Full Cost Accounting of Urban Water-Use

Guo-jun Song and Wen-cheng Gao

Abstract The full cost of urban water use is all the cost paid directly or indirectly by urban society based on market price. According to the life cycle of urban water use, full cost can be divided into five parts: water intake cost, water making cost, water supply cost, water draining cost, and sewage treatment cost. In this study, an accounting method is constructed for calculating full cost of urban water use, and it has been proved reasonable and feasible. The case study of city A shows that city A's full cost of urban water use reaches 6.23 Yuan/ton at least, while local domestic water price is only 2.05 Yuan/ton, which obviously does not cover full cost urban society pay for water use and undoubtedly cannot reflect the real value of urban water resource. It is suggested that water price should be made based on full cost so that the cost of urban water use could be explicit; thus, water price policy can play a more effective role in water resource allocation. Besides, full cost of urban water use accounting can effectively promote popularization and application of private-public partnership (PPP) mode in the field of water service. Lastly, it is necessary to improve information disclosure of full cost of urban water use to realize scientific and democratic management.

1 Introduction

China's urban water consumption increased year by year. China's industrial and domestic water consumption has increased from 171.5 billion cubic meters in 2000 (Ministry of Water Resources of the People's Republic of China 2001) to 212.1 billion cubic meters in 2014 (Ministry of Water Resources of the People's Republic of China 2015), with a compound annual growth rate of 1.53%. According to a study by China Development Research Foundation, the annual water consumption of

G.-j. Song (✉)
School of Environment, Renmin University of China, Beijing, China
e-mail: songguojun@ruc.edu.cn

W.-c. Gao
Beijing Capital Group co., LTD., Beijing, China

S. Köster et al. (eds.), *Urban Water Management for Future Cities*,
Future City 12, https://doi.org/10.1007/978-3-030-01488-9_22

urban areas in China will grow by 2.4% during the 13th five-year plan period, and urban water pressure will continue to increase. Meanwhile, the low efficiency of water resources utilization in cities aggravates the pressure, for current water price is too low to stimulate the water-saving behavior of residents. At present, the water price generally refers to the engineering water price, containing only the cost of water production part, which cannot totally reflect the full cost of water use, making society generally thinks water is cheap and even free public services, and lack deep understanding of the real value of water resources scarcity. In most Chinese cities, water resource cost and sewage treatment cost are also included in the water price. But even the current generalized water price reflects only a part of urban water use cost, and some are not reflected such as the cost of construction of pipe network, cost of environmental damage and land use, etc. Therefore, it is necessary to check the full cost of urban water use and pricing on it to promote water conservation.

Full cost pricing is the basic principle of water price making, and water use cost should include the costs of water resource exploitation, utilization and sewage treatment processing. Water price standard should be based on the full cost of water use (Ma 2014). Rogers et al. indicate that the social cost of water use includes not only the production cost of the entire water system but also the opportunity cost and externality cost (Rogers et al. 2002), which actually means another interpretation of full cost of water use. However, if not based on the full cost pricing, intervention via public policy means such as subsidies will make the real cost of water use be underestimated, leading to market failure (Arpke and Strong 2006). In the United States, all the infrastructure investment costs that make natural water resource available form water price (Mao 1999). For example, in California where shortage of water resources is a big problem, the local state government built large-scale water diversion project to ensure water supply access to everybody, and the project investment and operational costs are both reflected in the final water price. In Europe, it is the key principle of European Water Framework Directive that water price needs to cover all related cost expense about water use (Unnerstall 2007). In order to improve the efficiency of urban water use, the European Union legislation presents clear requirement that water engineering cost and environmental cost must be taken into consideration in the progress of water price formulation (Hansjuergens and Messner 2002). Kanakoudis builds the methodology of the full cost of urban water use system, states that full cost is the basis of urban water price policy, and divided the full cost into direct cost, environmental cost, and resource cost (Kanakoudis et al. 2011). In China, Liang Ruiju et al. think that in addition to the cost of water supply, full cost water price also includes the opportunity cost, the economic externality cost, and the environmental externalities cost (Liang et al. 2003); otherwise it will cause potential water use efficiency loss (Zhang 2002). Some scholars have defined the full cost of water use as resource cost, engineering cost, and environmental cost (Fu et al. 2006) and constructed the basic model of full cost water price (Fan and Ma 2008). At present, the research on China's urban full cost of water use has made some progress, but specific case studies are still limited. Generally full cost water price researches only consider the resource cost, water making cost, wastewater treatment cost, and environmental cost while ignoring the

other hidden costs such as the cost on water transporting pipe network and on sewage collection pipe network investment (Chen 2011; Yang et al. 2008); therefore, the full cost water price currently being researched actually did not completely reflect full cost of water use.

