sustainable use of rainwater and wastewater.

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I. INTRODUCTION

Beijing lies in the northern tip of the North China Plain and has a moderate continental climate with average annual rainfall of about 500 mm. It covers an area of 16,808 km². In 2008, Beijing had a permanent population of more than 16.95 million (not counting the 4 million migrants); of which 4.67 million people live in the peri-urban districts and counties of the metropolitan area.

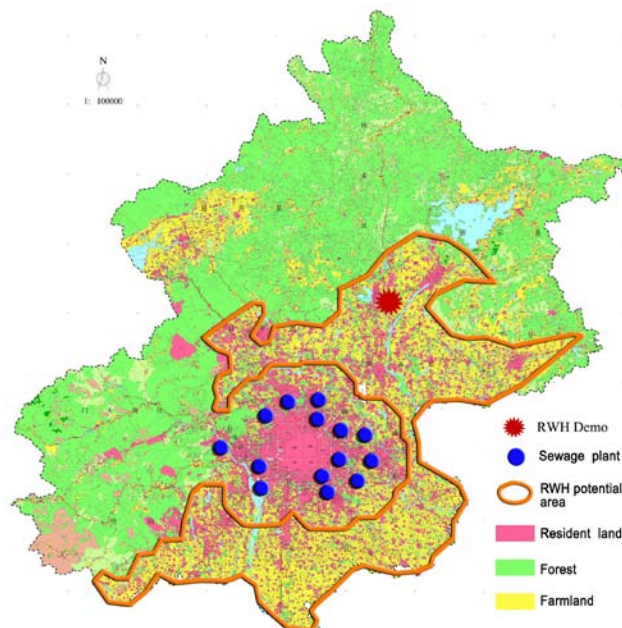


Figure 1 Urban and peri-urban Beijing, also showing area of rainwater harvesting demonstration

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Metropolitan Beijing has experienced rapid economic growth averaging 15 per cent per annum from 2005 to 2008. The rapid growth in population (3 per cent annually during same period) has brought some new challenges: a sharp disparity between urban and rural incomes (2.3:1 in 2008), a vast inflow of migrants, rapid loss of farmland, and a rapid deterioration of the urban environment.

Beijing is a water-scarce city; the per capita fresh water resources of 300 m³ per year, are 1/30th of the world's average and will not cope with increasing demand (Liu, Yao & Gao, 2003). Current water consumption⁴ is about 3.5 billion m³ annually or 209 m³ per capita. Consumption for domestic use was 1.47 billion m³ in 2008 and increasing quickly along with population growth and improvements in living standards. Due to increasing population and decreasing groundwater resources, it is foreseen that water consumption will outstrip available water resources in the near future. Beijing has decided to disperse businesses that consume large amounts of water out of the city, including irrigated agriculture, which will deprive vulnerable group of people, notably migrant farmers, of their livelihoods.

The focus on developing peri-urban areas and ambitious plans for the Beijing water sector in the 11th five-year plan (2006-2010) brought challenges but also opportunities. This ambition is also expressed in the 12th five-year plan (2011-2015).

Urban and peri-urban planning

The prevailing urban and peri-urban planning system in China is a centralised process, in which national government, municipal government and other lower level local government plays different roles. Lower levels, including municipal governments, usually make plans for their own districts or cities, and ask for approval from the upper levels of government. Large cities, like Beijing, require their plans to be approved by national government. In terms of economic policy, more flexibility can be enjoyed by various levels of governments, especially when some special economic development zones are concerned.

China's economic policy has focused on urban development in recent years. Little attention was given to development of the countryside around the cities, although the rapid urbanisation affected the surrounding villages enormously. This changed with the 11th year plan where attention to modernising the countryside went hand in hand with the protecting and strengthening rural cultural traditions.

⁴ Water demand can be much higher than consumption but not fully realised due to shortage of resources. Distribution priority is applied to limit the consumption of certain sectors.

China's economic transformation created relatively balanced growth with high job generation, but also resulted in undesired side-effects, with an alarming income inequality between urban and rural areas as well as within the urban population. Many of the challenges facing China today stem from the rapid heavy industrialisation of the Chinese economy and, although manufacturing will remain important, a more consumer and service-oriented economy is seen as the way forward. The 11th Five-Year Plan saw natural resource depletion as a challenge; the 12th Five-Year Plan has a greener ambition, seeking more inclusive, balanced, and sustainable economic development.

The nationwide New Countryside Development Programme that started in 2006 is characterised by the integrating agriculture and the countryside that exists within city limits into urban planning and enhancing the income of rural farmers by implementing various preferential policies. These include encouraging financing for small and medium enterprises in agro-enterprises, investing in infrastructure in peri-urban and rural areas, subsidising production materials to farmers and exempting rural villages from agriculture taxes. Most Chinese reforms start with pilots and so did the development of urban agriculture in China.

Although major attention is given to rural areas, it is important also to link urban and rural areas, and especially to develop the peri-urban areas of large cities. Indeed, urban agriculture is seen as a creative concept that links modernisation and cultural inheritance. Privately owned land does not exist in China; all land is owned by the state (in urban areas) or by village collectives (in rural areas). This determines the way cooperatives are organised. Village land began to be contracted to farmer families on a 30-year basis with a system of “household contract responsibility” that set farm output quotas for each household and linked remuneration to output. This mobilised the peasant enthusiasm for agricultural production. In addition agricultural cooperatives have been created and stimulated, facilitating capacity building and joint marketing and often closely linked to (party-led) village-level management. Of the 150,000 farmer cooperatives in the country, about 1,000 are located in peri-urban Beijing.

The purpose in encouraging farmer cooperatives is to strengthen the modernisation of agriculture through the institutional reform. By so doing, it is expected that farmers can be more organised and realizing the scale of economy in production. Farmers can also become more entrepreneurial through this practice and through competition in marketing.

Given the merit of this new organisation reform, and the basic fact that Beijing is seriously shortage of arable land and of water, there is a great demand for creating any innovations in new water sources and efficient water use. It is in this larger planning system and circumstance, that the work of SWITCH was positioned.

Urban water management in Beijing

As demonstrated above, Beijing is a city faced with a shortage of water. The amount of water use has been decreasing for the past few years, but is still very high, while rainfall has been below average over the nine years from 1999 to 2007. It is not yet clear whether this is a trend.

The main water sources are rainfall, surface and groundwater. Because of this downward trend in rainfall, surface water reduced and the level of ground water lowered (Beijing Water Authority 1999-2008).

Box 1 Available water declining

The available surface water in Beijing has fallen from 1.743 billion m³ in 1980 to 0.447 billion m³ in 1995 and to 0.142 billion m³ in 2003). The average water table is more than 20 metres deep, and in some places it is more than 30 metres below the surface, making it difficult for farmers to use.

The decline in available surface water is partly due to increasing water consumption of the growing city (and a corresponding decline in the large reservoirs that supply water) and partly due to overuse in upstream provinces such as Hebei and Shanxi. This induces a vicious circle that starts with the increased use of groundwater, which lowers the water table, so that farmers dig new wells and add pumps. The decline in available water affects agricultural production within the city boundaries. Although groundwater is still the main water source for agriculture within Beijing area, it has fallen from 90% in 2003 to 70% in 2008 and has become unavailable in some areas.

In addition to the building of large reservoirs and inter-regional water transfer projects, the government is stimulating water reuse and conservation. Alongside improved water management, new water sources are sought, including wastewater reuse and rainwater harvesting.

Integrated reuse of wastewater, rainwater harvesting, and more efficient water use by village water managers and farmers' water use cooperatives are important technological and institutional innovations in Beijing.

Wastewater use

Beijing not only has a severe water shortage, it is also a city with serious water pollution. The city produced 3.6 million m³/day of wastewater in 2008, of which only 79% was treated (Beijing Municipal Bureau of Statistics, 2009). Although the situation has improved (in 2004, only 56% was treated), large amount of untreated wastewater is still dumped into main rivers in the city, polluting the river water,

soil, and underground water. Beijing has invested in the building of nine municipal wastewater treatment plants with a total capacity of 3.3 million m³/day.

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, a move initiated by the municipal government to reducing the depletion of groundwater. In 2004, only 70 million m³ of treated water was used for urban agriculture in Beijing. This increased to 230 million m³ in 2007 when it accounted for about 20% of the total water for irrigation. Under the 11th Five-Year Plan, it was planned to have 400 million m³ treated water available for more than 0.66 million Ha of croplands in Beijing (mainly located in Daxing District) by the end of 2010. This is still less than one quarter of the agricultural land in Beijing Municipality; not all farmers around Beijing can access treated wastewater because they are located too far from the treatment plants.

