018530 - SWITCH

Sustainable Water Management in the City of the Future

Integrated Project
Global Change and Ecosystems

Deliverable 5.2.1 - Annex 2

An overview of water resources situation in Beijing

Due date of deliverable: M18
Actual submission date: M30

Start date of project: 1 February 2006 Duration: 63 months

Organisation name and lead contractor for this deliverable:

Revision [final]

Project co-funded by the European Commission within the Sixth Framework Programme (2006-2011)		
Dissemination Level		
PU	Public	X
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RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

An Overview of Water Resources Situation in Beijing

1 water resource in Beijing

From the west to the east of Beijing, there are five natural rivers. They are called Juma river, Yongding river, Beiyun river, Chaobai river, Linyun river. There is not a natural lake. Beijing have 85 reservoirs, Miyun reservoir, Guanting reservoir, Huairou reservoir and Haizi reservoir are larger than other reservoirs.

Hypothesis the total population of Beijing adds up to 15 million, Per capita water resource of Beijing are insufficient 300 m3, which is below 1000 m3 of per capita. It is less than the national 1/8 and Per capita amounts of world 1/30. Water is scarce in Beijing.

The water resource of Beijing contains two parts, one is rainwater, and the other is water coming from Upper reaches.

Rainwater: There are average 595 mm of rainfall in Beijing during years. The amounts of rainfall are about 9.9 billion m3 in Beijing each year. Except 6 billion m3 rainfall is vaporized, the others is turned into water resource in Beijing. Among these, there are 1.77 billion m3 surface water and 2.56 billion m3 groundwater. Reducing the 0.59 billion m3 of surface water and groundwater which are repeating calculated, there are 3.74 billion m3 water resources which is come into being by rainwater.

Entering a country water yield: There are 1.61 billion m3 water which come from other place and 1.45 billion m3 water go out every year.

1.1 The characteristic of water resource space-time distributes in Beijing

Annual rainfall in Beijing is a misdistribution. The amounts of the rainwater in the slope facing the wind are between 700mm and 800mm, and below 500mm in the northwest and the north of mountainous areas, and between 500mm and 650mm in the plain and parts of mountainous areas.

According to every month rainfall which is measured in 20 weather stations from 1961 to 2004, there are 15 weather stations whose data is all ready, and the data of other 5 weather stations is measured from the middle of 70 ages.

Table1 the average value of rainfall in Beijing from 1996 to 2004

stat value	Average value	mean square	Partial modulus	Kurtosis modulus	Minimum value	Maximum value	The pole
Rainfall	578.9	137.9	0.2	-0.97	350.2	849.1	498.9

1.1.1 The distribution of rainwater time in Beijing

Annual change

According to annual rainfall, the amount of rainwater in 1969 is the most, and the amount in 1965,1975,1980 and 1999 was small. The disparity between the most and the least adds up to 498mm. According to average rainfall every 5 years, the amount of rainwater between 1975 and 1979 is the most and the amount between 1999 and 2003 is the least.

In order to clearly analyzing the change of rainfall in Beijing in different year, this article stated the average amount of rainfall from 1960s and 1990s. As the table indicates, the amount of rainfall was increasing before 1980s, but after 1980s, the amount of rainfall began to decrease. Compared with the amount of rainfall both 1960s and 1970s, the amount of rainfall in 1980 was reduced to 13.5% and the amount in the 2000s was reduced to 20.6%.

Table2 the amount of rainfall in Beijing in different years

years	1961-1969	1970-1979	1980-1989	1990-1999	2000-2004
Amount of rainfall	605.9	617.1	533.6	593.1	481.1

Annual inner change

Because of the location and climate of Beijing, the distributing of rainfall in Beijing is extremely equal. The fact that every monthly average rainfall takes up the yearly rainfall percentage from 1961-2004 tell us that the rainfall of Beijing primary occurs in summer, which accounts for 72.5% of yearly rainfall. Especially the rainfall in July is the most and accounts for 32% of yearly rainfall. However, the rainfall from January to march and from November to December is relative infrequent and only accounts for 5.25 yearly rainfall.

As the table 3 indicating, the gradient of Mann-Kendall is negative. Especially in august, rainfall reduced to 1.92 mm/a which confirms that rainfall in august is the most proportion in rainfall reduction in summer. Kendall is plus which shows that rainfall in autumn is increasing in Beijing. The rainfall in September is the most.

Table3 change of rainfall-the gradient of Kendall

Month	1	2	3	4	5	6	7	8	9	10	11	12
gradient	0.00	-0.08	-0.07	0.14	0.39	0.09	-0.98	-1.92	0.36	0.25	0.06	0.01

1.2 The analyses about rainfall space distribution in Beijing

The trend analyses the annual rainfall

(1) Rainfall distributes uneven in space, which is related with landform. Because the warm and moist atmosphere is rises by Yan mountain and Taiheng mountain, the area facing wind has more rainfall and the leeward area has little rainfall.

(2) The larger rainfall is located in facing wind area. From the southwest to the northeast, rainfall gradually decreased. The areas where rainfall is the most are Fangshan area, Miyun area and Huairou area, and the rainfall adds up to 650mm.

(3) From the southwest to the northeast, the space distribution of rainfall gradually decreased. Rainfall is below 500mm in the mountainous areas of the northwest and the north and is not worth 600mm in Tongzhou and daxing plain.

In sum, rainfall in Beijing is decreasing since 1961, except Huairou area and Fo yeding area. Especially rainfall in the southwest decreased sharply. There is a decreasing center in city zone, especially declining in Haidian area where rainfall cuts down 3.7mm every year is the largest.

The analyses of each season rainfall

In order to explain and stat, this article regards 3-5 month as spring, 6-8 month as summer, 9-11 month as autumn and 12-2 month as winter and analyzed sequence of

every season rainfall.

In spring, rainfall is increased in Beijing except Shijingshan area, and there are two obvious ascending center in Yanqing area and Miyun area where the extent of raise added up to respective 0.61mm/a and 0.64mm/a.

Rainfall is obvious decreased in summer in Beijing and drops to -3.26mm/a. Except Foyeding area, other areas are all decreased. There is an obvious declining center in building-area. The decline of rainfall in Haiding area is faster than other areas and drops to 6.62mm/a.

Rainfall is increased in autumn. The increase of rainfall is the fastest in Foyeding and adds to 1.84mm/a. The increase of rainfall is the smallest in Miyun. There is a jerkwater decrease in the center of Beijing and Changpin area.

As the same as summer, rainfall is decreasing in winter, but the descendent trend is not obvious. There are three descendent centers. They are respectively Foyeding area, Zhaitang area and the center of Beijing.

As the table indicates, rainfall in Beijing is concentrated in summer and average adds up to 428mm. However, rainfall is exiguous in winter. There is a trend of rainfall in spring and autumn and Kendall gradient is plus. And there is a descendent trend in summer and winter, especially in summer, the decline of rainfall amount to 3.26 mm/a.

