



Input to deliverable 6.1.5-6 Comparative Analysis of Enabling Factors for Sustainable Urban Water Management

Case study brief – Beijing, managing water for the eco city of the future

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Abstract

Introduction

Global changes such as climate change and volatility, urbanization and industrialization, population growth, urban sprawl, rural-urban migration put pressure on cities. The Switch project emphasizes the importance of integrated water resource management.¹ The approach is very much focused on closing the urban water cycle, defined as the link between the resource, its use for drinking water and the eventual reuse to allow the water to flow back in the resource. For integrated urban water cycle management the available water resources, the required drinking water supply and proper waste water treatment are three important moments, with each its specific problems in China.

Besides drinking water problems in the north, flooding is common in the south, just like polluting the rivers everywhere in China, while rivers are also important for irrigation, drinking water, transport and fishing activities. There is not enough water in northern China for the different types of use and for the big cities, which have high per capita consumption figures, also because of substantial losses.¹¹ A deteriorating environment accelerates the trend towards a gradual shortage of fresh water. Resources are polluted, drinking water is scarce and the quality of the water produced by waste water treatment plants is not always appropriate, while the consumer price is too low and includes only a small amount for waste water treatment. Since the mid-1980s, Beijing, the capital of China, is faced with continuing periods of drought and the increasing population have worsened water scarcity.

A large number of initiatives to make Beijing a more ecological city have been launched, ranging from separating grey and brown water to financing sophisticated ecological projects in the framework of the Olympics in 2008 (Van Dijk, 2009). We will first give some examples of problems in the water and sanitation sector in China. Subsequently the hierarchy of Chinese government will be explained, before describing the stakeholders in water governance at the national and municipal level. A separate section is devoted to changes in the water governance structure that have been implemented already in Beijing. Water governance has been reformed to achieve more integration and promote experiments to deal with water scarcity. We have studied some of these water and sanitation projects. In particular the separation of grey and brown water and reusing the treated grey water and the promotion of rainwater harvesting will be discussed. The governance structure of these projects, of which one has been supported by Switch, will be analyzed. At the end of this contribution we will draw some conclusions about Beijing becoming an eco city.

The hierarchy of Chinese water governance structures

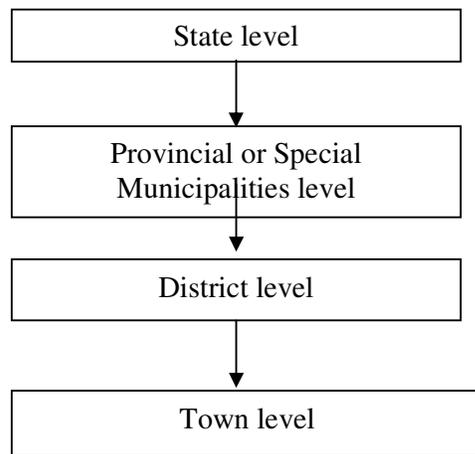
Beijing has an estimated population of 15 million inhabitants. It is located in the north of China and is facing severe water scarcity problems. Given the negative effects on the environment, Beijing has decided to direct businesses which utilize large amounts of water out of the city. Several projects to link the southern rivers (in particular the Jiangtze river) with northern rivers (in particular the Yellow river) are undertaken to guarantee that enough water will be available.

The governance structure to achieve this is relatively simple. It is hierarchical and centralized through the role of the Ministry of Construction and the corresponding line offices at the city and district level. However, it also excludes participation of the users. There are numerous problems with the water cycle in China, which can be partially blamed to this governance model. Just to mention some examples: what is the impact of climate change on water

resources and development in China (China Daily, 2-7-2004). What are the risks linked to the current practice of water management for Chinese rivers? A few years ago Beijing has reorganized its governance structure related to water supply, water management and sanitation. The Beijing Water Authority is now the single agency involved, which makes it more efficient than the previous model where various ministries and agencies had responsibility for water related issues.

The Chinese governance structure is a multi-layered hierarchy. The various agencies within the structure are divided by territory, function and rank. Figure 1 shows the hierarchy in terms of territory. The arrows lead from the order-giving body to the order-receiving body. Beijing, like Shanghai, Tianjin and Chongqing, is a provincial municipality or a city state, so the province level is at the same level as these municipalities and the municipal governments of these cities report to the state government (the national level) directly.

Figure 1 Territorial ranks in urban China



Every agency or bureau within the government structure is given a rank. The units with the same rank can not issue orders to each other. Only the higher ranking agency can issue an authoritative order to the lower ranking agency. For example, the Ministry of Construction has the same ranking as the Beijing Municipal government. So the Beijing Municipal government can not issue orders to the Ministry of Construction, or the other way around. Instead the communication should go up and down to the next level. It would also be rare for the provincial government to issue commands to the town level skipping the municipal and district levels.

Water management at the State and Municipal level

The State Council and National People’s Congress are at the top level, commissions are a step down, ministries are another step down, and bureaus are another step down. The State Development Planning Commission (SDPC) is responsible for 1) formulating and implementing strategies of national economic and social development, 2) arranging construction projects funded by central government appropriation, key construction projects, and foreign-funded key projects, 3) organizing and managing the work of special inspectors for key projects, 4) the approval of all infrastructure projects. It is also the source and manager of capital funds for government sponsored investment projects and those of most state owned enterprises. It is also a functional agency with local level representations.

Municipal Governments in China are responsible for planning, surveying, designing, constructing, operating, and managing irrigation, drainage, flood control works, and rural hydropower. They are also responsible for county and municipal tasks such as constructing and maintaining canals, related irrigation and flood control structures, medium-sized reservoirs. At the municipal level a number of institutions are involved, as will be explained for Beijing below.

In the old structure at the city level the Municipal Administration Committee was there primarily to guide, coordinate, supervise and inspect land, environmental protection, water supply and other infrastructure within the city. The Price Bureau is responsible for implementing price policies and laws and to supervise and monitor the price of commodities and services. The Urban Planning Administration Bureau is mostly responsible for the urban planning and design. It contributes to the design and organization of urban space and activity and it is responsible for the approval of the initial project construction.