In this article, based on the water use process of urban society, full cost of water use is defined firstly. Then the corresponding accounting method is put forward, and typical city case is selected to calculate the full cost of urban water use.

2 Concept Definition and Research Method

2.1 Full Cost Definition of Urban Water Use

From the perspective of users, full cost of urban water use can be defined as the sum of all direct and indirect costs water users pay in terms of market price. Among them, the direct cost is generally expressed as the water bills, and the water resources and sewage treatment fees are always included in the water bills in most cities. Indirect costs include urban water-related infrastructure spending paid by the government finance, the opportunity cost such as land resources cost for the building of waterworks, sewage plants and environmental damage cost, etc.

Based on the concept of full cost of urban water use, all the specific projects of full cost can be further refined. According to urban water use management links, full cost can be divided into five parts: water intake cost, water making cost, water supply cost, water draining cost, and wastewater treatment cost. According to the concrete forms of full cost, it can be divided into land cost, infrastructure cost, operation and maintenance cost, and environmental damage cost. The structure of full cost of urban water use can be seen in Fig. 1.

To keep corresponds with urban water management, management links are selected to do first cost classification; concrete cost forms are chosen to do second

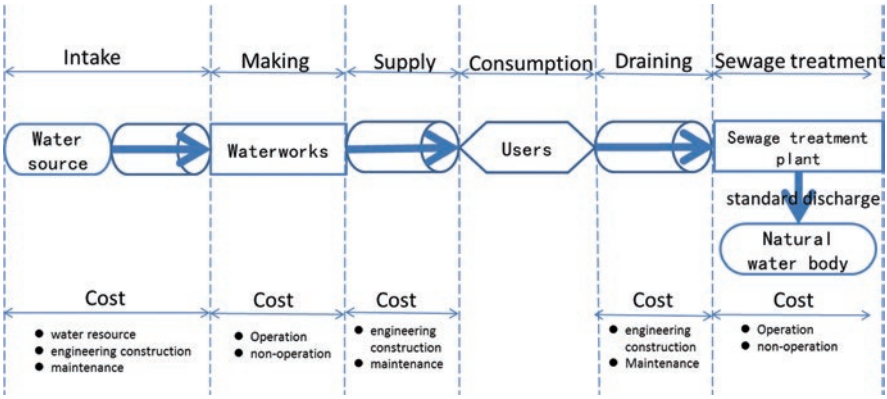

Fig. 1 Structure of full cost of urban water use (Source: compiled by the authors)

Table 1 Instruction on structure and accounting method of full cost of urban water use

Class I	Class II	Class III	Accounting method
Water intake cost	Water resource	–	Water resource fee
	Intake	Engineering construction	Replacement cost method/straight-line depreciation method
		Maintenance	Expert interview method/indirectly calculating method
Water making cost	Operation	Electricity	Market price
		Flocculant	
		Disinfectant	
		Labor	Survey
		Management	
	Nonoperation	Depreciation of fixed assets	Triennial method/straight-line depreciation method
		Amortization of intangible assets	
		Land	Opportunity cost method
Water supply cost	Supply	Engineering construction	Replacement cost method/straight-line depreciation method
		Maintenance	Expert interview method/indirectly calculating method
Water draining cost	Drain	Engineering construction	Replacement cost method/straight-line depreciation method
		Maintenance	Expert interview method/indirectly calculating method
Sewage treatment cost	Operation	Electricity	Market price
		Pharmaceutical	
		Tap water	
		Sewage sludge treatment	
		Labor	Survey
		Management	
	Nonoperation	Depreciation of fixed assets	Triennial method/straight-line depreciation method
		Amortization of intangible assets	
		Land	Opportunity cost method

Source: compiled by the authors

cost classification. Water service belongs to the quasi-public industry; therefore in the process of accounting full cost of urban water use, transportation pipe network cost of water intake, supply, and draining must be considered based on the current market price. At the same time, with the acceleration of urbanization, the scarcity of urban land resources is increasing, and the opportunity cost of land use should be taken into account. The detailed instruction on the structure and accounting method of full cost of urban water use can be seen in Table 1.

3 Full Cost of Urban Water Use in City A

City A is a prefecture-level city located in central China, along the Yangtze River, with per capita GDP of about 1 billion Yuan. Three waterworks from one water company are responsible for the water supply in urban area, and two sewage treatment plants S and W are responsible for the sewage treatment. To ensure the reliability and convenience of water use full cost estimates, the three waterworks are regarded as a whole in the water intake, making, and supply parts research, and an open drainage integration program with PPP model in city A (including sewage treatment plant S and related drainage pipe network facilities) is chosen to study draining and sewage treatment parts. The year of 2015 is taken as the time point.