Rainwater harvesting

The use of rainwater is an important potential source of water for parks, gardens and agriculture in Beijing. Rainwater harvesting systems are currently being promoted and installed by the Ministry of Science and Technology with the Municipality in residential areas in urban and peri-urban Beijing. Capturing rainwater in residential areas of the city has been promoted since 2000, using techniques like porous pavements and roadside gutters to collect stormwater from roofs and roads. This water is initially stored in local deposit pools and then transferred to larger ponds for primary treatment (sedimentation) and can be used for many purposes, such as irrigation of parks and gardens, aquifer recharge, maintaining water levels at small ponds and lakes, and, after simple treatment, for other uses like car washing (Ji, Cai and He, 2010). The years before the Olympics saw an increase in rainwater harvesting (RWH) projects in Beijing; in the Beijing Olympic National Stadium itself rainwater was used for flushing toilets, cooling towers, fire fighting, and irrigation of green areas (Scholes and Shutes, 2008). By 2006 more than 300 rainwater-collecting projects had been built and 45 million cubic metres of rainwater were used in 2008.

Rainwater harvesting using roofs of houses in rural China has been practised for thousands of years. Capturing rainwater for irrigation of crops by using the roofs of greenhouses has been promoted in Beijing since June 2005. Agriculture is still the largest consumer of water in Beijing, and relies 70% on groundwater (in 2008) (Cai and Ji, 2008). The Beijing Agricultural Bureau promotes rainwater harvesting from greenhouses via service extension offices in each district, and subsidised at district level. These rainwater harvesting projects became popular, because they are relatively simple to use and maintain, and because they are subsidised by the Government. The SWITCH demonstration project in Beijing supported this work by analysing water flows and cost/benefit analysis of typical farming systems, and by

working with a Huairou Vegetable and Fruit Cooperative, to link other productive activities, like mushroom production and agro-tourism⁵.

Rainwater harvesting increases the availability of water, especially when combined with significant storage capacity. However, it does not provide more water overall for the city, since the water would have flowed into surface water or groundwater.

Rainwater harvesting (RWH) with greenhouses

“The Beijing Agricultural Extension Bureau (BAEB) has been promoting RWH for some time. The potential is high, since currently only 1 per-cent of urban agriculture in the city is under greenhouses or other forms of RWH.

At least 4 types of agricultural greenhouses exist in Beijing.

Type 1 (mostly built around 2005) consists of a greenhouse with a storage pool

Type 2 consists of one big storage pool with several greenhouses.

Type 3 is an open storage pool (the pool in Beijing is normally closed to reduce evaporation, but open pools cost have lower construction costs).

Type 4 is the greenhouse RWH system for multi-functional agriculture, such as in Huairou, which includes mushroom growing, summer and winter, and agricultural tourism.

In Beijing, the aim was to have 3.5 million Mu (233,000 hectares) under greenhouses with RWH by 2010.

There were already 80 sites with RWH supported by the BAEB around Beijing by the end of 2008.

Huairou district is one of nine experimental areas in Beijing. Greenhouse RWH is more popular in northern districts of Beijing, (such as Huairou) where there is higher rainfall and lower groundwater.

The research with SWITCH is important in exploring limitations. For instance, the need to open the roof in the summer hinders the optimal capture and storage of rainwater. Research is also necessary to find the cost/benefits for different crops. Current research concentrates on mushrooms, but how these investments (in underground storage, etc.) work out for other products, like vegetables, and in combination with other functions of agriculture still needs to be explored.

One important result is that findings on the potential of RWH have become the scientific basis for water saving, including offering various options to farmers and cooperatives, which can be fed into future Beijing and National Plans”.

Interview with Ms. Wang Zhi-Ping, Agricultural Extension Bureau, member of Beijing SWITCH Working Group

⁵ Agro-tourism, known as Nongjiale in Chinese, offers visitors from urban areas an opportunity to stay in farmers' houses, eat their food and enjoy nature. There is a win-win result as visitors pick fresh vegetables or buy food from the farm at higher prices than in the market, so that peri-urban farmers increase their income significantly and urban residents enjoy relaxation. RUAF China has become a leading expert in this practice.

Water pricing

In April 2007 the Beijing Municipal Government started to charge a fee for agricultural use of ground water beyond a certain quota. Water use efficiency in agriculture is still comparatively very low and there is a lot to gain from measures to improve efficient use of water. The fee also provides an incentive for farmers to collect and use rainwater.

Improving water management

The Beijing Municipal Water Authority was founded in 2004, at the beginning of water management reforms in urban and peri-urban Beijing. Integrated urban-rural water management is being developed at four levels: municipality, districts and counties, water stations and at user (farmer) level. The Beijing Municipal Water Authority has village water managers and stimulates the organisation of farmers' water use associations or cooperatives. These village associations manage issues such as access to water and develop alternatives at grass-root local level, such as the use of wastewater and rainwater harvesting infrastructure, water pricing, irrigation practices, and quota management among the members. By the end of 2006, Beijing had established more than 3,300 of these farmers' water use associations.

Governance

The Beijing Water Authority, which came from merging the early Beijing Drainage Corporation, the Water Supply Corporation and the Water Savings Bureau, is responsible for water supply, drainage, sewage, and groundwater exploitation in the municipality. However, given its complexity and special nature, water use for urban agriculture is still related to many different departments such as Beijing Agricultural Bureau, City Departments, Ministry of Housing, Urban Planning, the Environmental Protection Agency and others. More integrated planning is necessary, and the facilitation of a platform for these institutions to meet, as offered by SWITCH, was welcomed.

Urban agriculture

The productivity of agricultural land in peri-urban Beijing has increased enormously in the past decade, and traditional farming has gradually given way to more intensive production systems often linked with agro-enterprises that undertake processing and marketing of herbs, vegetables, animal products, flowers, tree seedlings, pot plants, etc. Other activities in the peri-urban areas of Beijing have also become more important. Agro-tourism in peri-urban Beijing has made great progress in the last decade and generates new income opportunities for the farmers. In addition, some 200,000 of the 4 million migrants in Beijing have developed their livelihoods based on urban agriculture.

The Beijing government, in cooperation with other stakeholders, is actively promoting the development of agriculture in the peri-urban areas as part of the New Countryside Development Programme, along two major lines: modernisation of agriculture and the development of multi-functional agriculture (including maintaining and revitalising rural heritage). The modernisation policy seeks to promote the intensification of agricultural production using greenhouses, irrigation and improved technology, and diversification from grains to vegetables, herbs, animal products, flowers and horticulture. Various types of capital-intensive agriculture are being stimulated. In addition, current policy seeks to enhance the multiple roles of urban and peri-urban agriculture, by combining agricultural production with other functions such as social inclusion of migrant farmers by employment creation in peri-urban horticulture, ecological improvement through stimulation of agro-forestry (with windbreaks, dust and CO₂ capture, and land and water management), and local economic development through agro-tourism and other services to urban citizens by peri-urban villages.

Due to the implementation of these policies, Beijing has experienced rapid growth and change in its urban agriculture development. Farmers' incomes have doubled in the last 10 years.

SWITCH in China

The Sustainable Water Management Improves Tomorrow's Cities' Health (SWITCH) project is a major research partnership funded by the EC, with a budget exceeding €20 million, undertaking innovation in the area of integrated urban water management (IUWM). Rather than focusing solely on new research, the project aimed to put research into use across different aspects of the urban water cycle in order to improve integration and scaling-up, and ultimately to achieve more sustainable urban water management.

SWITCH in China was mainly implemented in two cities, i.e. Beijing and Chongqing (later shifted to Chengdu). The basis for research and implementation work came respectively from two themes (work packages) under SWITCH: one on urban agriculture and the efficient use of rainwater harvest and the other on eco-sanitation.

Water resources management, drinking water supply and wastewater treatment form three important parts of the integrated urban water cycle, with specific problems that are high on the agenda in China. The SWITCH project came at an appropriate moment. The involvement of the Ministry of Housing and Urban-Rural Construction was sought to give findings from SWITCH a national influence. It was agreed that SWITCH would seek to develop scenarios for the sustainable city of the

future, and that innovative approaches in urban water management and multiple water use would be integrated in urban planning.

Box 2 Objectives of SWITCH in China

- To establish an active learning alliance (LA) network on water issues in Beijing and Chongqing (later Chengdu).
- To improve the water management in Beijing and Chongqing/Chengdu through a multi-stakeholders approach.
- To improve urban planning and urban development in Beijing and Chongqing/Chengdu from the perspective of integrated water use and management.
- To seek best models and technologies for water use in Beijing and Chongqing/Chengdu through international cooperation.

Originally SWITCH planned to work only in Beijing, but due to building regulations for the 2008 Olympics part of the demonstration project had to be shifted to another city (Chongqing). This effected the development of SWITCH, particularly the involvement of multiple stakeholders through a learning alliance.

This report

SWITCH undertakes regular assessments of the intervention logic and its effectiveness in the SWITCH cities. This report is based on an assessment made in 2009.

Specifically this assessment aimed to:

- Identify lessons learnt on the effectiveness of the intervention logic.
- Define recommendations for the final year of project, with a focus on activities that could still be undertaken to achieve the project goals.
- Identifying mechanisms for scaling up and sustaining impact beyond the life-span of the project.