Table4 the statistics characteristic value of rainfall in Beijing

	Average value (mm)	Method difference	Standard deviation	partial state modulus	Peak state modulus	Minimum value	Maximum value	The pole	β
spring	64.9	1244.6	35.3	0.95	0.94	15.1	177.4	162.3	0.34
summer	428.6	16024.1	126.6	-0.04	-1.03	195.1	669.7	474.6	-3.26
autumn	87.6	2486.9	49.9	1.93	5.97	20.9	297.7	276.8	0.77
winter	9.3	66.0	8.1	1.05	0.12	0.1	30.6	30.5	-0.02

2. the using of water resource 2001-2002 in Beijing

2.1 The amount of water resource, supply and consume in 2001

The total amount of water resource

Average rainfalls in Beijing are 462mm in 2001. Total rainfalls are 7.8 billion m3 and are more 5.5% than last year and less 22.3% than average year.

The amounts of water resource on the ground in 2001 are 0.78 billion m3 and more 22.7% than the amounts last year.

The amounts of entering water are 0.53 billion m3 in 2001 and are less 25.6% than the amount last year and are less 70.1% than average year amount.

The amounts of exiting water are 0.74 billion m3 in 2001 and are less 28.2% than the amount last year and less 57.6% than average year amount.

The amounts of underground water in 2001 are 1.57 billion m3(0.97 billion m3 in mountain area, 0.11 billion m3 in plain) and are less 3.4% than the mounts in 2000

and more 37.7% than average year amount.

In 2001, the amounts of overground water are 0.78 billion m3 and the amounts of underground water are 1.57 m3. Reducing repeating 0.43 billion m3, the amounts of water are 1.9 m3 and less 47.1% than average year amount and more 13.9% than the amount in 2000.

The amount of water supply

The amount of water supply are 3.9 billion m3 in Beijing in 2001 and are less 0.2 billion m3 than last year's and occupy 30.1% in the total amount of water supply. The amount of underwater supply are 2.7 billion m3 and occupy 69.9% in the total amount of water supply.

The amount of water use

The amount of used water are 3.9 billion m3 in Beijing in 2001 and are less 0.15 billion m3 than the amount last year. The proportion of water consume for living occupies 31% of the total amount of water consume, for environment occupies 0.8%, for industry occupies 23.6% and for agriculture occupies 44.6%.

Water consume

The amounts of water consume are 2.3 billion m3 in Beijing in 2001 and the rate of water consume is 59%. The amounts of urban water consume are 0.1 billion m3 and the proportion in the total water consume is 4.4%; the amounts of countryside water consume are 0.3 billion m3 and the proportion in the total water consume is 14.6%; the amounts of industrial water consume are 0.27 billion m3 and the proportion is 11.5%; the amounts of agricultural water consume are 1.34 billion m3 and the proportion is 58.3%; and the amounts of woods, farming and fishery water consume are 0.26 billion m3 and the proportion is 11.2%.

2.2 The amount of water resource, supply and consume in 2002

The total amount of water resource

There are 413mm of rainfall in beijing in 2002 and 6.9 billion m3 of the total rainfall. It is more 10.6% than the rainfall of last year and less 30.65% than the rainfall of average year.

There are 0.5 billion m3 of overground water resource., which are less 32.5% than last year's and less 75.9% than average year's.

The amount of entry water are 0.23 billion m3 and are less 50.8% than last year's and less 85.3% than average year's.

The amount of exit water are 0.6 billion m3 (including 0.46 billion m3 of polluted water and recycling water) and are less 15.1% than last year's and more 64 percent than average year's.

There are 1.5 billion m3 of underground water resource (including 0.9 billion m3 of montane water resource and 1.1 billion m3 of plain water resource), which are less 6.4% than the amount of 2001 and are less 41.7% than average year's.

There are 0.53 billion m3 of overground water resource and 1.45 billion of underground water resource in 2002. Reducing 0.38 billion m3 of repeating water resource, the total water resource are 1.6 billion m3 in Beijing and less 36.3 percent than average year's and less 16.1% than the amount of 2001

The amounts of supplying water

The amounts of water supply are 3.5 billion m3 in Beijing in 2002 and are less 0.4 billion m3 than the amounts of last year. The amounts of overground water for engineering are 1.04 billion m3 and occupy 30% of total water supply; the amounts of underground water are 2.4 billion m3 and occupy 70% of total water supply.

The amount of water use

The amount of used water are 3.5 billion m3 in Beijing in 2002 and are less 0.4 billion m3 than the amount last year. The proportion of water consume for living occupies 31.3% of the total amount of water consume, for environment occupies 2.3%, for industry occupies 21.8% and for agriculture occupies 44.6%.

The amount of water consume

The amounts of water consume are 1.9 billion m3 in Beijing in 2002 and the rate of water consume is 59%. The amounts of urban water consume are 0.2 billion m3 and the proportion in the total water consume is 9.6%; the amounts of countryside water consume are 0.2 billion m3 and the proportion in the total water consume is 8.1%; the amounts of industrial water consume are 0.14 billion m3 and the proportion is 7.4%; the amounts of agricultural water consume are 1.2 billion m3 and the proportion is 59%; and the amounts of woods, farming and fishery water consume are 0.3 billion m3 and the proportion is 16%.

2.3 The analyses of water consume proportion 1980-2000 in Beijing

In 2000, the amounts of water consume are 4 billion m3 in Beijing. The amounts of agricultural water consume are 1.38 billion m3, the amounts of forest, herd and fishing water consume are 0.27 billion steres and occupy 40.8% in the amount of total water consume; the amounts of industrial water consume are 1.1 billion steres and the proportion is 26.04%; the amounts of living water consume are 1.34 billion steres and the proportion is 33.14%.

2.3.1 The change of water consume in Beijing

The proportion of agriculture and industrial water consume is decreasing and the proportion of urban and living water consume is increasing.

Table5 the change of water consume in Beijing

years	The amount of water consume	Industrial water consume		Agriculture water consume		Living water consume	
		The amount	rate	The amount	The rate	The amount	The rate
1980	42.08	13.5	32.08	24.46	58.13	4.12	9.79
1990	41.12	12.34	30.01	21.74	52.87	7.04	17.12
1996	43.21	12.64	29.25	19.68	45.55	10.89	25.2
1997	40.26	11	27.32	18.12	45.01	11.14	27.67
1998	40.47	10.84	26.79	17.39	42.97	12.24	30.24
1999	41.71	10.56	25.32	18.45	44.23	12.7	30.45
2000	40.4	10.52	26.04	16.49	40.82	13.39	33.14

2.3.2 The dynamical analyses of water consume changing

Industrial water consumption is correlated positively with the industrial output value and water quota, but negatively with the recycle ratio. Growth of the industrial output value always needs the increasing of water; decreasing of the water quota and improving of the recycle ratio make for the reduction of industrial water consumption. Variety of industrial water consumption is an equilibrium response of integrated effect by the 3 factors mentioned above.

Industry upgrade is another reason which led to the increase of industry value but reduction of water use. In theory, if industry structure is stable, recycle rate and the quantity of water use will be stable for limit of industry water use, and industry value has a direct proportion relation with water use, the increase of industry value results in the rise of water use. In fact, based on the developed country experience, the reduction of industry water has a closely relation with industry evolution. While labor-capital intensive industries change into technology –knowledge industries, the quantity of industry water use stops increasing and even declines.