The Public Utilities Bureau (PUB) is responsible for managing all municipal public utilities, such as gas supply, heating supply, transportation, water saving, etc. For the water sector, PUB is in charge of collecting water fees and supervising the municipal waterworks company and municipal water saving office. However, Beijing’s water governance has recently been reformed.

Water management in Beijing: structure and policy making

For water management in Beijing, there are three layers from the municipal to town levels (shown in table 1). Each one has its own authority with corresponding responsibilities.

Table 1 Three layers for water management of Beijing

Municipal Level	Beijing Water Authority	Responsibilities: Water resources, water supply and water pollution management and etc. within the municipality. Coordinating among districts/counties
District/County level	District/county Water Authority	Responsibilities: Water resources, water supply and water pollution management and etc. within the district/county. Coordinating among subdistricts/towns
Subdistrict/Town level	Subdistrict/town Water Management Station	Responsibilities: Water resources, water supply and water pollution management and etc. within the area

Source: Pan (2006).

At the lowest level a Water management station has limited autonomy for the area covered. The hierarchical water governance structure is caused by the complex system of state level ministries, agencies and lower level bureaus involved. It leads to an unclear policy making process. Finding out how policies are made in China is much like tracing the movement of a single blood cell through the entire human body: the journey is time consuming and involves a network of organs, and the specific route depends on the situation (Hou, 2000). On top of a rigid hierarchical structure, the cooperation between agencies at the same hierarchical level is

very poor. Government officials interviewed do not give their opinions about the functioning of the governance structure, but rather repeat the official point of view on the division of power between the different levels of government. For that reason we mainly rely on a description of the administrative structure of the country and the views expressed in the literature, in which case we give the references. For the projects studied in detail in the framework of the Switch project we will describe the governance structure.

Major stakeholders in the water and sanitation sector in China

State Environmental Protection Agency (SEPA)

Some agencies exist with the particular functions. SEPA was set up as a Ministry in March 1998 when the original Environmental Protection Agency was upgraded from a sub-ministry to a ministry. The responsibility of SEPA is 1) the environmental supervision and management, 2) administrative inspection of the environmental protection, 3) environmental statistics and information collection, 4) formulating general and specific policies, laws and regulations, and administrative rules for environment protection and environment impact assessment, 5) coordinating and organizing pollution prevention (source from website of SEPA).

Environmental norms have been put at a high level in China, but unfortunately there is a problem with the implementation of these norms. The SEPA is not very powerful, compared to the Ministry of Construction which is responsible for the construction of water and sanitation facilities and follows a very technical approach. SEPA like other state level organizations has corresponding agencies or bureaus at provincial, municipal, county and district levels. For example, there are State Environmental Protection Agency (SEPA), Provincial Environmental Protection Agency and Urban Environmental protection bureaus. SEPA is responsible for the Provincial Environmental Protection Agencies, which in turn control the Urban Environmental Protection Bureaus. The leader of SEPA can appoint the leader of the Provincial Environmental Protection Agency. These functional agencies exist with different territorial ranks. So in different provinces or cities, the functional agencies concerned with the water services and resource governance are almost the same.

The Ministry of Construction

The Ministry of Construction is responsible for the overall administration of the construction sector. In the water sector, it is responsible for the planning and construction of municipal water systems, including sewers and treatment facilities, and for formulating the policies, regulations and administrative rules concerning construction of facilities.

The Ministry of Construction is a typically a functional department that has a local counterpart, the Beijing Urban Construction Bureau. The Beijing Water Conservancy Bureau, and the Beijing Environmental Protection Bureau are other examples of local counterparts of national level institutions.

The Ministry of Water Resources

The Ministry of Water Resources is responsible for 1) the management of all national water resources, including improving and developing major rivers, 2) planning and supplying water to urban centres, 3) constructing irrigation facilities, soil and water conservation programs, 4) supplying rural hydropower, 5) building and managing medium-size and large reservoirs for flood control.

Non governmental organizations

Non governmental organizations in the water sector are scarce, except for the World Wild Life Fund (WWF), which is very active (WWF, 2005 and CICODE, 2006). Liang-Yin Hau (2007: 384) notes that it is "a long march towards civil society" in China. Referring to the issue of HIV/AIDS the author notes that NGOs are allowed more influence, but a genuine partnership between NGOs and the government may still be far off, given the political reality in China.