This paper focuses on SWITCH progress in Beijing. Although SWITCH is also working in Chongqing/Chengdu, the ambition of creating effective linkages between the work in these two cities under a National Learning Alliance were not met and a separate review was not conducted in Chongqing or Chengdu.

Methodology

It became obvious in the course of the SWITCH project that the process in Beijing would not progress according to the planned route. It would have been very valuable to monitor and document discussions and activities undertaken and the outcome of these inputs, given that SWITCH in China travelled its own road. Unfortunately, no regular process documentation was undertaken in Beijing,

although short notes of activities were made by the team members (most of them in Chinese). However, the published research papers in various journals both in Chinese and English can reflect to a certain extent what progress has been made and how to make a difference in Beijing.

The assessment that led to this report is therefore itself a significant piece of process documentation.

The assessment used the following methods:

- Review of available papers, reports and city progress reports.
- Reflection with the facilitating team and the two PhD students.
Interview/discussion with a selection of the Beijing Working Group (WG) and some important outsiders; the aim of the interviews was to get stakeholder perspectives on their role in the project, and the main changes they have seen as a result.
- Meeting with RUAF coordinator, MPAP coordinator and facilitator.
- Reflection about progress and capacity for scaling up the work in a discussion between the authors.

A major limitation for the lead author was language, since many documents are in Chinese, and a number of discussions with working group members were conducted in Chinese with translation into English.

Impartiality, no doubt also plays a role in this assessment, since authors have been involved in the process from the beginning. We hope that we took advantage of the benefits of being well informed, while remaining critical of ourselves and the processes that emerged.

II. THE SWITCH APPROACH IN BEIJING

The SWITCH programme in Beijing, together with RUAF-China, seeks to demonstrate a model of urban agriculture that incorporates multiple sources and efficient use of water, delivering higher returns by diversifying production and services. These higher returns not only cater for water fees, but also enable farmers to pay for the relatively high investment for the rainwater harvesting facilities.

SWITCH Beijing assisted peri-urban farmers to develop multifunctional urban farming systems in dealing with the growing problem of lack of water for irrigation, and to take the opportunities provided in the 11th five-year plan. Given the rapid increase of production under greenhouses in peri-urban Beijing, a demonstration project on rainwater harvesting was developed with several institutions and a vegetable cooperative in Huairou district in Beijing. It shows that the technology indeed provides a useful source of water for intensive agriculture under

greenhouses. It will particularly be feasible and profitable if the multiple functions of agriculture are combined (Ji, Cai and Wang, 2010). In the demonstration the underground (closed) rain water storage pond is not only used for irrigation in the greenhouses, but also for growing mushrooms during dry seasons when (part of) the storage pond is empty. The high humidity of the pond in fact is good for growing mushrooms, which provides the farmer with a higher economic return.

The SWITCH activities, and hence its focus in China, built on existing contacts between the ETC Foundation with IGSNRR-CAS under the programme of the International Network of Resource Centres on Urban Agriculture (RUAF Foundation).

As a RUAF regional focal point, RUAF China is based in IGSNRR-CAS. Working through Cities Farming for the Future⁶ (CFF), RUAF China facilitated a process called Multi-stakeholder Policy Influencing and Action Planning (MPAP). The MPAP working group on urban agriculture also involved key institutes such as: Beijing Rural Economic Research Centre (a think tank for the municipal government), Beijing Agriculture College, China Agriculture University, the Agricultural Promotion (extension) departments of Huairou and Chaoyang Districts, the Beijing Huairou Green Vegetable and Fruit Cooperative, and various town officials. Just at the time the SWITCH programme started, MPAP agreed a City Strategic Agenda on Urban Agriculture in which the issue of water featured prominently. Under SWITCH, IGSNRR facilitated linkages between research and the demonstration projects, and between institutions participating in the learning alliance. Other relevant relations and contacts include Wageningen University and Research Centre (WUR), MOHURD, and IHE-UNESCO, but these institutions were not brought into the project team or the learning alliance.

The main SWITCH work packages in China were:

- WP 5.2 Water for Urban Agriculture: Performance of rainwater harvesting and wastewater reuse technologies.
- WP 4.1 Eco-sanitation: Adoption and performance of non-conventional wastewater management schemes.

In addition, through SWITCH or through PhD students, the following work packages had work attached to them in China:

⁶ Agro-tourism, known as Nongjiale in Chinese, offers visitors from urban areas an opportunity to stay in farmers' houses, eat their food and enjoy nature. There is a win-win result as visitors pick fresh vegetables or buy food from the farm at higher prices than in the market, so that peri-urban farmers increase their income significantly and urban residents enjoy relaxation. RUAF China has become a leading expert in this practice.

- WP 1.1 to develop sustainability indicators addressed to urban water management and to apply them to current projects in Beijing and Chongqing.
- WP 6.2 Learning Alliances.
- WP 6.4 Financing cost-recovery and institutional models.

The intervention logic in Beijing was largely based on the following sequence:
 Exploring the main challenges through the background and context analysis on water issues in greater Beijing areas based on earlier research and experience,
 Identifying the priorities and pathway through learning alliance workshops and networks on visioning and strategic planning based on the explored challenges
 Setting up working group within the learning alliance network to supervise the further research and demonstration in an aim to discover best practice in RWH for urban agriculture development and a possible approach to scaling up under the design of work package 5.2 (as described below).
 Disseminating findings in the network and writing up training materials/guidelines in RWH practice in Beijing, which can largely also be applicable in Northern China in similar settings.
 Influencing policy-making by presenting findings at various government organised workshops.

Project coordinating team

The lead partner from the start has been IGSNRR, through the RUAF China group, coordinated by Prof. Cai Jianming (urban planning and urban sustainable development including urban agriculture). Other members of the IGSNRR team are: Prof. Li Lijuan (water management) and three PhD students Mr. Ji Wenhua (supervised by Prof Cai) and Mr. Li Jiuyi and Mr. Li Bin (both supervised by Prof. Li). Another student, Miss Zhang Feifei, left the programme in 2008 to further her studies in Europe. Lv Aifeng is a post-doc student, who assisted the SWITCH programme as from 2009. The team is well balanced in gender.

The team had direct contact with SWITCH management on city coordination and with IRC Water and Sanitation Centre (the Netherlands) on learning alliance development. ETC visited IGSNRR once or twice a year to discuss progress. In addition, ETC and IGSNRR met each year with representatives of other partners working on WP 5.2 (urban agriculture) in Lima and Accra to compare progress. Representatives of IHE-UNESCO, WUR, IRC, University of Chongqing (UC) and ETC visited Beijing to attend the first LA.

The logic of the SWITCH activities on urban agriculture

The main focus of the work in Beijing was on the safe use of rain and wastewater.

A major obstacle lies in lack of recognition of urban agriculture as an important urban livelihood strategy. Better understanding of farmers' innovations and perceptions of wastewater use (quality, economic value and health issues) is needed to inform planning initiatives of the policy-makers and the urban authorities. Flexible scenarios need to be developed for specific locations along with appropriate risk reducing strategies that are technically, economically, socio-culturally and politically compatible. The activities employed under SWITCH aimed to contribute to a paradigm shift in wastewater management and sanitation towards a closed loop approach in which wastewater would be recycled and reused. SWITCH also worked on multi-stakeholder processes for action research on productive use of water and wastewater.

The aim was to bring about significant improvements in agricultural production, processing and marketing, and other livelihood activities, by using freshwater, stormwater and wastewater. Since this involved technological, organisational and institutional innovations, the activities (and deliverables) followed a sequence of implementation. Based on a situation and stakeholder review, working groups would be formed that received training in multi-stakeholder action planning, and which acted as, or were integrated in, the city learning alliances. These working groups were closely involved in, and informed on, specific MSc and PhD research and action research, which was closely linked to a demonstration project. Meanwhile, information was disseminated, and a handbook on rainwater harvesting, with new guidelines and training materials in Chinese, was developed in 2010. This could be translated into English if there was an additional budget for translation.

Research

Research focused on technological and organisational innovations in production and related income improving activities, such as agro-tourism, by diversification in access to water sources through developing and testing an improved rainwater harvesting and storage system. After a general review of water and urban agriculture, one PhD student continued to work on the issue of water scarcity. He made an assessment of the potential of water sources and cycles at catchment level applied to greater Beijing area, and the potential of these different sources of water for productive uses, using RS and GIS technologies (Li, 2009).

A second PhD student closely monitored the development, performance and up-scaling of a demonstration project in Huairou District, Beijing. The research was highly participative: the PhD student was part of the working group, and with the project team and the most active members of the working group, they jointly designed, adapted and closely followed water availability, rain capture, storage, and use in addition to aspects such as regulations, cooperative organisations,

marketing, and finance. Based on the research, guidelines and training material were developed on rainwater harvesting and treatment in Beijing (Cai and Ji, 2010).