Agricultural water includes irrigation water and farming, forestry, animal husbandry and fishery water, and irrigation water is over 90 percent of agricultural water. In recent years, it is effective in saving agricultural water and gets rid of consumptive irrigation such broad irrigation and fleeing irrigation in Beijing. Since the end of 1980s, the areas of spurt irrigation increase 0.133 billion square meters per year and the proportion of spurt irrigation areas is 34.2% in 1995 and 1998 is 40.9%. The saving irrigation areas increase from 0.35 billion square meters in 1980 to 2.53 square meters in 1998 and the quantity of irrigation water decreases from 3.07 billion cubic meters in 1980 to 1.38 billion in 2000. Though the quantity of farming, forestry, animal husbandry and fishery water increase in recent years, the quantity of agricultural water is decreasing for saving irrigation water.

The effect of urbanization to agricultural water use is divided into two aspects. The first is that the quantity of agricultural living water is rapidly increasing and originally agricultural water source is turned into no-agriculture water source with construction of satellite cities and townships, increase of resort areas and development of township enterprise; the second is that city spread and city construction result in the reduction of irrigated area and agricultural water quantity.

The effect of rural industrial restructuring to rural water use. In rural GDP, the proportion of is agriculture decreasing and the proportion of no-agriculture is increasing. In agricultural output, the proportion of stockbreeding is increasing and the proportion of farming is decreasing. In farming, the areas of consuming water crops are quickly reduced.

Living water includes urban living water and country living water. Urban living water includes residents water and public water (including commerce, construction, floating population, entironment, tour water, etc.) and country living water includes farmers living water and cattle living water.

The increase of population and per living water and city construction are the main causes of increase of living water.

3 The organization of water resources management in Beijing

3.1 Beijing water authority

Beijing water authority which is recently established in May, 2004 has not only originally administration duty, but added water supply duty, drainage duty, sewage disposal duty and groundwater exploitation, using and protection duty in planning areas. Beijing drainage corporation, water supply corporation and water saving bureau are merged into Beijing water authority.

For a long time, the management of water resource in Beijing is dispersing, and the management of surface runoffs and groundwater, city water use and country water use, provide well and tap water, clean water and waste water were separate. The orders came from different departments and were inconsistent, which seriously affected the Beijing water resources optimizing, restricted water saving and surface water irrigating, the harmony of surface water and groundwater etc.

3.2 The problems of water management in different department

The main problem which puzzles water authorities is that the duty of water management is implemented by different departments, such as agriculture department, water department, city department, planning commission. Therefore, the most is that water resources should be uniformly managed on the base of laws and schemes.

Water resources in Beijing are managed by water bureau, geology and mineral bureau, urban planning bureau, public bureau, municipal engineering administration department and environmental protection agency.

1. The water managed by different bureaus leads to difficulties in municipal management for many bureaus is usually involved in a job.
2. Nobody is responsible to co-ordination of water supply and demand. Because of current the system of water resources management, experts regarded Beijing as an ample water city. Actually water is not shortage in zoology in Beijing and shortage in population. The key problem is that water management is independent in different bureaus, and so we can not study the problems by the relation between the system of water resources and the system of social economic development. Take Shenzhen for example, it not only reuses industrial water, but makes full of seawater.
3. Can not save water. Different water management leads that governments are united with corporations. And nobody is responsible for saving water.
4. Can not control pollution in effect. The postulate of pollution control is that the amounts of emitting contamination are less than the amounts of accommodating contamination. However, the amounts of accommodating contamination are determined by water bureau and the amounts of emitting contamination are determined by environmental protection agency.
5. The problems of river pollution and ground sedimentation are neglected.
6. Can not constitute a uniform law of water resources management. The experiences of Tokyo, Paris and Berlin indicate that it is difficult to constitute uniform law of water resources management, and even if a law was constituted it con not be implemented in effect for being short of executants.

7. Can not constitute reasonable the price of water. The water price in each city is now increasing in china, but how much it should increase, how should the incomes be distributed in departments, and who can guarantee consumers on better water quality? If water resources are not uniformly manage, these problems would be solved.
8. The difficulty is how the duty is harmonized in different bureaus and in other countries as well. Because of short of water resources, water resources management must be united as roads do. Otherwise, the shortage of water resources will be enlarged, which will restrict the development of society and economy. So it is time to uniform water resources management in lacking water cities. The reform of district departments is a chance to solve it.
9. It is suspicious that water bureau was founded by current personnel.
10. There is a law to guide the water bureau.

4 Water market management in Beijing—water price

4.1 The mechanism of water price development

From 1949 to nowadays, the reform of water price development and management has been implemented in Beijing, which included the phase of free water, low price water, equal price water and commodity water. The contents are as the follow:
1. Collecting water resources tax. Groundwater and surface water is free to use except tap water after 1949. It began to collect tax to surface water in the middle of 60s and collect tax to groundwater in the beginning of 80s. Since 2002, it began to collect tax of water resources.
2. Collecting sewage disposal tax. It began to collect the tax of sewage disposal on the base of the price of water supply. The standard of sewage disposal tax is based on the regulation of national sewage disposal tax.
3. From free using to charge using on water engineer. The water law which was put into practice on October, 1, 2002 prescribes that these who make use of water from water engineer will pay cost for Water Supply Corporation.

4.2 The problems of water price

4.2.1 The price of water is so low that it can not regulate water economy.

The price of water in Beijing is based on its cost. The profits of water are considerable before 1980s. However, the profits are decreasing after 1980s and decreasing quickly after 1987.Reducing fiscal allowance, the profits are less than expenditure in 1988 and 1989. For example, water cost of the ninth water factory, which was built in 1988, is 0.587 yuan/m3. However, water price for residents is 0.12 yuan/m3 and others is 0.25 yuan/m3. After water price increasing, the highest water price is 0.45 yuan/m3, which is less than the price in 1988. Because of low water price, Beijing government has to give supply water enterprises allowances. The sums of allowances are 34 million yuan in 1992 and are 30.8 million yuan in 1993. After the two phase of the ninth water factory, the deficits of supply water enterprises added up to 100 million yuan.

4.2.2 The current water prices fall short of the price of south to north water transfer.

4.2.3 There is not a reasonable prices system of water resources

The prices of water resources which are not only steady but change on the base of the supply-demand and cost of water resources are reasonable. The price system of water resources is divided into the price of surface water, the price of groundwater, the price of tap water, the price of waste water and so on. These prices are coherent and affect each other. When we set water prices we must consider them completely.