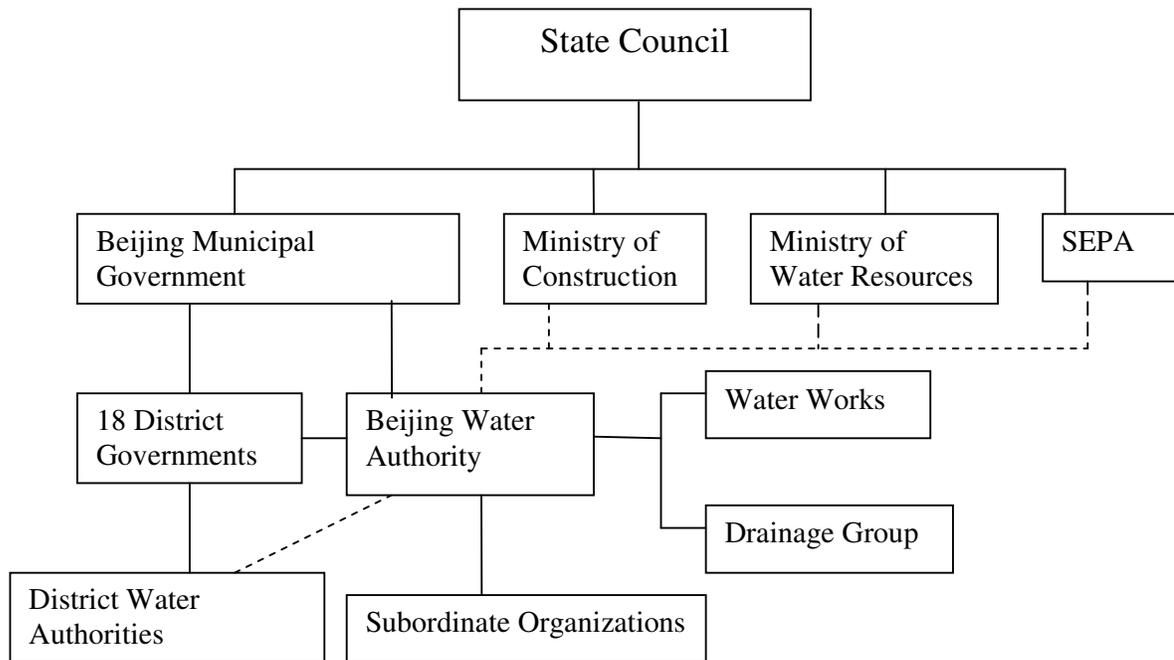
The private sector

The private sector is not so much involved in the water and sanitation sector in China, except sometimes through building contracts. Also a number of investments are financed through Build Operate and Transfer (BOT) formulas, where the national investors have now replaced the international companies to finance these projects.

Changes in the water governance structure in Beijing: the creation of the BWA

China has reformed its water governance structure and started the reform in Beijing. The purpose of the reform is to reduce the number of agencies and bureaus involved in water management. The Beijing Water Authority (BWA) is a new institution for water resources and services management. It is expected to be in charge of water service and management in the different territories. Such an authority is established in many other cities and provinces as well at the moment.

Figure 2 New water governance structure of Beijing (Pan, 2006)



The changes in the water governance structure have been implemented, starting in Beijing. The old water governance structure reflects the hierarchical order in the water sector and shows all kinds of agencies involved in water management in Beijing. The Beijing Water Authority has taken over the role of a number of these bureaus. The Beijing Water Authority has two main organs: Water works and Drainage group, and also commands 30 subordinate organizations. The functions of the new organisations will be described. Due to the territorial

hierarchy, the 14 District Water Authorities are all under the Beijing Water Authority. In total there are 18 district governments in Beijing. Except for four districts in the city centre, the other 14 districts have separate water authorities.

The Beijing Water Authority was established in 2004 and is owned by Beijing Municipal government. Figure 2 shows the new structure for water governance in Beijing. It reveals that only the three most relevant agencies: Ministry of Construction, Ministry of Water Resources and State Environmental Protection Agency and the Beijing Municipal Government are involved in the water management.

The new water governance structure of Beijing is the example for other Chinese cities and provinces. According to the hierarchical structure, there will be Provincial water authorities, Urban water authorities, and District or County level water authorities. However, it is a big challenge to change the existing governance structure entirely in China. Even Beijing has not yet completed the water governance structure reform process. We mention the responsibilities of the new authority and the two groups that have been formed under it.

Besides the Beijing Water Authority there are the 14 district or county water authorities and another 26 sub-districts or town water management stations, which are all managed by Beijing Water Authority. The responsibility of Beijing Water Authority is 1) to formulate the policy, regulation and administrative rules on water management, 2) to formulate the regulations on water tariff and wastewater fee, 3) to supervise the water services and the standard of technology, 4) plan and organize the water supply and water allocation, 5) manage the institutions concerned with the wastewater discharge and reclamation. Newly constructed centralized waste water treatment systems are managed by specialized institutes of the Beijing Water Authority. The reform of the water governance structure of Beijing decreases the number of the institutes involved into the urban water management considerably. Accordingly, the number of stakeholders involved into the management of the centralized systems decreases. The hierarchical order in the water governance becomes weaker.

The Beijing Waterworks Group (BWG) is the only tapped water supplier in the Beijing area and is responsible for the supply of the urban areas as well as seven other suburbs of Beijing. There are about 20 drinking water factories that can supply more than 2.93 million m³ per day with an annual production in excess of 700 million m³. The Beijing Drainage Group (BDG) is a wholly state-owned wastewater utility established in February 2002. The principal activities of the BDG are the collection and treatment of sewage as well as reclamation of treated wastewater, aiming at water pollution control and effective management of water resources (from website of BWG, see below).

The Beijing Water Saving Office was established in 1981. Before the reform of water governance in Beijing, it was a small institute of the Beijing Public Utilities Bureau. It means the rank of the Water Saving Office is lower than the bureau level. However, after the reform of the water governance in Beijing, the rank of the Beijing Water Saving Office increases to the bureau level. Because of the deteriorated water scarcity in Beijing, the promotion of water saving becomes more intensive and extensive. Consequently the responsibility of the Water Saving Office is enhanced. Beijing water saving office belongs to Beijing Water Authority, which is responsible for supervising the water services and the standard of technology. It provides subsidies to the initial investment of water reclamation system. Almost all the water reclamation systems of Beijing are subsidized to around 50-100% of the initial investments by the Beijing Water Saving Office. The responsibility of the Municipal Administration

Committee is to supervise land use and environmental protection. It is involved in formulating the policy of construction standards of water reclamation plants. Finally, the Urban construction bureau is also involved into formulating policy of construction standard of water reclamation plant and supervising the plant construction.

How does Beijing deal with water to become the eco city of the future?

In Beijing there are about 30,000 ecological initiatives to make this city greener. To assess the ecological character of Beijing we use the criteria for ecological cities suggested in Box 1. We can distinguish the first five, which are directly water related and the second five, which take a broader point of view. All ten will now be analyzed.