In 2008 research on urban agriculture and eco-sanitation were conceptually combined under SWITCH as Decentralised (Waste) Water Use. The objective of this subject group is to combine findings on pollution prevention and reuse approaches and technologies to waste and stormwater handling in urban areas on a decentralised scale, with safe and productive reuse of urban water for agriculture, and seek to integrate this into the policy, legislative and regulatory, frameworks for urban planning and decision-making in cities. Although there have been several exchanges of ideas and findings in the learning alliance, the combination of these topics has not followed through in research.

The Huairou Fruit and Vegetable Cooperative in An ge zhuang village, in the Huairou district of Beijing, started in March, 2004. SWITCH collaborates with this cooperative which comprises 1,108 households specialising in the production of vegetables, grapes and Chinese dates. Ms. Zan, the cooperative director, told the assessment group:

“The farmers of the cooperative used groundwater for the irrigation, but in recent years, the water table dries up very quickly, and some wells cannot be used anymore. Digging deeper and pumping up water increases cost...

Rainwater harvesting is very important to the cooperative, but funding for building the rain harvesting systems is a problem as not all farmers have access to subsidies. SWITCH helped us to improve the rain harvesting system...

We are now using the underground space to plant mushrooms. The environment of the basement by the side of 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 in controlling growth conditions and gives us more benefits.... Agro-tourism is another opportunity to raise the value of our products..)

Opportunities and constraints posed on our cooperative by 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. (Indicated this would include collaboration with RUAF) ...

Current challenges are on the technical design of the rainwater capturing system, the amount of land needed, and convincing the authorities (national and district) as well as the farmers to invest in these systems. Economic and financial calculations have shown that a certain amount of subsidy will remain necessary”.

Interview with Ms. Zan, Director Huairou Cooperative, member of Beijing SWITCH Working Group

Capacity building

Three aims were set for capacity building:

- Training the city working groups on multi stakeholder processes and action research.
- Specific training on technologies and methodologies.
- Adapting materials from Beijing for the SWITCH global training package.

Although the first of these did not happen as envisaged, a number of individual training sessions were organised in Beijing with IGSNRR and the local organisations hosting the demonstration project. Training under WP 5.2 for research teams, working-group members and selected authorities, covered stakeholder involvement, financing, planning, and mushroom farming. Further information exchange and awareness raising was done bilaterally with working group members, or as part of learning alliance meetings.

Based on the findings of the demonstration project and research, IGSNRR developed the handbook on innovative rainwater harvesting and storage and use for multi-functional urban agriculture in and around Beijing. Some of this material has also been used by ETC and WUR, supported by Local Governments for Sustainability (ICLEI) to prepare specific training related to the subject group and for the SWITCH training manual developed by ICLEI.

Demonstration

Originally a combined demonstration was foreseen in Beijing as collaboration between the two themes (SWITCH work packages 5.2 (rainwater harvesting and wastewater reuse technologies) and 4.1 (eco-sanitation). However, even before SWITCH had been approved by the EU, it became clear that demonstration activities linked to eco-sanitation could not take place in Beijing, due to the embargo on “other building activities not approved for the 2008 Olympics”, hosted by the city. In agreement with the major Chinese institution involved, the Ministry of Housing and Urban-Rural Construction, and the major stakeholder, Chongqing University, the related research and demonstration activities on wastewater treatment of grey water through constructed wetland moved to Chongqing Municipality (and later to Chengdu).

Box 3 Chongqing becomes China’s biggest municipality

Chongqing is located in the southwest of China and has become the most important economic and cultural centre in the higher part of the Yangtze River and Three Gorges Area

in recent years. During an adjustment in 1998, Chongqing absorbed more land and population and became China's biggest municipality in terms of area and population, which doubled from 15 million people in 1995 to 31.1 million in 2003. According to the Chongqing Master Plan of 1996-2020, residents will be accommodated in an urban hierarchy consisting of one mega-city (with a population of about 5 million), two large cities (Wanzhou and Fuling with populations of more than 0.5 million each), nine middle-sized cities, 33 small cities and 709 towns (Chongqing planning bureau, 1995). Water pollution in Chongqing is very serious. In 2002, less than 20% of the 43.95 billion tons of wastewater discharge was treated. Infrastructure construction for sewage treatment lags behind the development of the cities.

In Beijing SWITCH focused on water for urban agriculture, and sought to add to the RUAF-China programme by:

Developing activities related to an important issue on the Beijing City Strategic Agenda: access to water for sustainable peri-urban agricultural development.

Using RUAF experiences and multi-stakeholder processes, in support and facilitation of the SWITCH working group;

Supporting the cooperative in Huairou in developing improved water management, in addition to developing improved organisation and agricultural practices.

The location and planning of the demonstration project on improved rainwater harvesting and efficient irrigation of a cooperative market oriented production system was approved in Beijing in 2007, after negotiation with the staff of Huairou District, Agricultural Extension Department and the Huairou Fruit and Vegetable Cooperative.

The demonstration is part of integrated approach to increase access to water for peri-urban agricultural development, through the use of wastewater, rainwater and by more efficient water use (e.g. by village water managers and farmers' water use cooperatives). This includes important technological and institutional innovations. The demonstration project collected rainwater from the outer surface of a rainwater collection flume, which flowed into a deposit pool, and used of this water in drip irrigation. Previously, the farm in Huairou depended totally on groundwater, since there was no access to surface water, and this groundwater needed to be pumped from a depth of about 40 m. using rainwater harvesting could reduce the cost of water and the damage due to scarcity (sometimes the water could not be pumped up) and increase available water. Capturing and using rain instead of groundwater could directly slow down groundwater depletion (although this might not be the case in the absolute sense, since it is argued that some of the water captured would have otherwise helped to recharge groundwater).

Other innovations are:

- Improved cooperative vegetable production for the Beijing market (grapes, dragon-cactus, and mushrooms).
- Agro-tourism as a new source of revenue for farmers.
- Groundwater infiltration of surplus water.
- Linking various (often new) sectoral institutions (water and agricultural bureaus).

The PhD Research in Beijing is very much related to the demonstration. This research showed that the higher returns did not only compensate for water fees, but also enabled farmers to pay for the relatively high investment of rainwater harvesting facilities.

From its start in 2008, the demonstration project showed positive results (2008 was a reasonable good year in terms of rainfall) providing high quality irrigation water and increasing farmers' income substantially. Local government, in the form of the Municipal Agricultural Extension Centre in Huairou District, participated in the working group, acknowledged the results and support the further application of the technology. The results have already been integrated into on-going policies and into the 12th five-year plan (2011-2015) where more effective water use and management has been encouraged including the rainwater harvesting both in urban and peri-urban areas.

Working groups, learning alliances and scaling-up

The demonstration on eco-sanitation moved to Chongqing, and the research and demonstration activities on urban agriculture remained in Beijing. At the first LA meeting, it was therefore agreed that two working groups would be facilitated: one in Beijing and one in Chongqing, both as part of the SWITCH Learning Alliance on decentralised (waste) water use systems. It was agreed to focus initially on the working groups, and seek to develop the learning alliance between the two cities (and perhaps nationally), in a gradual manner. This broader (Beijing and Chongqing) Learning Alliance met only three times with all members participating. However, many informal meetings took place between LA partners.

Box 4 Full list of learning alliance members at the first meeting (in 2007)

Ministry of Housing and Urban-Rural Construction of China, Department Science and Technology	Mr. Wu Yong, Chairman
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IGSNRR-CAS	Prof. Cai Jianming, coordinator LA Beijing Prof. Li Lijuan, facilitator Lu Aifeng, post-doctoral Mr. Ji Wenhua, PhD candidate Mr. Li Jiuyi, PhD candidate Miss Zhang Feifei, RUAF China research assistant
Chongqing University	Prof. He Qiang, city coordinator Chongqing Dr. Zhai Jun Guan Enhong
Water Resources Department of the Ministry of Water Resources Beijing Hydraulic Research Institute	Sr. Eng Ye Zhihan
Beijing Water Environment Protection Bureau	Dr. Wang Yan
Beijing Municipal Research Institute of Water Planning	Chief Eng. Zhang Tong
Chinese Research Institute of Urban Planning and Design	Sr. Eng. Zhou Changqing
Beijing Agro-Technical Extension Centre	Wang Zhiping, Deputy Leader
Beijing Municipal Water-Saving Centre	Eng. Zuo Jianbing
Beijing Normal University-WUR	Dr. Zhang Mingshun Professor Liang Jinshe Prof. Wang Hongrui
China University of Geo-sciences	Dr. Wang Jin
Xiedao Group	Mr. Fu Xiuping (President),
Huairou Cooperative	Ms. Zan Xiaojing and Mr. Zhao Qingzhong

“The Beijing Working Group on urban agriculture is active and meets several times. The wider Beijing Platform is predominantly informal. Members are kept informed, are invited to working group sessions, and working group members bilaterally visit these key institutions to discuss progress and activities...”

“The Working Group had a meeting of stakeholders where each party explained what they do or plan to do in 2009-2010, directly or indirectly related to urban agriculture. The City Strategic Agenda and the yearly work plan consists of this list of activities”.

