URBAN WATER CONSERVATION EXPERIENCES FROM CHINA

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BACKGROUND

1. Water shortage and water pollution are two major problems in many cities in China. Along with the rapid economic growth in recent years, urban water conservation and protection of water resources have been adopted as basic policy in the national social-economic development plan. As reported in the International Seminar on Urban Water Demand Management held on 22 April 1993 in Dalian City, China, at the end of 1992, there were 514 cities in China, provided with a total daily plant production capacity of 156 million cubic metres of water, in which 43.6% or 68.3 million cubic metres were from city waterworks. The total annual water demand was 42.7 billion cubic metres, equivalent to 117 million cubic metres per day. The total length of urban water supply piping networks in China was about 110,000 km. The domestic water demand was 199 liters per capita per day as the country's average, and 92.1% of the urban population was served with potable water from urban waterworks. Large scale water and wastewater projects, including long-distance interbasin water transfer works, such as the Luanhe River diversion to Tianjin City (distance 234 km, capacity 1 billion cubic metres per year) and the Yellow River diversion to Qingdao City of Shandong Province (distance 253 km, capacity 550 million cubic metres per year).

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China is a country with comparatively poor water resources. Although the total water resources is about 280 billion cubic metres, ranking the 6th in the world, the water resource per capita is 2,440 cubic metres, only 1/4 of the world average. Especially in the northern parts of China, due to seasonal and spatial variations in precipitation, acute water shortage exist in large cities, like Beijing, Tianjin, Dalian, Qingdao etc. In addition, because of inadequate urban water supply facilities, almost two thirds of the Chinese cities are in different degrees short in water supply, and the amount of water shortage was estimated at about 10 million cubic metres per say. The domestic water demand in 1990 amounted to 26.2% and the industrial demand 67.9% of the urban water supply. Household water consumption and public consumption each about 50% of the domestic demand.

2. In addition to the shortage of water resources and inadequacy in urban water supply facilities, the following issues also cause serious concerns in many cities in China:

a. Water pollution: About 80% of the cities in China were polluted in various degrees. Only less then 10% of the cities have municipal wastewater treatment plants, and industrial wastewater pollution control is still far from satisfactory. Water pollution exacerbates the water shortage.

b. Ground Subsidence: Due to over-extraction of groundwater, ground subsidence has been observed in more than 30 cities. In Shandong province, seawater intrusion to groundwater aquifers was observed in an area of more than 400 square kilometres.

c. Considerable waste in both industrial and domestic uses were observed. Obsolete production technology and plant facilities, inefficient management and low water tariff are the essential reasons.

d. More and more projects have indicated sharp increases in capital construction cost for new water supply and waste-water facilities due to long-distance water diversion and serious water pollution. As water demand forecast generally indicates increasing future demand to cope with the social-economic

development, a heavier burden on public expenditure would be expected.

ACHIEVEMENTS IN WATER CONSERVATION IN CHINA

3. In order to ameliorate the water shortage and water pollution in Chinese cities, water conservation has been adopted since 1970's as a basic policy. Relevant legislative, institutional, planning, technical and public education measures have also been enforced. From the years 1983 to 1992, the accumulated amount of water saved was 10.2 billion cubic metres. Industrial water recycling rate increased from less than 20% to about 50%. The water demand per 10,000 yuan of urban industrial output decreased from 459 to 270 cubic metres, equivalent to 1,539 cubic metres per US Dollars 10,000 of urban industrial output. Approximately 1.1 billion cubic metres in water demand and 0.9 billion cubic metres of wastewater discharge were reduced per annum. Not only water pollution and water shortage were partly alleviated, but also a considerable portion of the urban infrastructure construction cost was reduced. Power consumption was also reduced correspondingly, as one cubic metre of water supply would generally consume about 0.5 KWH of power. In addition, together with the urban groundwater resources management measures, including stringent control on groundwater withdrawal and appropriate replenishment, ground subsidence has been effectively controlled in certain cities.

LEGISLATIVE MEASURES

4. Subsequent to the adoption of urban water demand management as priority measures in comparison with the water supply management since 1970's in China, the First National Urban Water Conservation Meeting was held in 1983. In 1984, The State Council issued a Circular on Enforcing Urban Water Conservation. The Law of the PRC on Prevention and control of Water Pollution was also effective as of 1984. The Water Law of the People's Republic of China was issued by the People's Congress in 1988, in which water saving practice and water demand planning were stipulated. In 1989, the State Council issued Stipulations on Urban Water

Conservation Management, and the Environmental Protection Law of the PRC was also issued by the People's Congress in 1989. The Second National Urban Water Conservation Meeting was held in 1990, and the Report on Further Improving Urban Water Conservation was approved and transmitted to various government agencies by the State Council. National standards on drinking water, surface water quality, integrated wastewater discharge, water balance test in enterprises, spare parts for low flow toilet cisterns and evaluation criteria for rational use of water in enterprises, as well as Ministry of Construction Standards on classification, assessment norms and calculation method of industrial water demand were issued in the last decade. In addition, management measures on establishing urban water consumption quota system, awarding advanced units and persons in urban water conservation and on installing the low flow toilet cisterns in urban buildings and supervising their function, were also issued by various ministries in recent years.

INSTITUTIONAL MEASURES

5. A National Urban Water Conservation Office under the Ministry of Construction was set up for the management of urban water conservation and urban groundwater resources. Similar agencies have also been set up in provinces, autonomous regions and the three metropolis (Beijing, Shanghai and Tianjin). More than 80% of the cities in China have also established cities' water conservation offices, responsible for effectively implementing various conservation measures thrcugh the two following institutional channels, i.e., municipality -- bureaus -- factories and municipality -- districts -- neighbourhood offices. In the very dry year of 1984, Dalian City water conservation office achieved in enforcing the planned water consumption quota system down to the workshops and work groups in factories, as well as to households and individual buildings for domestic consumers.