Box 1 Criteria for defining eco cities:

1. How does the city deal with **water** related issues?
2. How does the city deal with **sanitation** issues?
3. How does the city deal with **pollution** issues?
4. How does the city deal with **climate change** issues?
5. Does the city follow an **integrated approach**?
6. How does the city deal with **energy** issues?
7. How does the city deal with **solid waste** issues?
8. How does the city deal with **transport** issues?
9. How does the city deal with **housing** issues?
10. How does the city deal with **sustainable urban development** issues?

Source: Van Dijk (2010).

1. How does Beijing deal with water related issues?

The goals of the Chinese 11th Five Year Plan for the water sector are ambitious. The planners want to reduce for example water consumption per industrial unit by 30 percent and to increase the coverage for water and sanitation facilities in line with the Millennium Development Goals (MDGs). Beijing is water scarce area and as such it would have interest in closing the water cycle, like Singapore has done (Ministry of Information of Singapore, 2008). It means not losing any of the scarce resource and controlling the quantity and quality constantly. Such an approach would favor integrating the management of the whole water cycle. Singapore has managed for example to close the water cycle and in principle, no water gets lost between resource and users. All of it is cleaned and made available for reuse. However, the main reason for not doing this in Beijing is the lack of confidence of the public in the quality of the water coming from the large scale centralized waste water treatment plants.

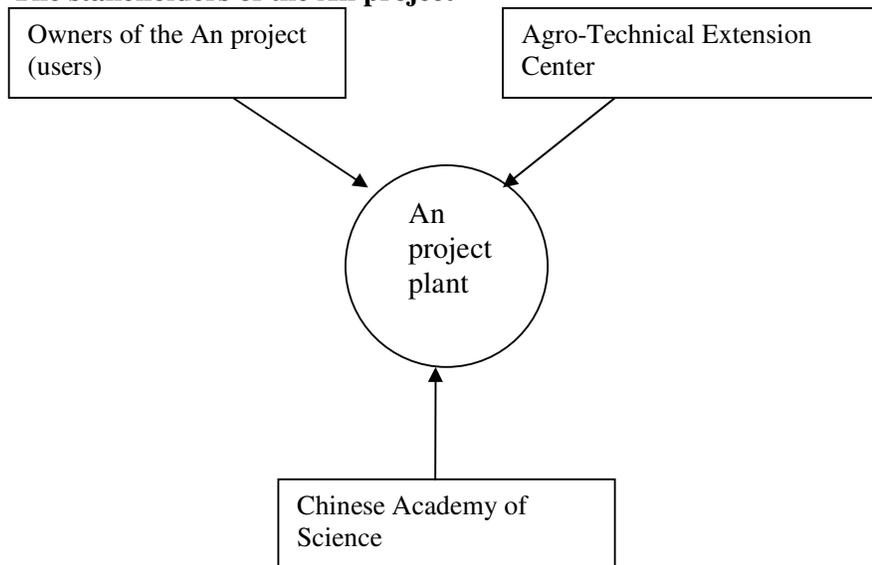
Flooding is not so much the problem, as well as a declining ground water level, pointing to over use of the aquifer below the city. Rainwater harvesting is promoted, in the centre of town and in the rural areas of the city state. However, it turned out that at the current price of electricity, and given there is no charge for pumping up ground water, it is cheaper to continue to use ground water than to invest in rain water harvesting in the rural areas of Beijing (Liang and Van Dijk, 2010).

a. The An rainwater harvesting project

In Beijing, water scarcity occurs in various fields such as agriculture and industry. The new decentralized projects concerned with water saving are managed by different institutions. For example, this rainwater harvesting project of the rural area is managed by the Agro-Technical Extension Center. The An project is located in Beijing rural area and is about rainwater harvesting, the stakeholders involved into the project are different from the other two projects. Below is the description of the stakeholders. It has a number of characteristics summarized in table 3.

In the rural areas of Beijing, a lot of rainwater harvesting projects is constructed to relieve water scarcity. Some of these projects are mainly supported by the Beijing Water Saving Office, and others are mostly supported by the Beijing Agro-Technical Extension Center. Generally the owners of projects and the Beijing Agro-Technical Extension Center/ Beijing Water Saving Office are the main stakeholders of these projects. In some cases, the academic institutes are involved into the management for the experiment. Figure 3 illustrates the main stakeholders of a rainwater harvesting project in the rural area of Beijing, the An project. In the An project, excepting the owner and the Beijing Agro-Technical Extension Center, the Chinese Academy of Science (CAS) is an important stakeholder.

Figure 3 The stakeholders of the An project



The users of the An project are also the owners of the An project. They are in charge of construction, operation and maintenance of the project. The cost and benefits of the project are managed by the owners. Because it is a demonstration project, a research institute is involved in the project. The Chinese Academy of Science subsidized around 35% of initial investments of the project. It also provides technology assistance to the operation of the project. The responsibility of the Beijing Agro-Technical Extension Center is providing farmers the training of the new agricultural technology and the technical support. The Agro-Technical Extension Center is not a professional institute in the water sector, that is why the Chinese Academy of Science. The responsibility of the Institute of Huairou District Agricultural Science and in particular the Agro-Technical Extension Center is facilitating agricultural development. It offered 35% of the initial investment to the An project. It helped to supervise the construction of the project. Moreover, it provides technology assistance on the operation of the project.

2. How does Beijing deal with sanitation issues?

In Beijing many public toilets have been built, which are cheap or free, but maybe not always 100 percent clean. They also do not always provide the privacy western tourists are used to. No eco sanitation technologies are usedⁱⁱⁱ, but collective toilets do provide poor people access to safe sanitation.^{iv} As mentioned decentralized waste water treatment is encouraged in Beijing for major new buildings, but currently this is not financially feasible for the investors, although it is economically feasible from a society point of view, if a cost benefit analysis is carried out (Liang and Van Dijk, 2009).