Interview with Ms. Liu Junping, Beijing Rural Economic Research Centre, Chair of the Beijing Platform on Urban Agriculture

Box 5 Roles of main participating institutions in Beijing

Beijing Municipal Research Institute of Environmental Protection: The first environmental protection sciences and research institute in China includes several research themes: water pollution control technologies, water pollution control engineering, air pollution control technologies, environmental management, environment integrated protection technologies, water pollution control of industry sewage, etc.

Beijing Agro-technical Extension Centre: is affiliated with the Beijing Agriculture Bureau. Its responsibilities include: demonstration and extension of new agricultural technologies, agricultural technologies training, documenting measures and experiences about agricultural production technologies.

The Ministry of Water Resources: is responsible for the administration and management of water resources, and the formulation of water-related policies, development strategies and plans. It also drafts and implements enabling legislation and design of water-related regulatory frameworks. The ministry also formulates economic regulatory measures for the water sector. They draft and review proposals and feasibility study reports on large and medium-sized water sector capital construction projects. The Ministry also provides guidance to activities related to rural water resources, and is responsible for the day-to-day work of the State Flood Control and Drought Relief Headquarters.

Other stakeholders were identified, and kept informed about the process, including the Beijing Water Saving Management Centre, Beijing Environment Protection Authority, Beijing Gardening and Greening Bureau (collects rainwater for plants), Beijing Drainage Group Co. Ltd, etc.

Beijing Water Conservation Office of Beijing Water Authority: Sets up policies related to water conservation, makes water conservation plan, compiles water conservation technology standard, collects water charges and impose penalties on those who exceed water use; makes assessment and examination of important water conservation projects.

Beijing Hydraulic Research Institute, Beijing Water Authority: Works on the protection of surface drinking water sources in Beijing. In particular has helped to improve the water quality of the two main surface drinking water sources for the city, the Miyun Reservoir watershed and the Guanting Reservoir watershed'.

College of Water Sciences, Beijing Normal University: The College, founded in 2005, researches water sciences, underground water environmental protection and engineering carries out water and sand research for the Ministry of Education.

Since the LA start up meeting in 2007, the Beijing LA was facilitated formally and informally by IGSNRR, through all kinds of (bilateral) meetings, mini-conferences, and interviews in which one or more members of the working group participated (live or using telephone and internet). The topics and issues discussed at these occasions, relate to the Beijing municipal water resource use and management, but are also relevant to the whole country. The SWITCH approach and experiences were in this way shared with all partners in the wider LA. A vision for Beijing water management was drafted in a short training session and then shared in the second LA meeting. By combining formal and informal approaches, the LA facilitators sought to provide a platform for communication and cooperation that could

influence further policy-making while reducing conflict between different departments.

The linkages between Beijing and Chongqing did not evolve as foreseen. However, the two working groups regularly met to facilitate on-going work. In addition the demonstration was transferred in 2009 from Chongqing to Chengdu. Eventually, only two Professors from Chongqing University attended the first two LA meetings in Beijing.

In Beijing, the following institutions formed the Beijing Working Group which met regularly:

- IGSNRR: Cai Jianming, Li Lijuan, Ji Wenhua.
- Beijing Water Environment Protection Bureau: Dr. Wang Yan
- Beijing Municipal Research Institute of Water Planning: Eng. Zhang Tong.
- Beijing Agro-Technical Extension Centre: Deputy Leader Wang Zhiping.
- Huairou Cooperative : Ms. Zan Xiaojing and Mr. Zhao Qingzhong.

In addition, at Huairou District level, the team members of IGSNRR met regularly with Zan Xiaojing and Zhao Qingzhong, as well with representatives of the District Authorities (such as the Huairou Agricultural Technology Institute, Mrs Shiran).

Box 6 Beijing Water Vision

After a training session about visioning, a first draft of the “Beijing water vision 2020” was shared and discussed in formal and informal meetings. A first official Beijing water vision and strategy conference was held in June 2009, where 20 LA members participated (IGSNRR, Beijing Water Conservation Office of Beijing Water Authority, College of Water Sciences, Beijing Normal University, Beijing Agro-technical Extension Centre, Beijing Hydraulic Research Institute, Beijing Water Authority, Ministry of Housing and Urban-Rural Construction. All stakeholders believed that a common water vision is necessary and agreed on an adapted version.

By 2030, the city of Beijing will achieve more sustainable urban water use through improved management of its available water, raising water quality, and ensuring a fair spatial allocation of water resources and good water governance.

A good balance between water availability, supply and consumption will avoid depletion of groundwater levels, which will be restored to 1960s levels, and low flows of rivers will be protected so that rivers flow all year round.

Water quality at the tap will meet the best international drinking water standards suitable for direct consumption, while rivers and lakes will be protected or rehabilitated to meet Surface Water Quality Standards grade III and above, and groundwater pollution will be minimised.

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 with a high level of water reuse. Harmonised regional water use is achieved through fair spatial allocation of water resources, avoiding conflicts with upstream and downstream areas through negotiation

and appropriate compensation.

Good water governance will build a water saving and pollution prevention focused society with open public access to information and participation of stakeholders in decision making. Good planning will prevent or mitigate disaster damage.

Information Management

Reporting and Monitoring

Monitoring and assessment of progress occurred through discussion in the facilitating team; with the working group (in Beijing); with the WP 5.2 coordinator by email and yearly visits; and through regular SWITCH reporting and work planning procedures, including the City Story, for the Annual Report and the Integration Report.

Process documentation

No regular process documentation was undertaken in Beijing. Short notes of activities were made by team members (naturally, most of these are in Chinese). One member of the facilitating team (Feifei Zhang) participated in the process documentation workshop in Lodz, in 2007. However, she left the team to pursue a Master's degree in Germany and Italy. Her work was taken over by PhD students, Ji and Li.

Dissemination

The following dissemination material was developed:

- A website (in Chinese) was established at <http://switchurbanwaterbeijing.yo2.cn>. Reports of events, important conferences, reviews, and research progress reports were uploaded, along with linkages to SWITCH and important institutions in Beijing. However, in the final two years the web site has not been kept up to date.
- LA and WP 5.2 training material has been translated in Chinese, and added to the website.
- Both the Urban Agriculture Magazine UA no. 20 on Water for Urban Agriculture (collaborative effort between RUAF and SWITCH) and no. 23 on Nutrient Management (RUAF, WASTE and SWITCH) were translated into Chinese in 2010. was also translated in 2010.
- IGSNRR, staff participated in scientific meetings and workshops.
- Publications and scientific papers in journals or workshops.
- Three PhD theses and subsequent papers.
- There are plans to develop a scientific community and student network working on IUWM (planning).
- Six papers (in Chinese) have been published in various journals, including the Journal of China Agriculture University and Resources Sciences, and one in English in the Journal of Chinese Population, Resources and

Environment. Information has also been shared through the UK magazine the New Agriculturist (see the article “The new Climate Change issue of New Agriculturist” by Paul Cox:

<http://www.new-ag.info/focus/focusItem.php?a=942>).

- A paper was published at “Water Infrastructure for Sustainable Communities: China and the World” in Sep. 2010.
- Dr. Astrid Freyeisen of ARD German Radio visited Beijing in 2010 to interview Prof. Cai and Dr. Ji about their work, especially related to SWITCH in Beijing.
- And Dr. Ji attended the annual Sustainable Water Infrastructure for Cities and Villages of the Future (SWIF) committee meeting in Beijing, and presented the SWITCH-Beijing programme and demonstration.

III. RESULTS AND DISCUSSION

In this section we give an overview of the results obtained by SWITCH in Beijing, following the logic of the work of SWITCH in Beijing as described above.

Research: showing the potential of the innovations

There are opportunities for innovations to influence the central planning system in China, but it is important to provide good scientific results for these innovations before assembling higher level authorities to discuss this. In that sense, the first objective of the SWITCH programme “to contribute to the scientific basis for IUWM” has been especially important. This has been done by a combination of efforts. General studies and collections of information have been important for overall understanding. PhD student Li Jiuyi, working with Prof. Li Lijuan, provided information on water resources and demand, and different scenarios in the Greater Region. Ji Wenhua and Prof Cai Jianming published several papers based on the review undertaken related to water sources for urban agriculture. The insights from these studies are predominantly valuable in linking existing sources of information on water sources and demand to water and use for urban agriculture in Beijing.

“We are going to try it out, and if it is good, we are going to do it”. Certain districts in Beijing are earmarked to allow for experiments in economic development, with technological and organisational innovations.

Beifang Town in Huairou, where the SWITCH Beijing Demo site (An Ge Zhuang village) is located, is one of the 33 experimental towns in Beijing. When any interesting things happen here, other villages and towns in Beijing will eager to learn or be invited to share experiences”.