Table6 the process of water prices evolvement in Beijing

category		Before 1991	1992	1996.4	1997.12	1998.8	1999.10	2000.10	2002.2	2003.1	2004.8
Tap water											
Water for residents		0.25	0.3	0.5	0.7	1.0	1.3	1.6	2.0	2.3	2.8
For industry and commerce		0.25	0.45	0.8	1.0	1.3	1.6	2.4	2.9	3.2	4.1
for accommodation , catering, entertainment			0.6	1.2	1.2	1.5	1.8	2.8	3.8	4.2	4.6
For agriculture			0.05	0.1	0.1	0.15	0.2	0.3	0.4	0.5	0.6
purity water and wash cars water					1.0	1.5	3.0	10.0	16.0	20.0	40.0
2.surface water											
For industry			0.15	0.25	0.3	0.36	0.4	0.6	0.67	1.27	1.77
For agriculture			0.00375	0.0575	0.07	0.09	0.1	0.15	0.2	0.2	0.2
Industrial recycling water			0.03	0.046	0.056	0.072	0.08	0.12	0.15	0.15	0.15
For agriculture	经济作物 economy crops		0.02	0.05			0.06	0.08	0.1	0.1	
	Foodstuff crops		0.01	0.03			0.03	0.04	0.04	0.06	
For tap water corporation			0.08	0.15	0.2	0.26	0.3	0.48	0.62	1.22	1.72
For park lake			0.015	0.04			0.06	0.09	0.15	0.3	1.3
3.groundwater											
For pure water					0.2	0.3	0.6	2.0	3.0	4.0	40.0
Others			0.1	0.16	0.2	0.3	0.4	0.8			
4.cost for sewage											
Cost for resident sewage disposal					0.1	0.1	0.3	0.4	0.5	0.6	0.9
others					0.3	0.3	0.5	0.8	1.0	1.2	1.5

source： http://www.bjwso.gov.cn

4.3 The methods of water prices reform

The methods: (1) Implementing different water prices. Water is divided into residential water, industrial water, and administrative water, serving water and special water on the base of water using. (2) It should confirm that the prices of water are composed of cost, expenses, taxes and profits and makes a detailed explain to them. (3) Setting a principle of water supply prices, such as compensate cost, proper income, economy water and equity assume. (4) Encouraging make use of recycling water instead of natural water or set the system of tap water, and set the connection between water supply price and tap water price;(5) Set a system of water supply declaration and examine and approve, introducing the system of price hearing of witnesses during setting water supply prices or adjusting, pushing the system of water supply auditing, and strengthening the management to profits of water.

4.4 The effect of the reform of water price on townsmen

In general, that whether water price is beyond resident receiving capacity or not is supervised by the rate of water expenditure in disposable income per capita. Research shows that residents can accept it when the rate is equal to 1%, residents will be considerate of it when the rate is equal to 2%, and it will seriously affect residents when the proportion is equal to 3%.

Table 7 the rate of resident water cost in disposable income per capita in Beijing, 1995-2004

year	Water prices/ ($RMB.m^{-3}$)	Water expenditure/RMB	Disposable income per capita/RMB	Rate /%
1995	0.3	9	5868	0.15
1996	0.5	15	6885	0.22
1997	0.5	15	7813	0.19
1998	0.7	21	8472	0.25
1999	1.3	39	9182	0.42
2000	1.6	48	10350	0.46
2001	2.0	60	11578	0.52
2002	2.5	75	12464	0.60
2003	2.9	87	13883	0.43
2004	3.7	111	15637	0.71

At present, residents in Beijing are satisfactory with water price. The increase of water price will not affect residents except low income residents.

4.5 The effect of water price reform on enterprises

The reform of water prices is implemented by government of Beijing for financing for south to north water, restricting development of enterprises which consume lots of water and collecting different water price for residents.

4.5.1 The structure of tap water price in Beijing

The prices of tap water are 3.01RMB/m3 in 2003 and the costs of water supply are 2 RMB/m3, taxes are 0.37 RMB/m3, water taxes are 0.69R MB/m3 and enterprises of tap water have no profits.

4.5.2 The effect of water reform on tap water enterprises

The prices of water are added to 0.5 RMB and sewage disposal fees are added to 0.3 RMB in 2004.

(1) Water price for residents increased from 2.3 yuan to 2.8 yuan
(2) Water price for enterprises increased from 3.2 yuan to 4 yuan
(3) Water price for administration bureau increased from 3.2 yuan to 3.9 yuan
(4) Water price for hotel and catering increased from 4.2 yuan to 4.6 yuan.
(5) Water price for bath increased from 10 yuan, 30 yuan and 60 yuan to 60 yuan.
(6) Water price for cars washing and purified water enterprises is changed from 20 yuan to 40 yuan.
(7) Water price of agriculture compensation increased from 0.5yuan to 0.6 yuan.

Water price for residents after reform is less than average water price, and the incomes of tap water for residents are less than costs.

The proportion of water sale for residents is 44.53%, catering and hotel 19.97%, commerce and industry 34.79%, bath 0.3%, washing cars and purifies water 0.02%, reclaimed water 0.38% and compensation water for agriculture 0.01%.

The proportion of water use for residents is the greatest and increases 3% every year during recent three years. The increase of water use for residents makes water supply enterprises to be bad.

The loss which is induced by residents water use is compensated by incomes of high price water. Water consumption of other price is the key to income of tap water Corporation, especially for bath, washing cars and purified water.

Recently, the amounts of tap water sell are decreasing by years and dropped to 5% from 2001 to 2003. The amounts of other water use are decreasing by years except water use for residents. The change makes the price of tap water low compared with average water price after reform. For example, the average water prices should be 3.13 yuan/m3 in 2003. However, the prices of water selling are 3.01 yuan/m3 in practice and are less 0.12 yuan/m3 than average prices. As a result, it not only consumes the profits of enterprises but makes enterprises to the bad.

5 Water saving--the association of water use for farmers

In order to improve the level of agriculture water economy, increase farmers' income, promote the sustainable using of water resources and realize sustainable development of agriculture, development water saving irrigation projects loaned by the World Bank come into effect in Beijing in may, 2001, which is the first international project after joining WTO. During the project, it develops the methods of agricultural water saving

and water management besides the projects of water saving, and introduce advance ideas and management—water using association. Farmers can take part in the management of irrigation areas and manage themselves and protect themselves by WUA. By the end of 2004, there are 30 towns WUA, 99 villages WUA and 159 farmers WUA in 7 countries in Beijing. WUA is accepted by farmer in practice and gain good social and economical benefits.

The characteristic of WUA

(1)WUA makes use of water on the base of market economy and follow the value rule and market rule. Parts of WUA just pay water costs and other expenses are paid by local governments and villages.

(2) Farmers take part in the management of irrigation areas. Farmers can take part in the construction and management of irrigation projects, constituting water use plans and supervising WUA and water supply enterprises. The higher level is that farmers take part in the construction of irrigation system.

(3) The status of WUA should be defined by laws. WUA should register at local Industrial and Commercial Bureau or Civil administration Bureau and gain independent corporation status.

(4) The symbol of WUA is that WUA works well, which means that WUA keeps balance between profits and costs on irrigation projects by the government police and participation of farmers.

(5) Standard operations. The WUA works on the base of management system and uniformly manage water resources. It supplies water and make use of water on plan and charges by the amounts of water use.

6 the project of rainwater collection in Beijing

6.1 Introduction of rainwater control an use technology of Beijing

The project of rainwater control and use technology of Beijing is carried out by the ministry of science and technology of people's republic china, BMBF, Beijing municipal commission of development of reform and Beijing water authority since 2000 in order to found the system of rainwater control, use and development, and it can make use of rainwater to delay the water crisis, cut flood peak runoff and defend capital safety. Therefore, the project researches on the rules of water quality of rainfall runoff and the technology of rainfall collection, harbor, transmission, recycling, pairing and advances the mode of rainfall use and constitutes policies and technologies and built five sorts of rainwater use areas whose acreages are 60 hm2. the project is identified by experts on February, 2005.