3.1 Water Intake Cost

Waterworks get water directly from the Yangtze River, so there is no large water intake project and no big water intake expenditure. The water quality of source water reaches II type. According to the local announcement of water quality of the water source in every month, the water quality qualified rate is 100%. The total amount of water got by the three waterworks is 80–90 million tons from the Yangtze River every year. In 2015, 88 million tons of water is got. With the price of 0.08 Yuan per ton for local water resources, the total expenditure of water resources is 7.04 million Yuan. Water intake facilities are all kinds of hydraulic structures used for water diversion, such as entering water gates, pumping stations and collecting water pipes, and so on. According to the similar urban water intake project investment information, the overall water intake engineering construction investment reaches about 250 million Yuan under rough estimate. The average annual depreciation cost is 8.33 million Yuan under concession period of 30 years. As to the water intake facilities maintenance cost, firstly the water making cost is deducted from the total cost of the waterworks, for water intake facilities maintenance cost is included in the waterworks, and then the maintenance cost of both water intake and water supply facilities is estimated to be about 33.99 million Yuan. Secondly, according to the proportion of water intake pipeline length (19 km) in overall water intake and supply pipeline length (1492 km), water intake facilities maintenance costs can be calculated. The result shows that maintenance cost is 0.43 million Yuan per year. Structure of city A's water intake cost in 2015 is shown in Table 2. It can be found that in the process of water intake, water resources and the construction of water intake facilities constitute the main cost, accounting for 97.3% of the total cost of water intake.

Table 2 Structure of city A's water intake cost in 2015

Cost	Class	Detail	Total cost	Unit cost (Yuan/ton)
Water intake	Water resource	Water resource	704.3	0.08
	Intake	Engineering construction	833.3	0.09
		Maintenance	43.3	0.005
Total	–	–	1580.9	0.18

Source: compiled by the authors

Table 3 Structure of city A's water making/purification cost in 2015

Cost	Class	Detail	Total cost	Unit cost (Yuan/ton)
Water making	Operation	Electricity	1688	0.21
		Flocculant	64	0.01
		Disinfectant	25	0.03
		Labor	3957	0.48
		Management	725	0.09
	Nonoperation	Depreciation of fixed assets	1279	0.16
		Amortization of intangible assets	53	0.01
		Land	2261	0.27
Total	–	–	10,051	1.22

Source: compiled by the authors

3.2 Water Making/Purification Cost

In 2015, the three waterworks totally supplied 82.26 million tons of water, and the water quality qualified rate was 100%. In terms of electricity consumption, the electricity price was calculated at 0.77 Yuan/KWH, the total electricity fee was 21.84 million kilowatt-hours, and the corresponding cost expenditure was 16.88 million Yuan. In terms of flocculant consumption, the total consumption volume of flocculating agent was 705.3 tons, and the corresponding cost expenditure was 0.635 million Yuan, according to the unit price of 900 Yuan/ton. Similar to flocculant, the total cost of disinfectant was 0.246 million Yuan according to the unit price of 2510 Yuan/ton. Labor and management costs in 2015 were 39.57 million Yuan and 7.245 million Yuan, respectively. All the operating costs above add up to 64.58 million Yuan. In terms of the depreciation of fixed assets, the annual depreciation cost is between 1.2 and 1.3 million Yuan, and the average cost of 2013, 2014, and 2015 is about 12.79 million Yuan. Similarly, the average amortization of intangible assets of 2013, 2014, and 2015 is about 0.53 million Yuan. As to land cost, according to local average piece of land used for commercial services (6784 Yuan/square meters), three water plants cover an area of 100,000 square meters, so the land cost is 678.4 million Yuan totally and 22.61 million per year on average under concession period of 30 years. The structure of city A's water making cost in 2015 is shown in Table 3. It can be seen that operating costs accounted for more than

Table 4 Structure of city A's water supply cost in 2015

Cost	Class	Detail	Total cost	Unit cost (Yuan/ton)
Water supply cost	Engineering construction	Pipeline with DN800 and above	184	0.03
		Pipeline with DN500–800	488	0.08
		Pipeline with DN300–500	478	0.08
		Pipeline with DN300 and below	1120	0.18
	Maintenance	Maintenance	3356	0.55
Total	–	–	5626	0.91

Source: compiled by the authors

60%. Actually, waterwork land is free of charge. If the opportunity cost of land is deducted, the unit cost is 0.95 Yuan/ton, and labor costs accounted for nearly half.