Interview with Cai Jianming

Action research, combined with the demonstration in Huairou, was more specific and focused. The work of the PhD Student Ji Wenhua analysed different types of rainwater harvesting propagated by the Beijing Agricultural Bureau, and their efficiency and cost/benefit, and specifically looked at the improved systems as developed with the Huairou Cooperative, which combines an improved RWH system with improved production (Ji, 2010). Another PhD student, Xiao Liang working on another work package: 6.3, (Socially Inclusive Urban Water Governance) supported this analysis. These studies showed the potential of RWH for agricultural production, but also underlined the need for continued Governmental support, not only in terms of subsidies but also with legislation and support in improving productive use such as agricultural production and agro-tourism).

What also has been important was to put the potential of the improved system in the context of scarcity of water and linked to potential sources of water as improved irrigation, management, and reuse of treated waste water, linked to improved production and income, both under the attention of the Beijing Water Authority and the Agricultural Bureau, and to do this research together as part of the Beijing working group.

“The discussions and approach generated by SWITCH links very well to the work and mandate of the Water Authority. For instance, the visioning exercises and discussions about different scenarios could be linked to those developed by the Water Authority itself. They have been adapted based on information from the SWITCH research and demonstrations. This has improved planning by the Water Authority.

The combined effort with the Agricultural Bureau (AB) in water saving using rainwater, and mapping the potential of RWH compared to the potential of reuse of treated wastewater, is a great achievement”.

Interview with Ms. Zhang Tong, Chief Engineer, Beijing Municipal Research Institute of Water Planning

Attention to the research has also grown in relation to the changes in village/producer organisations and management that is on-going in China alongside the traditional village committee. Good publications on the research and demonstration, especially those showing the (potential) impacts and developing scenarios, are key inputs for decision-making at higher levels.

Seven papers have been published in various Chinese high quality journals, of which one has been in English. Several publications in English were produced for the SWITCH scientific meetings. International attention has stimulated the use of the research and the work of the working group.

The research described above has not been truly demand-driven in the sense that the LA members jointly defined it. But the research is to a large extent determined by the work that had already been conducted by IGSNRR with the cooperative in Huairou, and so it does reflect the needs of local stakeholders: the cooperative, the Huairou District Agricultural Bureau and the Water Bureau. Respondents from the Beijing Working Group underlined this link and the importance - and success - of such a process. Furthermore, the research has been positioned in the rapidly changing Chinese reality, characterised by the combination of rapidly changing central planning, selected local experimentation and policy influencing, local entrepreneurship and increasing market orientation. The partners and IGSNRR as main facilitator have sought to do this in an optimal way, not always according to SWITCH convention.

Universities and research institutes (like IGSNRR) are seen as neutral and are optimal facilitators in China. They can mobilise authorities at different levels, without political connotations. They are also seen as think tanks, providing officials with evidence and new ideas, but their information needs to be innovative and scientifically reliable. Networking is a critical key here, and IGSNRR has carried this out well in relation to research, consultancy and action planning.

The research to a large extent has been participatory; in fact the demonstration in Huairou was based on the idea of the cooperative leader, who is a true farmer innovator. In the development and research into the efficiency of this innovation, researchers and the farmer collaborated with other local stakeholders.

The RWH technologies themselves were not new. However, the combination of the technology, improved production, the cooperative organisational model and the institutional linkages amounted to new innovation that led to financial savings on water and higher incomes. Finding the best RWH technologies and models for Beijing and supporting their uptake is an important issue. The Agricultural Bureau is experimenting with several RWH models, including the one supported by SWITCH. Therefore, it is equally important to learn from and share the experiences from the Agricultural Bureau and the farmers who have experiences with other RWH systems. This was also done in the working group meetings. The PhD student analysed several of these systems and identified a few problems regarding rainwater collection efficiency, or suitability for certain locations. Indeed, the system developed by SWITCH with the Huairou cooperative does not suit all other farmers and cooperatives, since the cost of the sealed underground pool might be too high. Also there are variations in rainwater water quality, which might affect drip irrigation systems. These problems will be further analysed and discussed in the working group, after the end of the SWITCH initiative.

Box 7 Protection bureau sees potential for rainwater harvesting

Ms Wang Yan from the Beijing Water Environment Protection Bureau (and a member of Beijing SWITCH Working Group) sees enormous potential for rainwater harvesting for productive uses in peri-urban agriculture. There are concerns about the groundwater table and rainwater harvesting is an important technology. Through her IGSNRR linkages with other (inner city) RWH initiatives were made.

Capacity building in multi-stakeholder processes and on findings

The process for capacity building in Beijing did not follow the suggested set up as envisaged in the package on urban agriculture, or by the Learning Alliance. Nevertheless, the capacity building activities, both formal and informal, group and bilateral, have been quite effective. After the initial training, IGSNRR and ETC provided continuous support to the members of this working group and facilitated the process. The members of the Huairou and Beijing working groups have been informed about and shared experiences on the process of multi-stakeholder action research and planning, which is similar to the work done under the RUAF-China programme on urban agriculture. All members of the SWITCH working group were enthusiastic about this “new” approach, and mentioned that they wanted to continue the collaborative and informative platform in further development of rural areas of Beijing.

Capacity building for the LA process was not pursued further than joint visioning and a first meeting to discuss strategic planning. The open discussion was appreciated most, both in the work package approach and in the LA. Formalisation of this strategic planning did not fit the Chinese situation and the adapted process as developed by IGSNRR. However, after two years of research and demonstration, a localised (municipal) workshop on visioning and strategic planning was held in 2010 to further elaborate the possible new strategic policies for urban water management in Beijing by 2030.

Based on the findings, the team developed a handbook on RWH for farmers and technical staff. One training course was held in 2010. The handbook covers RWH experiences in China in general, guides the user in making choices for the type of technology and shows how to construct greenhouse, as well as covering capture devices, storage tank(s) and irrigation methods. The handbook is in Chinese, and will be translated into English when a budget is available.

Demonstration projects and efforts to scale up the results

Looking back, the demonstration fitted the work package. However the project failed to develop combined work that was originally foreseen on eco-sanitation,

which would have meant work on both the supply and demand side of the approach to urban resource recovery and (re)use of water and nutrients. Also more effective linkages could have been established with other research such as on wetlands or stormwater management. Exchange of ideas and information occurred, but too late in the process to allow for joint research and demonstration projects.

The potential of the adapted RWH technology combined with improved production is high. Beijing Agro-technical Extension Centre and IGSNRR have patented the technology. Available surface- and rain-water is less than future demand in Beijing, while the South-North Water Transfer Project⁷ has been delayed and even so will primarily be for domestic use. RWH is therefore a key resource in forthcoming years in Beijing, to ensure water safety. Attention to rainwater reuse has been developing quickly in and around Beijing.

Given the existing acreage of agriculture land under greenhouses is far less than the municipal planned, there is great potential for further development both in building more greenhouses and in using rainwater harvesting for irrigation in Beijing. The current proportion in using rainwater harvesting for irrigation in the existing greenhouses is still very low, accounting for less than 1 per cent.

In 2009, IGSNRR agreed with the Beijing Agri-technical Extension Centre, one of the key stakeholders in the SWITCH programme, to undertake more joint action research at selected demonstration sites on RWH. Recent research in which SWITCH participated on other rainwater harvesting projects in six other districts of Beijing, confirmed the promise of the technology used in the demonstration in Huairou. About 10 other RWH programmes were analysed, while managers of some government departments and selected farmers were asked about RWH and wastewater reuse in Beijing.

It was difficult to start the process as originally foreseen by SWITCH. Although the participative approaches for the work package and that of the Learning Alliance do match, confusion was created with the facilitating team, because the SWITCH learning alliance approach began late, and aimed for participation by higher level authorities. In the current political context of China, it is still not yet an effective approach to bring together different hierarchies from various stakeholders in one platform or learning alliance to jointly develop a city strategic agenda related to water reuse, or peri-urban agriculture. Policymaking is evidence based, so one needs to offer higher-level authorities good results or new technologies with proven potential, to allow strategic planning to be done at that level. Visioning can be done in advance, but strategic planning is uncommon with higher-level

⁷ The South-North Water Transfer Project is a large national project in China that aims to transfer 40 billion cubic metres of water per year through 3 transfer lines from the Yangtze River in Southern China to North China. The eastern transfer line was planned to be in place in 2012 but will be delayed until 2014.

authorities if there is still no concrete research-based evidence. In practice, therefore, SWITCH started with research and practical pilots (as the demonstrations are) in a “learning by doing” mode. The three PhD. researchers were important in providing and analysing the necessary scientific information related to integrated water management at greater Beijing level and the innovations at the demo. Furthermore, as an important advisor to the national government on (peri-) urban planning, IGSNRR can effectively disseminate the findings and lessons to other cities in China. In fact, through formal and informal linkages with different government institutions, the adapted technologies in urban agriculture and use of various water sources have been successfully scaled up in various other areas in peri-urban Beijing. The LA activities have been documented in the form of short reports (in Chinese), available at the SWITCH City website: <http://switchurbanwaterbeijing.yo2.cn>.

“The Beijing Network increasingly operates as a national network. Firstly, because the Beijing team is involved in National Policy influencing (5 year development plan, etc.), and secondly, because many other cities are asking to become a member of RUAF China. National recognition will be official soon”.