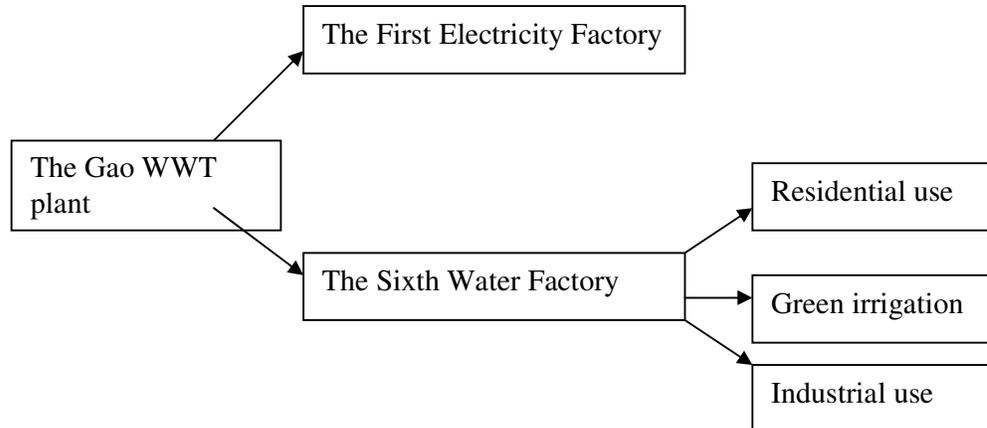


Figure 4 The map of the distribution of the reclaimed water of the Gao project

b. Large scale waste water treatment, the Gao Bei Dian plant

The Gao Bei Dian plant built in 2000 is a good example of a centralized governance system. The Gao Bei Dian project (Gao project) is the largest wastewater reuse project and the first centralized wastewater reclamation plant in Beijing. The reclaimed water of the Gao project will be used for agricultural irrigation, industrial cooling water, green lands irrigation and residential toilet flushing and car washing. According to the interviews, it is rare that the reclaimed water used for agricultural irrigation at present. Largely the reclaimed water of the Gao project is used for industrial cooling water, green irrigation and residential use, which is shown in Figure 4.

Table 2 indicates the quantity distribution of the reclaimed water of the Gao project. Around 200,000 m³ reclaimed water of the Gao project is transferred to “The First Electricity Factory” to be cooling water each day. About 100,000 m³ water is delivered to “The Sixth Water Factory” each day to be processed again for the water quality improvement and then the water goes to residential use, green irrigation and industrial use.

Table 2 Quantity distribution of the reclaimed water of the Gao project

Place	Quantity (m ³ /day)
The first electricity factory	200,000
The sixth water factory	
1. Residential use	20,000
2. Green irrigation	30,000
3. Industrial use	50,000

Total	300,000
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The Gao project is owned by the Beijing Drainage Group which belongs to the Beijing Water Authority. It is shown in Figure 5 that there are three main stakeholders in the Gao project: the Drainage Group, the Municipal Administration Committee and the Urban Construction Bureau. In the “old” structure of water governance of Beijing, there would have been 8 institutes involved into the management of the Gao project, while in the “new” structure, the Beijing Drainage Group, being the owner of the Gao project, is the key manager of the Gao project. It results in a more effective and efficient management of drinking and waste water treatment plants of a larger scale.

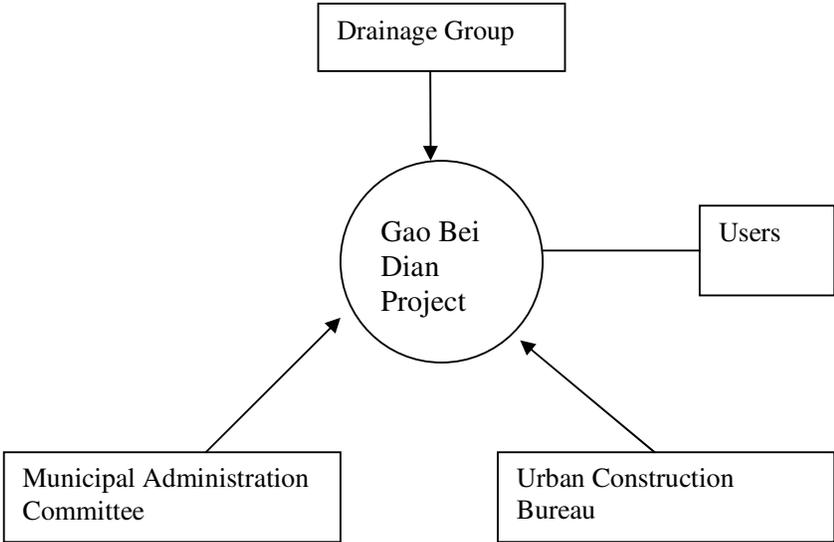


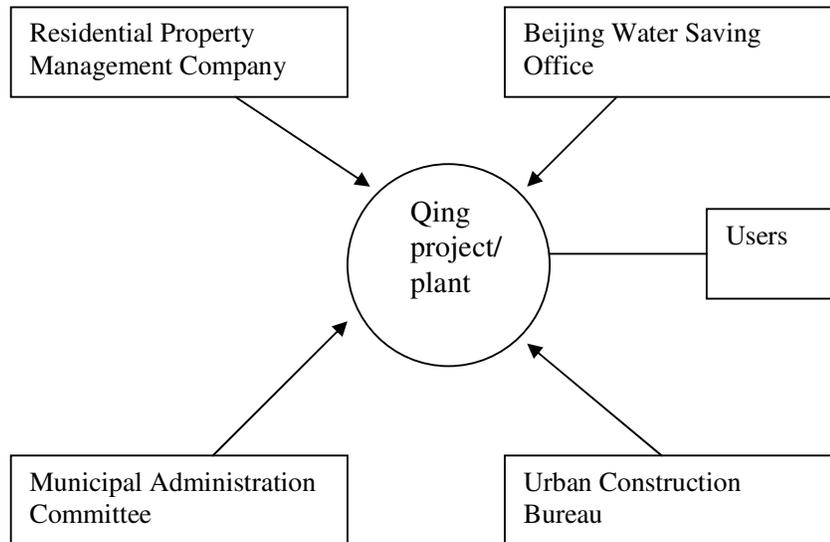
Figure 5 The main stakeholders of the Gao project

c. Beijing: the Qing grey water reuse project

Beijing is unique in the world because it has legislation forcing all major new buildings to separate brown and grey water and to treat their grey water on the spot. The success of this policy is limited, however, since it is cheaper to buy clean municipal water than to make the effort of cleaning grey water and then using it for flushing the toilets and irrigating the garden (Liang and Van Dijk, 2009).