PLANNING AND ECONOMIC MEASURES

6. As industrial water demand accounts for about 70% of the

urban total, a planning system consisting of establishing water consumption quota for various products, carrying out water balance tests in factories based on meterage for obtaining clear pictures of wastes in water consumption, awarding water saving and fining overuse of water , has been implemented in most cities. Ten-year water conservation plans, including demand forecast, conservation targets and measures, have been drafted in many large cities.

7. Low water tariff is the main reason of waste in water use. Water tariff should reflect actual production costs and appropriate profits to water enterprises, and produce incentives for consumers to reduce demand. A more rational water pricing system was established in many cities, and the originally very low tariff was raised. Other economic measures, such as sewage tariff, charge on users of wastewater facilities and block rate or higher tariff for water consumption surpassing the stipulated quota, were also enforced in order to control the increasing demand for water.

UNACCOUNTED-FOR WATER

8. Average leakage figure for most of the waterworks in China is around 8%. All flows into distribution from water plants and supplied to consumers are generally metered. Checking and replacement for repair of meters are generally carried out according to conventional requirements. Leakage detection teams are responsible for sounding of mains and service pipes. In certain water companies, electronic leak detectors and leak noise correlators have also been used. Precise metering, quick repair of leaks, replacement and rehabilitation of mains, check and elimination of illegal connections, as well as recovery of filter backwash water and the discharges from sedimentation units are conservation measures, which should be further studied and implemented in city waterworks.

WATER REUSE

9. Recycling/reuse of water in industries are important measures

in urban water conservation. Recycling rate of cooling water is generally quite high in the water shortage cities in China, but could be further enhanced by improvement on water stabilization technique. Reuse of cooling water effluent from one factory to other factories in industrial zones of Shenyang City indicated promising benefits in water conservation. On the other hand, reuse rates of process water and condensates are generally lower due to the complexity and high cost of treatment and piping works. More than 20 projects of grey water reuse in commercial and institutional facilities are in operation in Beijing. Reuse of effluent from municipal secondary wastewater treatment plants for cooling and process water supply for several factories in Dalian City results in an annual saving of about two million cubic metres of potable water and other economic benefits.

The estimated total annual wastewater discharge in China is about 30 billion cubic metres, most of which untreated. Reuse of wastewater would be a potential new water source for urban industrial uses.

REPLACEMENT OF FRESH WATER WITH SEA WATER

10. Use of sea water for cooling and industrial processing to replace fresh water is practised quite extensively in water shortage coastal cities in China. The large majority of sea water use occurs in chemical, petrochemical and power plants. A seawater plant with a daily capacity of 10,000 cubic meters has been in operation in Tianjin City to supply preliminarily treated sea water to a large chemical plant for cooling and processing. Sea water usage totalled 1.69 million cubic metres per day in Dalian City, which is more than five times the daily fresh water usage in industry. Sea water intake design and corrosion control measures have been studied and adopted in the last decades. Large scale multi-stage flash evaporation desalination units commenced operation recently in a large power plant in Tianjin City to supply the high pressure boilers with make-up water of very high quality. Using the power-water dual purpose desalination technology, the unit cost of desalinated water is less than that of potable water with additional treatment by reverse osmosis or ion-exchange.

GROUNDWATER RESOURCES MANAGEMENT

11. Urban water conservation offices are also responsible for the management of urban groundwater resources, as over-extraction of urban groundwater has resulted in continuous lowering of groundwater table, decrease in yield, sea water intrusion and ground subsidence in some cities in China. Hydrogeological survey, groundwater monitoring, quota system, meterage and charge on groundwater withdrawal, stipulation of approval procedures on boring of individual wells, replenishment of aquifers, storage of cold water in winter by injection to the aquifer and extraction in summer for cooling in the factories etc, are effective measures adopted mostly in the coastal cities in China. A case study indicated that the maximum accumulated ground subsidence in Shanghai City reached 2.63 metres in 1965, and an average annual figure of 98 mm. After stringent control on groundwater extraction and effective implementation of artificial recharge, the annual ground subsidence has been reduced to only 3-5 mm. Groundwater resources management resulted not only in water conservation, but also in the improvement on urban flood control and energy conservation.

WATER SAVING DEVICES

12. Installation of water saving devices, such as low consumption toilets, taps and showers in domestic and non-domestic premises, are indispensable conservation measures. Experience in Dalian City indicated 30-50% of water consumption could be reduced in this way, and a pilot study project on the use of low consumption fixtures in a university was recommended. Program on research, manufacture, installation and retrofitting of water saving devices would need careful consideration and effective implementation.

SOCIAL CAMPAIGNS AND EDUCATION

13. The following education and social campaign measures have raised the level of public awareness for water conservation in cities in China:

a. The public is reminded regularly on the importance and ways to conserve water through broadcasts, television, newspapers, pamphlets, video tapes and posters.

b. Water conservation is one of the topics included in school textbooks. Students are organized to visit the waterworks, so as to let them understand that tap water has not come easily.

c. Strengthening the social campaign on water conservation on certain day or week as the city's water conservation day or week. The recent decision by the United Nations on setting March 22 every year as the World Day for Water strengthened this activities in Chinese cities.

d. Awarding the good performers on urban water conservation and criticizing the bad ones, as well as organizing workshops to introduce the advanced experiences are also effective means in social campaign.