6.2 The use of mountainous rainwater in Beijing

6.2.1 The approaches of mountainous rainwater collection

Collecting road runoff

The traffic of mountainous areas Beijing is convenient, dense and smooth and the rate of runoff is high which is beyond 0.85.

Collecting slope runoff

The slopes are integrated and are suitable for runoff. The rate of runoff is between 0.1 and 0.3. the areas of runoff are so large that large amounts of runoff can be collected without manual work in rainy season.

Collecting manpower runoff

Collecting roof and shed runoff

Collecting farmland runoff

After construction of river areas for years in Beijng, many terraces and fields are built in river areas. So the projects of runoff can be built at selected slopes.

6.2.2 The methods of mountainous rainwater collection

Building sorts of collecting rainwater projects are the main methods of collecting rainwater in mountainous areas in Beijing. The main collecting rainwater projects include large reservoirs, medium reservoirs and miniature reservoirs. The miniature reservoirs include pools, wells and so on.

This article summarizes three modes of rainwater collection and use in mountainous river areas on the base of the fact of mountainous river areas in Beijing.

(1) The optimize disposition between reservoirs, cisterns and wells. Water is provided by reservoirs through channels which link pools and water cellars, and every reservoirs and water cellars are independent and water supply are on the base of crops, which can improve the efficiency of water supply and store water facilities use.

(2) The optimize disposition between seasonal fountain and store water facilities. Take wells as guarantee water source, take storing water facilities as accommodating water source and take pool as supplying water source. Water cellars and pools are absolute collecting water systems and were connected with storing water facilities.

(3)The optimized disposition between spring water and the pond dam, reservoir, water storage pit projects. Take mountain spring as the guarantee of water sources, running water of mountain springs and runoff water of slope face are assembled into small pond dams or reservoirs, and delivered into other ponds and water storage pits, while at the same time, the small water storage projects as ponds and pits have their independent flow concentration system with special attention to the highly effective use of water use system and the implementation of field water-saving projects.

6.3 The use of collecting rainwater technology in mountainous areas in Beijing

In 1997, the fourth drought took place in Beijing since 1949 and lasts spring, summer and autumn, which harmed two million mu farmlands and made saplings die seriously.

Facing seriously situation, the government of Beijing studied foreign experience of collecting rainwater and carried out irrigation projects in mountainous areas in order to find collecting rainwater technology suitable for Beijing, which can improve

production condition in mountainous areas and ensure farmers to be richer.
There are 0.32 billion cube meters of water outflow in mountainous areas in Beijing on the base of stat data from 1985 to 1997. Collecting rainwater projects not only solve the problem which precipitation is not at the same time with crop growth, but keep water and soil.

6.4 The technique

(1) Collecting system. The collecting system is a collecting rainwater area, which may be a brace, holt, road surface and other manual place. We can combine existing collecting areas, such as roads, braces, channels, courtyards, with governing of mountains, water, forests and farmlands to be collecting systems
(2) Depositing system. It is a sluice establishment which can cumulate rainwater by transport water systems and accessorial establishments for blocking sands or dirt, which includes underground sluice pools, half overground pools, half underground pools and wells etc.
(3) Using system. It is a sort of establish which can make full use of collecting rainwater, such as supply water systems for people and livestock. The irrigation system of collecting rainwater projects should maximally reduce the water loss during irrigation in order to advance the rate of water use and make fruiters and crop to be more output and benefit. The technology of collecting rainwater and irrigation which is suitable for Beijing is a dripping irrigation, spray irrigation, tiny spray irrigation, seeping irrigation etc.

6.5 The effect of collecting rainwater technology

During the project of rainwater collection, the practicing policies, such as completely performing land policy, encouraging farmers to build irrigation establishments, bring on the increasing proportion of the investment on irrigation establishments. For example, the sums invested on irrigation establishments are 0.94 billion yuan and the proportion of farmers' investment is 54%.
The layout can guarantee the favoring development of irrigation establishments. The Beijing water authority organizes municipal research institutes in order to guide the planning of different regions. The technologists of different water authorities go to villages in order to investigate and constitute country planning. They have realized the planning aim of road up mountain, water up mountain, fruiter up mountain and technology up mountain by researching the balance of water resources in areas, planning the roads of mountains, water, forests and farmlands and the governing the flood on the base of the principles of economy, society and zoology.
At present, the capability of water establishments is 25 million cubic meters, which include 16 million cubic meters of reservoirs, 3.4 million cubic meters of collecting rainwater projects and 5.1 million cubic meters ponds. The potential of water resources provides opportunity for the construction of water projects. The water surface can adjust the dry climate of Beijing, reduce sand blown by wind, restrain urban hot island effect and improve the local environment.

The adjustment of mountainous economy structure is various. The construction of water projects impel the form of mountainous cornerstone industry, promote the adjustment of agricultural structure and development of Fish breeding and poultry raising, create the opportunity for the development of process, camp pin and tourist trade, provide the space for the application of advanced technology and come into being the situation of fruit with, green with water and farming with green.

In order to virtuous circle of ecological conservation, enriching-people engineering construction, which sticks to take small river basin as element, carry out three functions which are the function of mountainous green zoology barriers, the function of protecting drink water field and the function of green industry base, according to circumstances. By the end of 2001, the sums of storing water adds up to 127.5 million cubic meters and the sums of keeping soil and sands, which improves the agricultural condition, optimizes mountainous water resources, increases the farmers' income and protects the environment.

Water management and urban agriculture development in peri-urban Beijing-----towards a demonstration proposal

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1. The serious situation of water shortage

Beijing is a city faced the shortage of water. Its rainfall is less than 600mm yearly. Water quota per person is less than 300 cubic meters, which is one eighth of the country and one thirtieth of the world average. In recent years, the rainfall is continuously decreasing, so surface water gradually dry up and the level of underground water declined.

2. Water resources in Beijing

Water resources of Beijing contain two parts, one is rainwater, and the other is water coming from upper reaches.

There are average 595 mm of rainfall in Beijing during years. The amounts of rainfall are about 9.9 billion cubic meters in Beijing each year. Except 6 billion cubic meters rainfall is vaporized, the other is turned into water resources. Among these, there are 1.77 billion cubic meters surface water and 2.56 billion cubic meters groundwater. Reducing the 0.59 billion cubic meters water which are repeating calculated, there are 3.74 billion cubic meters water which is available by rainwater.

According to annual rainfall, the amount of rainwater in 1969 is the most, and the amount in 1965, 1975, 1980 and 1999 was small. The disparity between the most and the least adds up to 498mm. According to average rainfall during every 5 years, the amount of rainwater between 1975 and 1979 is the most and the amount between 1999 and 2003 is the least.

As the table indicates, the amount of rainfall was increasing before 1980s, but after 1980s, the amount of rainfall began to decrease. Compared with the amount of rainfall both 1960s and 1970s, the amount of rainfall in 1980s was reduced to 13.5% and the amount in the 2000s was reduced to 20.6%.

Table1 the amount of rainfall in Beijing in different years

years	1961-1969	1970-1979	1980-1989	1990-1999	2000-2004
Amount of rainfall	605.9	617.1	533.6	593.1	481.1

In addition, there are 1.61 billion cubic meters water which come from other place and 1.45 billion cubic meters water go out every year.