Interview with Ms. Liu Junping, Beijing Rural Economic Research Centre, Chair of the Beijing Platform on Urban Agriculture

So the participative (action) research and involvement of multiple stakeholders focused on district level, while communication with the National (Beijing and Chongqing LA members) was done by phone, email, and bilateral visits, while the city website acted as a depository of information.

Further efforts to scale up the SWITCH approach were undertaken at international conferences, such as the Sustainable Water Infrastructure for Cities and Villages of the Future (SWIF) conference in 2009, and at the 2010 EU week at the Shanghai World Expo.

IGSNRR is one of the founders and key actors of the Urban Agriculture Association of China, which is very active nationwide in promoting sustainable urban agriculture. IGSNRR also coordinates the Centre for Water Resources Research of the Chinese Academy of Sciences, and has setup a joint research centre on water issues with the Australian Academy of Sciences. The Ministry of Housing and Urban-Rural Construction has awarded a proposal for additional research on eco-sanitation/ decentralised wastewater management that was jointly proposed by Chongqing University and Wageningen University. This research will focus on water-saving toilets. IGSNRR is one of the key partners of the Chinese Eco-sanitation China Node, which is promoted by SIDA and the China Environment Protection Association. The Chinese Academy of Sciences has established a joint research centre on sustainable urban development with Arizona State University,

in which IGSNRR and the Research Centre on Ecological Environment are the two main institutes, and under which water is one of the key issues.

Planning and networking for change

In China, stakeholders in the process of IUWM and urban agriculture are represented at various levels – village, town (or county), district and city, and national level – and at all these levels there is additional funding. Planning is a complicated process of bottom up influence and top down implementation. Influencing policy is a delicate matter, and the higher the level you seek to influence, the better your evidence and offer need to be. On the other hand, at village level, the commitment of village authorities is important, since farmers see authorities at this level as their representation.

“The higher you get the better your story and offer needs to be. Therefore, you need to show good results and evidence story when inviting higher officials at city level for visioning and strategic development session. This is often not well done, and lots of current findings are not very convincing to the decision makers.”

Interview with Mr. Cai Jianming, IGSNRR, SWITCH City Coordinator and Mr. Ji Wenhua, IGSNRR, SWITCH PhD Student

At those meetings, it is also the usual custom that the higher official talks, and then leaves. This is slowly changing, and those involved in SWITCH appreciated the open character of the process very much where one could talk and express opinions, while avoiding conflicts. Still a mix of pull and push is needed: to convince people to try out new things and to be open in discussions on the one hand, and to provoke debate and constructive criticism on the other, rather than adopting a new structure exactly as it is presented.

As a relatively new approach in China, the LA basically remained informal and in most cases was restricted to a series of bilateral discussions between institutions involved in the SWITCH (and this is similar in the RUA Multi-Stakeholder Platform and other networks). This was the preferred style of operation and proved to be effective in reaching consensus. IGSNRR subsequently disseminated these agreements to the larger group of stakeholders in the informal network. In this way, innovation and experimentation was made possible while staying aligned with official city planning and the city strategic vision of official city development policies.

The role of the core/working group was essential in bringing together main and active partners to adapt, facilitate and promote innovations in rainwater harvesting and urban agriculture. In this sense, the cooperation between IGSNRR

and the Beijing Water Authority and between Agriculture and Water Authority has been important.

Multi-stakeholder processes are felt to be time-consuming and as the country is experiencing rapid growth and transition, most local government bodies lack the patience to go through this process, and tend to support arguments in favour of quick decisions. Changes can take place overnight; and in this context, practical decisions need to be made based on “learning by doing”; the link to practical pilot projects is paramount. To support this rapid change and learn from failures and successes one needs to (better) document the process and exchange information.

The Beijing level informal network brought together different actors involved in peri-urban agricultural development, including farm cooperatives, universities, research institutes, and government departments. Urban producer organisations play a key role in the development of sustainable multi-functional peri-urban agriculture in China. Involving the Huairou Cooperative in the multi-stakeholder working groups, demonstrated their significance to the other institutions, and allowed opinions on the RWH technologies and the need to improve water saving and production technologies to be shared. The partners in the Huairou working group kept the participating institutions informed and visited them regularly to obtain their views on certain issues. In this way the exchange between the stakeholders was realised and shared views on certain issues were developed even though these were not formally expressed in larger meetings. In this way, the informal LA was very important in facilitating information exchange and dialogue between the various stakeholders and influencing policy development.

Since the Municipalities (either at provincial or district level) are the main driving forces for planning and investment in the peri-urban areas, this initiative of working with peri-urban producers and cooperatives, and creating linkages through the working groups and the informal LA, fits well in introducing a form of coordinated inter-institutional planning that is quite rare in China.

The working group, together with the LA network partners, supported by institutions that had not met/collaborated before, started to get to know each other’s work, and find ways of collaboration. The informal character – no “red stamp” (official signatures) needed – created the possibility of freely exchanging ideas and information, thereby influencing policy development within the institutions, and also at district level and potentially at municipal and national level as well.

“The City Strategic Agenda has not been printed and officially signed by all the parties. It is and will remain informal. The problem lies in getting the red stamp. Personal and group commitment is no problem, but to get the institutional authority signing (and giving the red stamp) is unlikely, and only suggestions for activities and policies can be made”.

Interview with Ms. Liu Junping, Beijing Rural Economic Research Centre, Chair of the Beijing Platform on Urban Agriculture

Policy awareness has been enhanced on the importance of peri-urban productive use and need for support. SWITCH, together with the RUAF working group on urban agriculture, has supported the enhancement and integration of urban agriculture and reuse of rainwater in peri-urban planning and these approaches are included in the 12th Five-Year Plan. The new policy of Beijing for the development of peri-urban areas gives a major role to farmer cooperatives in the development of peri-urban agriculture. Furthermore, cooperation (between departments; public-private organisations; and between different levels) has been stimulated with diversity at village, district and city levels.

RUAF and SWITCH introduced and further stimulated new development models, like small farmer - and community based - agro-tourism (which contrasts with the very large scale enterprise based agro-parks) and has stimulated farmer-led cooperatives for intensive market oriented horticulture (as an alternative to the former state led cooperatives). RUAF activities have also stimulated the development of a new zoning plan for peri-urban Beijing, including various types of urban agriculture, and contributions to the further development of the New Countryside Development Programme policies of the Beijing Agricultural Bureau. The Huairou Green Vegetable and Fruit Cooperative are now relatively successful in terms of its income (as compared to similar cooperatives). Huairou district government is convinced now that mushrooms can be a promising product in the Beijing market and has designated mushrooms as one of the pillar agro-products for the district and has put a mushroom growing stimulation policy in place.

“IGSNRR has always been very supportive to the work of the cooperative and involved us in the wider network.

“The difference between RUAF and SWITCH was not always very clear. The work was very related. Of course the investment in the underground tank, capturing the rainwater from five greenhouses, and the many visits and the research of Ji Wenhua (PhD), and the visits by local, national and international experts were very visible.”

Interview with Ms. Zan Xiaojing, Director of the Huairou Cooperative, member of Beijing SWITCH Working Group

The potential of RWH was already acknowledged. In 2001, the Chinese State Council approved the “Capital Water Resource Sustainable Use Planning of the 21st Century”, announcing that using rainwater is a key measure to relieve severe water scarcity, and at the time of the start of SWITCH in Beijing, the attention for using rainwater accelerated. For intra-urban areas some important policies came into being, such as the “Beijing Municipality Water Saving Measures”, which encourages citizens and state departments to use rainwater or wastewater for watering landscape and the city environment. New construction projects now use

rainwater reuse technologies where appropriate. However, proper policies were missing for the peri-urban areas of Beijing, but the Beijing Municipal Agriculture Bureau and the Beijing Water Authority, who provided subsidy and technical support, now join hands. The SWITCH-Beijing programme enhanced this development.

IV. CONCLUSIONS AND RECOMMENDATIONS

SWITCH aims to contribute to a paradigm shift in urban water management to a more integrated and participatory approach. It tackled this through a combination of demand-driven research and engagement with stakeholders, brought together in multi-stakeholder platforms, or learning alliances.

Each of the cities in SWITCH has built its own intervention logic and methodology using general methodological elements. The objective of this paper was to assess the intervention logic of SWITCH in Beijing, China, and to define recommendations, so that the processes set in motion could be sustained and scaled up where relevant. It draws its conclusions on the basis of interviews with stakeholders from the city, as well as meetings with project staff involved.

Main conclusions

Beijing is a water scarce city, facing a range of water-related problems. The research and demonstration project in Beijing has stimulated the use of available and on-going research. Innovations were not only in terms of technology and improved production but also in the cooperative organisational model and new institutional linkages. They succeeded in supporting moves towards saving water and higher incomes for farmers and fit on-going developments in China towards more efficient water use. Finding the best RWH technologies and models for Beijing and supporting its uptake is an important issue, and responded to the potential of the adapted technology of RWH. Efforts to scale up the results of the demonstration projects and the research are on-going and promising.