Many decentralized projects concerned with the water saving have been constructed since the mid-1980s. The Beijing Water Saving Office plays an important role in the management of the decentralized projects. Figure 6 indicates the main stakeholders of a decentralized wastewater reuse project in Beijing, the Qing project. The owner of the project is the Municipal Administration Committee. Both the The Residential Property Management Company and the Water Saving Office play an important role in the management of the project. As a brief description of the project we provide five characteristics in table 3 and illustrate the institutional setting in figure 5. The Residential Property Management Company is in charge of the operation and maintenance of the Qing plant. All cost and benefits of the Qing plant are managed by the company. It informs other stakeholders about the status of the Qing project.

Figure 5 The stakeholders of the Qing projects



The Beijing Water Saving Office was established in 1981, before the reform of water governance in Beijing. It was a small institute of the Beijing Public Utilities Bureau. The rank of the Water Saving Office is lower than the bureau level. However, after the reform of the water governance in Beijing, the rank of the Beijing Water Saving Office increased to the bureau level. Because of water scarcity in Beijing, the promotion of water saving becomes more intensive. Consequently the responsibility of the Water Saving Office is enhanced. Beijing Water Saving Office belongs to Beijing Water Authority (BWA), which is responsible for supervising the water services and the standard of technology. It provided subsidies to the initial investment of water reclamation system. Almost all the water reclamation systems of Beijing are subsidized around 50-100% of the initial investments by the Beijing Water Saving Office.

Moreover, the BWA is in charge of checking the quality of reused water of the Qing project. Generally the Residential Property Management Company takes reused water samples to relevant institutes for quality testing, and then sends the reports to Beijing Water Saving Office. This happens twice each year. If the water quality can not reach the standard requirement, the Beijing Water Saving Office will provide technical assistance or criticize the project management institutes.

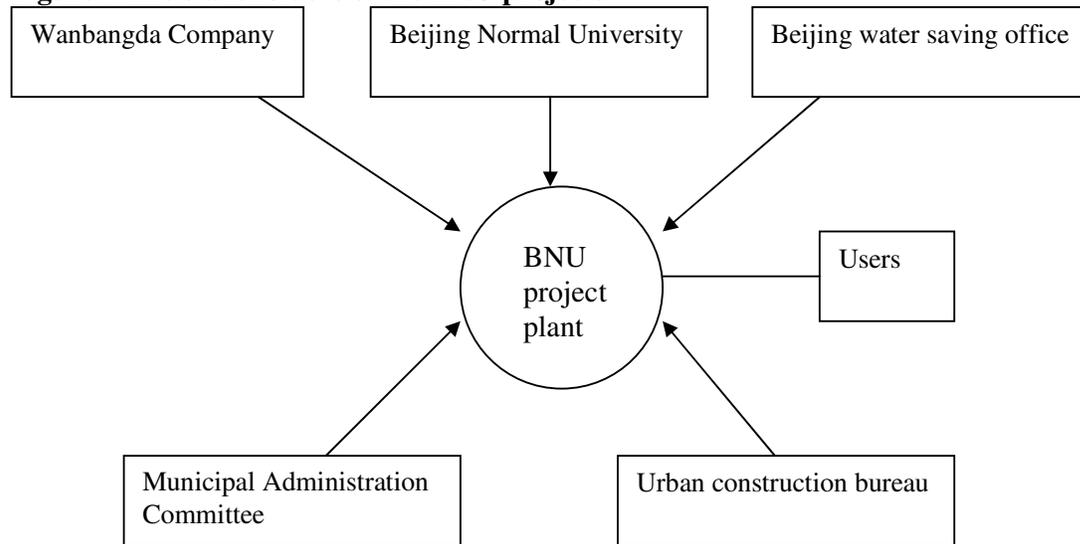
The responsibility of the Municipal Administration Committee is to supervise land use and environmental protection. It is involved in formulating the policy of construction standards of water reclamation plants. The Urban Construction Bureau is also involved into formulating policy of construction standard of water reclamation plant and supervising the plant construction.

Around 2500 residents in the Qing residential area are being served. Since some people think the reclaimed water is too dirty to be used for toilet flushing, around 20% residents refuse to use the reclaimed water from the Qing project. The price of the reused water is supposed to be lower than the price of the municipal water. However, the operational cost of the Qing plant is so high that the reused water has the same price as municipal water. So the users don't find any benefit in using reused water instead of municipal water.

d. Decentralized WWT, the BNU grey water reuse project

This is similar to the Qing project. The characteristics are summarized in table 3. The institutional embedding is provided in figure 7. The stakeholders of the BNU project are similar to that of the Qing project. But for the BNU project, there are two crucial stakeholders which are Wanbangda Company and the Beijing Normal University. Because the functions of Beijing Water Saving Office, Municipal Administration Committee and Urban construction bureau are the same as the previous description, they are not described here.

Figure 7 The stakeholders of the BNU projects



The owner of the BNU project is the Beijing Normal University, and the manager of the project is Wanbangda Company. All cost and benefits of the project are managed by Beijing Normal University. The main responsibility of the Wangbangda Company, which has some kind of management contract, is construction, operation and maintenance of the BNU project. All information of the plant could be obtained from the company. The Wanbangda Company is a state owned company, which belongs to the Beijing Normal University. The relation between the Wanbangda Company and Beijing Normal University determines the financial status of the BNU project.