3. Water use in Beijing

3.1 Water consume 1980-2000

In 2000, the amounts of water consume are 4 billion cubic meters in Beijing. The

amounts of agricultural water consume are 1.65 billion cubic meters (1.38 billion cubic meters for irrigation and 0.27 billion cubic meters for forest, herd and fishing) and occupy 40.8% in the amount of total water consume; the amounts of industrial water consume are 1.1 billion cubic meters and the proportion is 26.04%; the amounts of living water consume are 1.34 billion cubic meters and the proportion is 33.14%.
The proportion of agriculture and industrial water consume is decreasing and the proportion of urban and living water consume is increasing in 1980-2000.

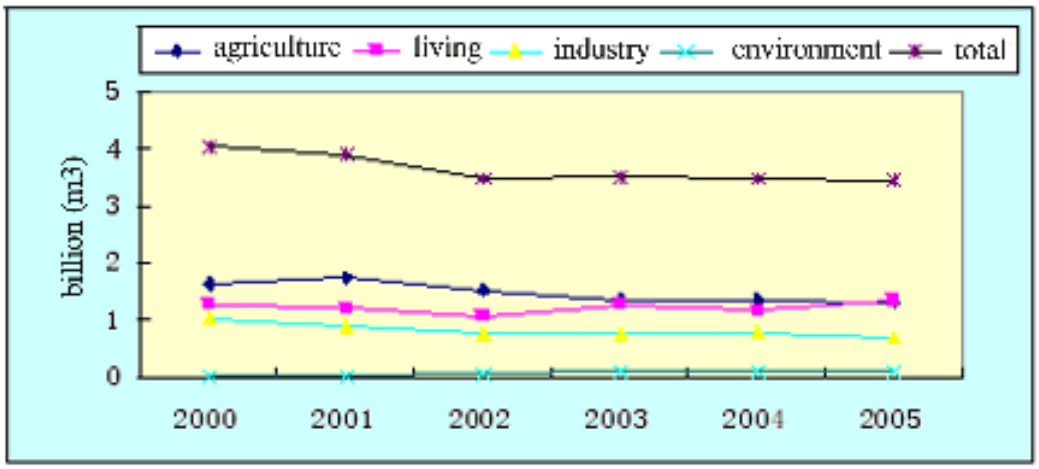
Table2 water consume 1980-2000 in Beijing

years	amount of water consume	Industrial water consume		Agriculture water consume		Living water consume	
		amount	rate	amount	rate	amount	rate
1980	42.08	13.5	32.08	24.46	58.13	4.12	9.79
1990	41.12	12.34	30.01	21.74	52.87	7.04	17.12
1996	43.21	12.64	29.25	19.68	45.55	10.89	25.2
1997	40.26	11	27.32	18.12	45.01	11.14	27.67
1998	40.47	10.84	26.79	17.39	42.97	12.24	30.24
1999	41.71	10.56	25.32	18.45	44.23	12.7	30.45
2000	40.4	10.52	26.04	16.49	40.82	13.39	33.14

3.2 Water consume 2000-2005

As the chart indicates, the total mount of water use decreased in 2000-2005. During the same period, the proportion of agriculture and industrial water consume is decreasing, the proportion of environment and living water consume is increasing. The proportion of agriculture water consume was bigger than that of living water consume before 2004, and agriculture was the biggest consumer of water. But living water consume increased very fast, it was almost equal to agriculture water consume in 2005.

Chart1 the trend of water use in Beijing 2000-2005



4. Water resources management in Beijing

4.1 Beijing water authority

Beijing water authority which was established in May, 2004 has not only originally administration duty, but added water supply duty, drainage duty, sewage disposal duty and groundwater exploitation, using and protection duty in planning areas. Beijing Drainage Corporation, Water Supply Corporation and Water Saving Bureau were merged into Beijing water authority.

For a long time, the management of water resource in Beijing was dispersing, and the management of surface runoffs and groundwater, city water use and country water use, provide well and tap water, clean water and waste water were separated. The orders came from different departments and were inconsistent, which seriously affected the Beijing water resources optimizing, restricted water saving and surface water irrigating, the harmony of surface water and groundwater etc.

4.2 The problems of water management in different department

The main problem which puzzled water authorities is that the duty of water management is implemented by different departments, such as agriculture department, water department, city department, planning commission. Therefore, the most emergency is that water resources should be uniformly managed on the base of laws and schemes.

Water resources in Beijing are managed by water bureau, geology and mineral bureau, urban planning bureau, public bureau, municipal engineering administration department and environmental protection agency. This situation will bring many problems:

1. The water managed by different bureaus leads to difficulties in municipal management because of these bureaus usually involved in a same job.
2. Nobody is responsible to balance between water supply and demand. Because of current system of water resources management, experts regarded Beijing as a city with ample water. Actually water is not shortage in zoology in Beijing but shortage in population. The key problem is dispersed management in different bureaus keep us from finding and studying the problems by the relation between the system of water resources and the system of social economic development. Take Shenzhen for example, it not only reuses industrial water, but makes full use of seawater.
3. Can not truly save water. The water managed by different bureaus lead to confusion between governments and corporations. And nobody is responsible for saving water.
4. Can not control pollution in effect. The postulate of pollution control is that the amounts of emitting contamination are less than the amounts of accommodating contamination. However, the amounts of accommodating contamination are determined by water bureau and the amounts of emitting contamination are determined by environmental protection agency.
5. The problems of river pollution and ground sedimentation are neglected.
6. Can not constitute a uniform law of water resources management. The experiences of Tokyo, Paris and Berlin indicate that it is difficult to constitute uniform law of

water resources management on the condition of water resource belonging to different departments, and even if a law was constituted it con not be implemented in effect for being short of executants.

7. Can not constitute reasonable price of water. The water price in each city is now increasing in china, but how much it should increase, how should the incomes be distributed in departments, and who can guarantee consumers on better water quality? If water resources are not uniformly managed, these problems would not be solved.

8. The difficulty is how the duty is harmonized in different bureaus, just like problems in other countries. Because of short of water resources, water resources management must be united as road net built in scarce land. Otherwise, the shortage of water resources will be enlarged, which will restrict the development of society and economy. So it is time to uniform water resources management in lacking water cities. The reform of local organization is a chance to solve it.

9. It is suspicious that current personnel are competent for the new water bureau.

10. There is a lack of law to guide the water bureau.

5. Policies and measures

In 2005, Beijing promulgated and implemented the “Water Saving Methods in Beijing city”, it was strict in water abstraction licensing, and it realized measure management and measure charging on water use. Based on reducing industrial and agricultural water, it reduced government organs and social units’ water use standards 15 percent in 2 years, and when the mount of water use exceeded its ration, the water price would be higher.

In addition, Beijing Water Authority published the Three-Step Strategy of Beijing water saving work in 2005:

1. In 2005, it managed to achieve the goals, including total amount control of water use, supply water in plan, and quota management of water use. Water use will be measured by water meter, statistic and reported monthly. The new construction projects must comply with the “Three-Simultaneity” system, the existed items will have the reconstruction planning. Water-saving irrigation in agriculture will occupy 90% of all irrigation area. The ratio of water reuse for industrial enterprises above the designated size will achieve 90%. About 90% of the urban sewage will be collected and treated. Beijing city will popularize water efficient appliance in public place and a set of water saving regulations and laws will be formulated.