“Given the limited budget in the project, the visibility of SWITCH Beijing is in fact quite outstanding. Its demo results have been already directly implemented by the local government and the special office in Beijing for RWH. SWITCH Beijing and the special office even applied a patent for this RWH techniques. It is foreseeable that in the coming years, a large up-scaling of this technique will occur in Beijing”.

Interview with Mr. Cai Jianming, IGSNRR, SWITCH City Coordinator and Mr. Ji Wenhua, IGSNRR, SWITCH PhD Student

The Beijing Working Group has been very active and met many times, although it remained informal. Members were kept informed, were invited to working group

sessions, while working group members visited key institutions. There is scope and interest, in the continuation of this platform. The wider Beijing-Chongqing LA was even more informal. They only met three times, and functioned as a network to exchange information and keep institutions up to date. This platform probably will not continue as such after SWITCH, but bilateral and informal relations might.

The network built upon experiences of the network on the role multifunctional agriculture plays in peri-urban development, facilitated by RUAF China (IGSNRR). Some members participated in the SWITCH working group on urban agriculture. Vice versa, SWITCH Beijing further enhanced and stimulated the network on urban agriculture in Beijing. Close collaboration existed in the enhancement of the production system, working on water and organisational strengthening, and on influencing policy. This enabled frequent communications between urban agriculture practitioners, policy makers and researchers via personal contacts, periodic meetings and workshops. The network also operates at national level, and is expanding to other cities including Shanghai, Chengdu, Nanjing, Wuhan, Tianjin, Harbin, Zhengzhou, Lijiang and many more. The official national network on urban agriculture (the Chinese Urban Agriculture Association) was established in 2006 with the help of RUAF-IGSNRR and acts as the national platform for exchange experiences among more than 20 Chinese cities, universities and national agencies such as the Ministry of Agriculture and Ministry of Sciences and Technologies that actively promote urban and peri-urban agriculture.

Supported by this national network, the Ministry of Agriculture established a new Department of Recreational Agriculture in 2007, which is the main policy making and regulating unit regarding urban agricultural development in China, including funding support for related projects. The RUAF-China network sought to influence the 12th five-year plan, from 2011 to 2015, with more attention for multifunctional agriculture and more efficient water use, including rainwater harvesting. The new five-year plan will see a much more integrated development of urban and rural areas, in which urban and peri-urban agriculture will be an important strategy.

“Actors, with whom the Water Authority did not interact before, have now become important informants and collaborators. Of course an important actor missing in these discussions is the Beijing Capital Urban Planning Bureau. The interest of the (national) Ministry of Housing and Urban-Rural Construction is important, but their low-level participation is disappointing. What is needed is to have a (final) seminar in which also national authorities participate”.

Interview with Ms. Zhang Tong, Chief Engineer, Beijing Research Institute of Water Planning under Beijing Water Authority, and a core member of the Beijing SWITCH Working Group

However, the dominance of one work package and the focus of the work by the leading institute, partly due to the forced diversion of some SWITCH activities to

another city, made SWITCH respond only to part of its original aims. The shift of the work on eco-sanitation out of Beijing was a major setback, both in integration and in the loss of involvement of key stakeholders, such as the Ministry of Housing and Urban-Rural Construction.

Some felt that the Urban Planning Bureau could have become more involved but a major problem has been that it does not see peri-urban agriculture as important on its agenda,

Delays in strategic planning under SWITCH and in learning alliance development confused and delayed the process by at least one year. On the other hand, the work on water for urban agriculture, as well as the experience of IGSNRR in facilitating these processes, made it possible to develop a China-specific approach. Despite delays in organisation of the learning alliance, SWITCH in China has made optimal use of the Chinese situation of experimentation and showing the potential of new sources of water to contribute to the water scarcity in the City and its surroundings.

Several challenges remain:

- Since monitoring and process documentation have not been adequately taken up, little of this process has been made clear to the outside world. If there are avenues to further write up the processes they should be taken.
- Although it functions informally, the establishment of the city level working group on water for productive (multifunctional agriculture), will need facilitation, by IGSNRR/RUAF China, if it is to survive the end of SWITCH.
- SWITCH technologies have untapped potential in terms of the number of farmers and institutions who know about them and apply them. The Huairou Cooperative partners have applied for a patent for the RWH technology. A handbook has been developed and is now translated into English but guidelines and training materials for other farmers still need further development.

Recommendations

The studies at regional level and the comparative studies on RWH in Beijing were important in demonstrating the potential of this model vis-à-vis other water saving options in general (wastewater reuse) as well as against other RWH models.

To further promote this, IGSNRR should seek to finalise and publish the various drafts which have already been developed at the time of writing. SWITCH material could be used to develop a specific policy brief on the experiences of SWITCH

China in decentralised innovation development and inter-institutional collaboration.

In addition to this sharing and informing a wide array of local, city and national institutions, IGSNRR should take steps to institutionalise and promote the position it achieved under SWITCH as well as those of the main institutions (the Cooperative, the Agricultural and Water Bureaus). For IGSNRR, this could mean linking the Water and Urban Planning groups and to RUAF China.

The existing linkages between the Promotion Office of the Agricultural Bureau and the Beijing Water Authority are also crucial in further up-scaling. IGSNRR should seek to extend their experiences to other dry areas of Northern China, and seek to position the developed (adaptive) process within the next five year planning and beyond.

IGSNRR did not manage to organise a final workshop of SWITCH to present the scientific findings and policy recommendations. But it would still be worthwhile for IGSNRR to seek to profile itself, the network, the handbook and the major findings to key stakeholders, such as other cities. The SWITCH website, and those of working group members, would be valuable for this.

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List of Interviewees

- Professor CAI Jianming, Institute of Geographic Sciences and Natural Resources Research (IGSNRR), Chinese Academy of Sciences (CAS), SWITCH City Coordinator
- Professor LI Ijuan, IGSNRR-CAS, SWITCH City Facilitator
- Mr. JI Wenhua, IGSNRR-CAS, SWITCH PhD Student
- Mr. LI Jiuyi, IGSNRR-CAS, SWITCH PhD Student
- Dr. WANG Yan, Beijing Water Environment Protection Bureau (BWEPB), member of Beijing SWITCH Working Group
- Dr. ZHONG Tong, Chief Engineer, Beijing Municipal Research Institute of Water Planning (BMRIWP), LA coordinator of Beijing SWITCH Working Group
- Ms. WANG Zhi-Ping, Beijing Agro-Technical Extension Centre (BATEC), member of Beijing SWITCH Working Group
- Ms. LIU Junping, Beijing Rural Economic Research Centre (BRERC), RUAF MPAP Coordinator
- Ms. ZAN Xiaojing, Director Huairou Cooperative, member of Beijing SWITCH Working Group
- Dr. ZHAI Jun, University of Chongqing (UC)
- Mr. Adriaan Mels, Wageningen University and Research Centre (WUR)

Overview of activities undertaken in SWITCH

2006

Start, identification of PhD students, of demonstration project

2007

Start of demonstration with cooperative, agreement with Huairou District

First working group meeting at Huairou level

Start of PhD 1

2008

First working group meeting at Beijing level

First LA meeting

LA training and vision development

Start of PhD 2

2009

Second LA meeting

LA discussion on Strategic Planning

Finalisation of PhD 1

2010

Finalisation of demonstration

Finalisation of PhD 2

ACRONYMS

AB	Agricultural Bureau
BAEB	Beijing Agricultural Extension Bureau
BATEC	Beijing Agro-Technical Extension Centre
BMRIWP	Beijing Municipal Research Institute of Water Planning
BRERC	Beijing Rural Economic Research Centre
BWEPB	Beijing Water Environment Protection Bureau
CAS	Chinese Academy of Sciences
CFF	Cities Farming for the Future
ETC (Foundation)	Netherlands based NGO supports countries' development of food security, water, energy, health care and education
ICLEI	Local Governments for Sustainability
IGSNRR	Chinese Academy of Sciences
IGSNRR-CAS	Institute of Geographic Sciences and Natural Resources Research - Chinese Academy of Sciences
IHE-UNESCO	Institute for Water Education, Delft
IRC	IRC Water and Sanitation Centre (The Netherlands)
IUWM	Integrated urban water management
LA	Learning Alliance
MOHURD	Ministry of Housing and Urban-Rural Construction of China
MPAP	Multi-stakeholder Policy Influencing and Action Planning
NGO	Non-Governmental Organisation
RUAF (Foundation)	Resource Centres on Urban Agriculture and Food Security
RWH	Rainwater Harvesting
SWIF	Sustainable Water Infrastructure for Cities and Villages
SWITCH	Sustainable Water Management Improves Tomorrow's Cities' Health
UC	University of Chongqing

WASTE	Advisers on Urban Environment and Development
WG	(Beijing) Working Group
WUR	Wageningen University and Research Centre