The users of the BNU project are the students and staff of Beijing Normal University. Most of the users accept to use reclaimed water for toilet flushing. There maybe three reasons for it. Firstly, the student being young generation can accept the new thing easily. Secondly the reclaimed water is used in student dormitory which is different to private living place, so the students don't pay much attention on water usage. Thirdly the students don't need to pay for the use of the water.

e. The institutional analysis for three demo projects

We now look at the governance structure for the demo projects in Beijing, first the Beijing Qing grey water reuse project, then the Beijing Normal University grey water recycling project and finally the An rain water harvesting project. Table 3 compares the key indicators.

Table 3 A comparison between the Qing and the Normal University grey water recycling project and the An rain water harvesting project

	Qing grey water recycling project	The Beijing Normal University grey water recycling project	The An rain water harvesting
a. Location	City center	City center	Rural area
b. Function of project	Water reclamation and reuse	Water reclamation and reuse	rain water harvesting and use for irrigation
c. Users	Residents	Students	Farmers
d. Function of water	Toilet flushing and green watering	Toilet flushing and green watering	Agricultural irrigation
e. Production	60 m ³ / day	60 m ³ / day	400 m ³ / day
f. Subsidies	Initial investment	Initial investment	60 % of initial investment

The BNU has a well organized governance structure by involving a separate company for the management. In the Qing project this is not the case. In the An rainwater harvesting project the farmers need to deal directly with the different organizations that help them. This makes it more complicated for them. All three project are economically feasible according to a cost benefit analysis, but financially, from the point of view of the investors, they are not (Liang and Van Dijk, 2009 and 2010).

3. *How does the city deal with climate change issues?*

China is aware of the dangers of climate change, although climate change is not linked so much to CO₂ emissions, as well as to water scarcity and the risks of desertification in the north west of China. For that reason Beijing invested in building a green wall to the north of the city, which should stop desertification and diminish the dust storms. The city is also experimenting with aquifer refill activities and rain water harvesting projects. Because the use of coal for heating is discouraged less CO₂ is currently is coming from that source. Also the relocation of polluting industries has diminished CO₂ emissions in Beijing.

4 *How does the city deal with pollution issues?*

The National government has introduced standards for pollution and Chinese provinces have to comply with these standards. The State level Environmental Protection Agency (SEPA) looks after the implementation of environmental policies. Beijing as a city state is at the same administrative level as a Chinese province.

Households have been weaned of using coal for heating purposes, while for factories stricter policies with respect to soil, air and water pollution apply. Noise pollution is not yet considered a big issue but cars are discouraged to use their horns too much. More strict environmental rules also apply for housing and the quality of furniture, to avoid that people suffer from the chemicals used. Taken together Beijing is still considered by many a relatively dirty city, with dust storms from the northwest and a lot of smog because of all the automobiles and polluting industries.

5. *Does the city follow an integrated approach?*

One notes a large number of disparate initiatives in Beijing to move in the direction of becoming an eco city. However, the city scores low on the indicators for an integrated approach and is hindered by the hierarchical top-down approach of the Chinese administration, which does not stimulate enough initiatives from below.

6. *How does this city deal with energy issues in general and CO₂ in particular?*

China did not want to commit itself, during the Copenhagen climate conference in 2009, to reduce its CO₂ emissions, but rather it suggested bringing down the quantity of energy per unit of gross domestic product (GDP). Households in China are asked through TV campaigns to bring back their electricity consumption and they are encouraged to use sun boilers for heating their water (Glaeser and Kahn, 2010). Isolation of buildings is promoted by subsidies from the national Ministry of Construction and in 2009 buying small cars was made more attractive as one of the ways to grow out of the worldwide economic crisis.

For the industrial sector Beijing is stricter in asking certain polluting and energy (or water) intensive industries to relocate. This policy contributes to a reduction of energy use and environmental problems in Beijing itself, but does not solve any problem at the country level. It is difficult to estimate the effects of these policies. At the national level it is known that the electricity produced by the Three Gorges dam was supposed to supply 5 percent of the national needs, but currently only serves half of that, given the increased demand for energy.

7. *How does the city deal with solid waste issues?*

Dealing in a proper way with solid waste is important but solid waste is also a source of energy, or may be used to recuperate precious raw materials. Beijing has a system of government waste collection from collection points, while small private firms and individuals are also collecting valuable objects. The recycling and reuse is mainly done in the private sector and creates quite a number of jobs. In Beijing there is a special tax for solid waste, which helps financing the multiplicity of waste collection and processing activities.

8. *How does the city deal with transport issues?*

Transport issues are important to make a big city a good place to live (Kenworthy, 2006). Beijing has substantially improved its public transportation system for the Olympics in 2008 and is trying to reduce the number of new cars by making it more difficult to obtain a license plate for a new car. However, the economic upturn in 2010 has led to a tremendous increase in the number of cars and China certainly broke a record when it was announced that 100 kilometer of congested high roads in the direction of Beijing were finally dissolved after ten days (De Pers, 26-8-2010). Local officials were still cleaning up the debris of lorry drivers who had been camping for days on this high road to Beijing (from Tibet).

In the city there are separate bicycle lanes, but bicycling is less popular nowadays, because of the risks involved given the increased number of cars, buses and lorries. Also distances have become bigger because Beijing has extended in all directions and the road infrastructure has been upgraded, in particular by adding more ring roads and high roads out of the city. Although the system is well planned and Beijing has invested heavily in infrastructure and transportation, the time spent on congested roads seem to increase over time.

9. *How does the city deal with housing issues?*

Many activities to promote eco cities are at the level of individual households, their house or neighborhood. China recognizes this by providing for example up to 30 percent subsidy of the construction cost of ecological housing projects. Such projects would have to save energy (through isolation for example), separate grey and brown water and use temperature exchange equipment, which makes use of the temperature of underground water to heat or cool a building. Van Dijk (2009) analyzes such a project in Wuhan, showing it is not successful in all respects. In particular more attention is given to isolating the building than to separating brown and grey water.