2. Approximately 40 % of the existed facility of water saving “Three-Simultaneity” project will be improved from 2006 to 2008. All the agriculture irrigation will be water-saving irrigation until 2008.The ratio of water reuse for industrial enterprises above the designated size will achieve 93%. Water efficient appliance will be common in urban families. By 2008, more than 90% of the sewage in the urban area will be treated, and the rate of reclaimed water reusing will be 50%.In Beijing, quality of the urban river and lake will be better in 2008.

3. Standard of quota management of water will be formed from 2009 to 2010.Reconstruction of all the existed water saving “Three-Simultaneity” project will be completed. Water efficient appliance will be common in society, the urban and

rural sewage treatment rate will reach 95%, and the rate of reclaimed water reusing will be 70%. The water efficient of agricultural and industrial production will reach advanced levels in China and the level of moderately developed countries.

5.1 Water price

From 1949 to nowadays, the situation of water shortage became serious step by step. So the reform of water price development and management has been implemented in Beijing, which included the phase of free water, low price water, equal price water and commodity water. The contents are as the follow:

1. Collecting water resources tax. Groundwater and surface water is free to use except tap water after 1949. It began to collect tax to surface water in the middle of 60s and collect tax to groundwater in the beginning of 80s. Since 2002, it began to collect tax of water resources.

Table3 the process of water prices evolvement in Beijing

category		Before 1991	1992	1996.4	1997.12	1998.8	1999.10	2000.10	2002.2	2003.1	2004.8
Tap water											
Water for residents		0.25	0.3	0.5	0.7	1.0	1.3	1.6	2.0	2.3	2.8
For industry and commerce		0.25	0.45	0.8	1.0	1.3	1.6	2.4	2.9	3.2	4.1
for accommodation ,catering, entertainment			0.6	1.2	1.2	1.5	1.8	2.8	3.8	4.2	4.6
For agriculture			0.05	0.1	0.1	0.15	0.2	0.3	0.4	0.5	0.6
purity water and wash cars water					1.0	1.5	3.0	10.0	16.0	20.0	40.0
2.surface water											
For industry			0.15	0.25	0.3	0.36	0.4	0.6	0.67	1.27	1.77
For agriculture			0.00375	0.0575	0.07	0.09	0.1	0.15	0.2	0.2	0.2
Industrial recycling water			0.03	0.046	0.056	0.072	0.08	0.12	0.15	0.15	0.15
For agriculture	经济作物 economy crops		0.02	0.05			0.06	0.08	0.1	0.1	
	Foodstuff crops		0.01	0.03			0.03	0.04	0.04	0.06	
For tap water corporation			0.08	0.15	0.2	0.26	0.3	0.48	0.62	1.22	1.72
For park lake			0.015	0.04			0.06	0.09	0.15	0.3	1.3
3.groundwater											
For pure water					0.2	0.3	0.6	2.0	3.0	4.0	40.0
Others			0.1	0.16	0.2	0.3	0.4	0.8			
4.cost for sewage											

Cost for resident sewage disposal				0.1	0.1	0.3	0.4	0.5	0.6	0.9
others				0.3	0.3	0.5	0.8	1.0	1.2	1.5

source： http://www.bjwso.gov.cn

2. Collecting sewage disposal tax. It began to collect the tax of sewage disposal on the base of the price of water supply. The standard of sewage disposal tax is based on the regulation of national sewage disposal tax.
3. From free using to charge using on water engineer. The water law which was put into practice on October, 1, 2002 prescribes that these who make use of water from water engineer will pay cost for Water Supply Corporation.

5.2 Rainwater collection project

The project of rainwater control and use technology of Beijing is carried out by the ministry of science and technology of people's republic china, BMBF, Beijing municipal commission of development of reform and Beijing water authority since 2000 in order to found the system of rainwater control, use and development, and it can make use of rainwater to delay the water crisis, cut flood peak runoff and defend capital safety. Therefore, the project researches on the rules of water quality of rainfall runoff and the technology of rainfall collection, harbor, transmission, recycling, recharging aquifer, advancing the basic mode of rainfall use, constituting policies and technologies and building five sorts of rainwater use areas in total 60 hm^2 land. The project is identified by experts on February, 2005.

5.3 Water saving--the association of water use for farmers

In order to improve the level of agriculture water saving, increase farmers' income, promote the sustainable using of water resources and realize sustainable development of agriculture, development water saving irrigation projects loaned by the World Bank came into effect in Beijing in may, 2001, which is the first international project after joining WTO. During the project, it developed the methods of agricultural water saving and water management besides water saving projects, and introduce advance ideas and management—water using association. Farmers can take part in the management of irrigation areas and manage themselves and protect themselves by WUA. By the end of 2004, there were 30 towns WUA, 99 villages WUA and 159 farmers WUA in 7 countries in Beijing. WUA is accepted by farmer in practice and gain good social and economical benefits.

6. Rainwater harvesting and greenhouse system project

Agriculture is a big consumer of water in Beijing, in its water use 90 percent relies on underground water. Land subsidence threatens Beijing's ecological environment and residents' live because of overdrawn of groundwater. Meanwhile, the lack of water supply influences the agriculture in area under glass. So, water saving in agriculture has become an urgent task and the common understanding of the whole society.

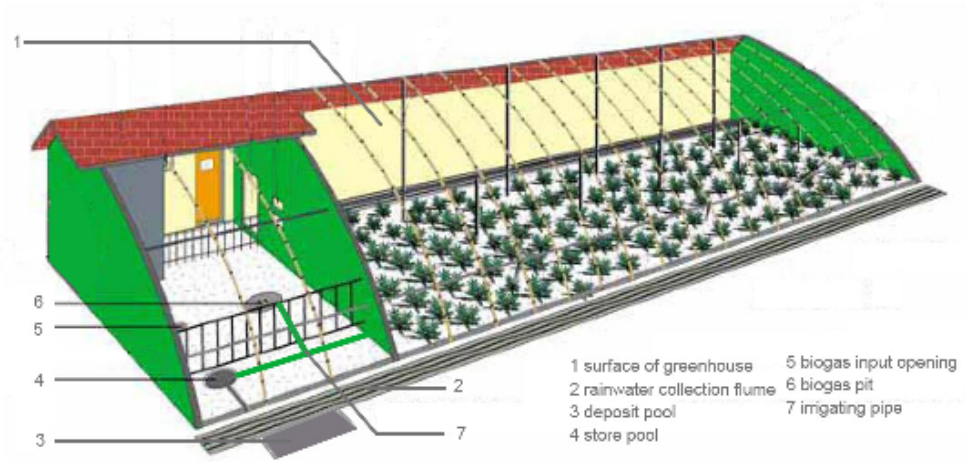
6.1 A new technology: Rainwater harvesting project

Rainwater harvesting and greenhouse system is a new technology developed by

Beijing agricultural technology dissemination station and soil & compost work station. They hold the principle of "tap new sources of supply and reduce consumption" and prevent pollution, using the surface of greenhouse to collect rainwater, and compost by micro – irrigation. (Fig.1)

This technology system is constituted of surface of greenhouse, rainwater collection flume, deposit pool, collection vault (underground), and micro- irrigation integrated compost system. Rainwater assembled through greenhouse surface to the rainwater collection flume on the bottom of greenhouse. After preliminary deposition and filter in the deposit pool, water flow into collection vault. Then it is pumped to store pool in the greenhouse and its temperature goes up. It will be used for irrigation after adding micro compost.

Fig. 1 structure of Rainwater harvesting system



Using this technology achieves significant effect:

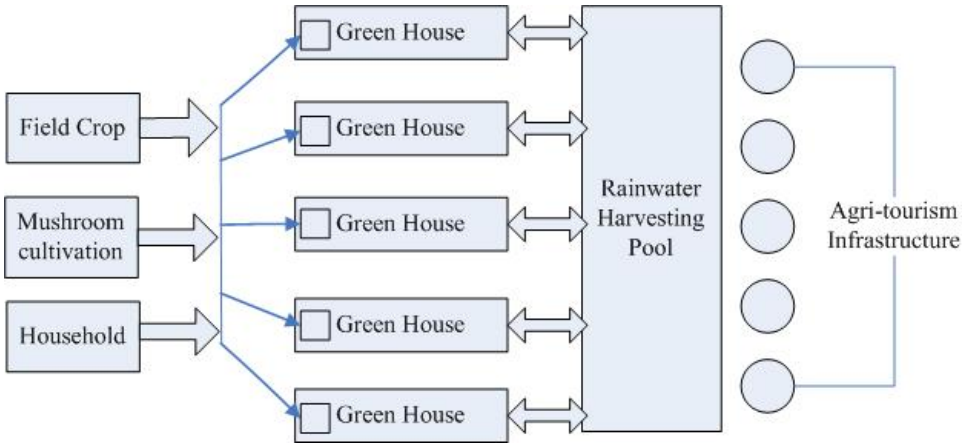
1. Supplies reliable water to and accelerates sustainable development of agriculture under structure; improves benefits and increases farmers' income.
2. Equip this technology to ongoing or be about to be built field, which prevents equipment input waste because of water shortage.
3. In areas lack of water but soil condition is suitable for vegetable, using this technology can promote the adjustment of agricultural structure.
4. Rainwater is good quality for irrigation and suitable for micro- irrigation. Low hydronium content makes it seldom deposit so it won't jam the micro- irrigation pipes.
5. It's simple to be implemented and easy to be mastered which is a good news to farmers.

By now water-saving Irrigation area in Huairou district has reached to 145 thousand mu, accounts for 85.3% in all of the irrigation land. In 2007, there are 20 newly built rainwater collection projects, and the ability of collecting rainwater is 220 cubic meters per greenhouse. Now there are nearly 200 rainwater collecting projects, and most of them are full of rainwater which will be used to irrigation and aquifer recharge.

6.2 Creation in Practice: Improvement to the existing system

Huairou Fruit and Vegetable Cooperative is one of the government's pilot projects and built 5 rainwater harvesting systems for each green house in its contracted farmland. But in the lead of the cooperative, Ms. Zan's opinion, the potential of this single-function of water and power saving system is not fully explored. Based on the principle of urban agriculture's multi-function, Ms. Zan and her colleagues plan to extend this rainwater harvesting and greenhouse system, to make it a compound system. By combining the existed 5 tanks (each one is 180 cubic meter), one big pool (about 500 cubic meter) will be built. Be centered of the big pool, a recycling system is as following:

Fig.2 An improved system for water saving and multi-function urban agriculture



The Cooperative is building a rainwater harvesting system and makes some improvements to the existing system: (1) the size of the store pool will be bigger, so it will bring economies of scale. The existing store pool is 10 meters long, 8 meters wide and 2.5 meters high. The volume of water is about 200 cubic meters. The store pool under building is 20 meters long, 10 meters wide and 2.5 meters high, the maximum volume of water is 500 cubic meters. Expanding the pool can reduce costs of unit area, and improve efficiency of rainwater harvesting system. (2) Enhance the pool's capability to protect against leaking. I conducted an On-the-spot investigation in October 23, 2007 and found that each existing store pool has different volume of water because of the different capability to protect against leaking. The store pool with minimum volume has already dried up, but the maximum one is 2 meters high and the volume of water is about 160 cubic meters. So it can supply agricultural production enough water resource. (3) Building underground water recharging system. On the situation of water absence for many years, vast of underground water is used, which has led to decrease of underground water tables. By now the underground water level in the site reach to 40 meters or more, and this influence the farmers' production and living. Rainwater harvesting system can meet the need of water in agriculture production even rural living, on the other hand, on the basis of rainfall concentrating in the summer, the rainwater harvesting system can collect water overrunning the store pool and recharge underground water. Obviously, it will help to improve the groundwater environment. (4) Using under ground space, developing there-dimensional agriculture. The water store pool will be built underground, and we

will overlay a 50 cm. soil layer to the top of the pool. So the land is still fit to agriculture production. In addition, the under ground pool has suitable temperature and humidity, and these characteristics give farmers a chance to produce some kinds of productions (such as mushroom and blanched garlic leaves), which usually have high price. The cooperative leader estimated that using under ground space to develop agriculture can achieve cost-recovery in there years.

RUAF China wants to help the cooperative to establish this multi-function rainwater harvesting system. It is also a demo for dissemination. It will be composed by:

-10-20 rainwater harvesting greenhouses

-Reuse of household grey and black water and waste and biogas installation (biogas for light bulb in greenhouses, compost dissolved in irrigation water,)

-Pond system with recreational facilities and ecological landscape such as reed, duckweed, fish, etc.

-Aquifer recharge.

-Tourism/ leisure infrastructure (fishing, houses, rural-flavor dinner).

The development of the demo is based on the following ideas and visions：

1. It is more economy and easier to build a big pond than 5 small tanks, though the cost at beginning is higher.
2. A big pond can develop not only for irrigation, but also agri-tourism, such as fishing, and farmer home stay.
3. The development of multi functional agriculture can improve urban agriculture's impact for community, by involving more farmers into vegetable, fruit production, aquaculture, fish and other leisure activities.
4. It will help to develop direct linkages with urban consumers of organic produce farmers in this, by CSA and farmer markets;
5. It will accelerate participative/bottom-Up development. The increasing income can definitely arouse the enthusiasm of members of the Huairou Cooperative.
6. The improvement of rainwater harvest makes it more rich in content. Through the extension of function, this system is more according with urban agriculture's principle.

6.3 Challenges in dissemination

This improved system will bring benefits to various stakeholders. However, the challenges in dissemination need to be considered.

1. The lack of local farmers. More and more farmers in peri-urban Beijing transfer to urban areas. Only elders and women engaged in agriculture. Shortage of male labor is a negative impact to dissemination, especially for the implement of new technology.
2. It's a problem to link small tanks in different households. The contracted land system decides that the land area of each household is only about 1to 2mu. If we want to link 5 tanks in 5 greenhouses to a big one, maybe 2 to 3 households need to be concerned.
3. The distance to pump water back from the big pool to each greenhouse is longer, which demands reasonable design.
4. The dissemination will be a multi-stakeholder development process, and there is a

lot work to do to persuade the members to realize the possible value.