10. *How does the city deal with sustainable urban development issues?*

Sustainability does not seem to be the major principle used for developing Beijing. For the Olympic Games in 2008 some efforts were made to give a greener impression of the city. On most of the criteria used to measure sustainable development Beijing scores low. After cannibalizing natural resources such as land, water and clean air, Beijing now starts to realize that a greener approach to urban development is necessary. However, just moving polluting industries to other cities is not going to do the job. Even closing 2000 industries, as recently announced (Financial Times, 11-8-2010), is not enough. A number of these industries will open again in the interior of the country, in the underdeveloped western part. Also public campaigns on television are good, but certainly not enough to change attitudes of households and entrepreneurs, who have been lax as far as sustainable development is concerned.

The scores of Beijing and Rotterdam compared

What would the ecological city of the future look like? The eco city of the future is not just about dealing with environmental issues. Such a city will also need a sound economic basis, appropriate solutions for its transport systems, its urban services and amenities. There is more and more attention for this dimension of the quality of life in cities and the presence of sufficient urban services and amenities is an important factor to make a city attractive.^v A lot more is possible within existing urban systems if one is ready to think in terms of creative solutions, using the experiences gained elsewhere. The challenge is to introduce environmentally and financially sustainable solutions. Different approaches have been chosen in Beijing. If scored on all the variables Rotterdam (a port city in the Netherlands) scores slightly better than Beijing, but none of the two cities reaches 80 out of 100 (Van Dijk, 2010). In China more radical solutions are tried, such as separating grey and brown water, while in the Netherlands a more conservative approach is followed: speed limits, pollution thresholds and energy and water saving programs. China is focusing more on water and promoting the separation of grey and brown water and rainwater harvesting, while in the Netherlands investments are made in energy saving and storing CO₂ under the ground. This has to do with the importance of the issues, the level of development and the available money and other resources, but in particular with the awareness of these issues among politicians, scientists and common people.

Conclusions

Ecological cities are more than ecologically managed closed urban water systems. Sustainable urban water management is just the beginning. Changes in the behavior of consumers will be required, just like a combination of better water management, better energy management, collection and treatment of solid waste and striving toward integration. Water demand management is a good start at the household level, just like separation at source and composting at home is a good start for ecologically friendly solid waste management. Closing the water cycle to deal with water in a more efficient way would be an option.

How can eco cities be promoted? Different instruments can be used: incentives, subsidies, demonstration projects and publicity campaigns. Urban development also means forging new partnerships between parties that have often not worked together: government officials, non-governmental organizations (NGOs) and private sector businessmen. This requires 'organizing capacity' (Van den Berg et al., 1993) and the ability to develop an integrated approach to the key issues facing the city. This is the job of an urban manager (Van Dijk, 2006). The challenge for urban managers is the integration of the different sectoral interests. Ecological cities imply integration of different approaches or sectors. Pollution, solid waste and

wastewater problems, all aggravated by climate change require a different urban management approach to build the ecological city of the future!

Most initiatives are taken at the level of the city, like the promotion of ecological neighborhoods and innovative housing schemes. Others come from the national level, for example subsidies (30 percent of the construction cost in the Chinese case). Finally, initiatives at the household level depend very much on the urgency of the issue and the level of awareness of the people concerned. Research has not yet explained how people and communities best respond to the threats posed by environmental, degradation and climate change. Sustainable development is a beginning, but not enough. Private developers are looking for new ideas, but they are mainly interested in cost savings and attractive alternative options for their projects. Urban managers are crucial in tackling global problems and can only do that successfully if local communities are involved. In particular regulation at the local level reflecting local priorities is important just like taking into account differences in the stage of economic development as could be seen by comparing initiatives in Rotterdam to those of some Chinese cities.

People in Beijing and people in Rotterdam followed a different approach to make their cities more environmentally friendly, but they can learn from each other. The best results can be turned into climate mitigation or adaptation policies to be implemented elsewhere. Water governance is normally complex, but in China the structure for water management is relatively simple and hierarchical, but not very participatory. The key is that the facilities are not owned and managed by local authorities, which makes the ownership vague and hinders innovative local technical solutions, innovative ways of financing (there are some examples of BOTs however) and means very little cost recovery is currently achieved. The cost for water treatment are recovered through the drinking water bill, the amounts charged are insufficient, however. The urgency of the problems in China has led to innovative solutions, but the emphasis has been on river linking rather than on desalination or more systematic water saving.

The scale of the issues in China in general and in Beijing in particular is often beyond our imagination. Organizing water and sanitation for 15 million inhabitants in Beijing is the same as trying to run the whole sector through one organization in the Netherlands, which counts 16 million inhabitants spread over a much larger area. It is important to find out whether decentralized small scale water treatment is cheaper and more ecologically friendly than the current system of large scale centralized water treatment.

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Notes

ⁱ Nine cities around the world serve as demonstration cities and learning alliances have been established in each city. Through the learning alliance platform, the barriers to information sharing are broken down and the process of technological and institutional innovation is speed up. Setting up a learning alliance in Beijing turned out to be difficult in such a big city with already a very hierarchical water governance structure As part of Switch an urban agriculture project is running in Beijing and we studied the economics of the separation of grey and brown water and of rain water harvesting (Liang van Van Dijk, 2009, 2010).

ⁱⁱ When freshwater supplies are clearly limited, usually water scarcity is caused by competition between water uses and by political, technological and financial barriers that limit their access to water (Falkenmark and Lundqvist, 1998).

ⁱⁱⁱ The method of constructed wetlands requires too much land for most Chinese cities.

^{iv} Some examples of eco sanitation have been studied (Shujie, 2004) and Zhang, 2006).

^v In the European Union this element is emphasized in its program of choosing every so many years ‘a cultural capital of Europe’. This is usually an opportunity for such a city to show what it has to offer and to make additional investments to increase its attractiveness.