3.3 Water Supply Cost

The water supply cost includes the construction of water supply facilities and maintenance cost of water supply facilities. The construction of water supply facilities mainly focuses on pipe network, so this paper only calculates pipe network cost, and other facilities such as water pressure pump are not included. The three waterworks serve 750,000 people and sold 61.54 million tons of water in 2015. The total length of the water supply pipe network in the service area is 1473 km, of which the DN300 network is the majority. Based on the market cost of different diameter pipe networks, it can be calculated that the replacement cost of a municipal water supply network construction amounted to 681 million Yuan, and the average annual depreciation cost is 22.7 million Yuan. The maintenance cost of water supply facilities is about 33.56 million Yuan according to the total pipeline transmission network proportion. The structure of city A's water supply costs in 2015 is shown in Table 4. It can be found that the construction and maintenance costs of the water supply pipe network are not small, and the unit cost reaches 0.91 Yuan per ton.

3.4 Water Draining Cost

In 2015, city A started to run the urban drainage integration projects through PPP mode. Public information shows that the project value of 788 million Yuan includes a sewage treatment plant named S with a capability of 100,000 tons/day, 206 km sewage pipe network, and other facilities, which means the total nonoperating cost of drainage and sewage treatment is 788 million Yuan. S sewage treatment plant is mainly responsible for local urban sewage treatment, and its fixed assets are worth

Table 5 Structure of city A's water draining cost in 2015

Cost	Class	Total cost	Unit cost (Yuan/ton)
Water draining cost	Engineering construction	2462	0.78
	Maintenance	4120	1.31
Total	–	6582	2.09

Source: compiled by the authors

about 49.37 million Yuan. Except S plant's fixed assets, drainage facilities construction costs are about 24.62 million Yuan per year on average under concession period of 30 years. As to the drainage pipe network operation and maintenance costs, according to relevant experts' opinion, the comprehensive cost of unit length of drainage pipe network operation and maintenance is about 200,000 Yuan/km per year; therefore, 206 km sewage pipe network will take 41.2 million Yuan per year. In addition, the leakage of untreated sewage in urban drainage will generally result in environmental damage, which is in fact part of the full cost of the drainage. If not considering leakage environmental damage, based on 31.55 million sewage flowing into S sewage treatment plant, the structure of city A's water draining cost in 2015 can be calculated and seen in Table 5, in which the unit cost of drainage shows 2.09 Yuan/ton. It can be found that the cost of drainage and water supply is similar, and the operation and maintenance cost of the network facilities is higher than the cost of infrastructure construction. In city A, there are S and W two sewage treatment plants in urban area, and the scale are, respectively, 100,000 tons/day and 50,000 tons/day. According to the size ratio of 2:1, the total cost of urban drainage reaches about 98.72 million Yuan. If considering the leakage environmental damage, the situation is as follows. Due to the cost of environmental damage or damage repair costs are much more than the cost of perfecting the network facilities to avoid leakage, therefore in accordance with city water flow material balance, suppose all the 61.54 million tons of water consumed by users flows into the sewage treatment plant for processing, thus avoiding environmental damage, the corresponding drainage facilities construction, and maintenance costs in proportion to increase. By calculation, the drainage facilities construction and maintenance costs are, respectively, 48.03 million Yuan per year and 80.36 million Yuan per year, and the total cost amount is 128.39 million Yuan per year.

3.5 Sewage Treatment Cost

Sewage treatment plant S with a capacity of 100,000 tons/day mainly treats domestic sewage using $A^2/0$ microporous aeration biological treatment process. The treated sewage water meeting the requirement of level 1 B GB18918-2002 standard is discharged into the Yangtze River. In 2015, 31.55 million tons of sewage was treated. The total consumption of electricity was 6437 kilowatt-hours. According to the electricity price of 0.77 Yuan/KWH, the corresponding cost was RMB

49.54 million Yuan. Pharmaceuticals mainly include polyacrylamide, hydrochloric acid, sodium chlorate, etc., and the corresponding cost is 0.316 million Yuan. The total amount of tap water was 7889 tons, and the corresponding cost was 23,000 Yuan, according to the unit price of 2.9 Yuan per ton.

The cost of sludge treatment is divided into two parts. One is the transportation cost. According to investigation, the sewage treatment plant S is only responsible for sludge transport, and the disposal is carried out by a third party. The average transportation cost is about 0.15 million Yuan per year. Another is the cost of sludge disposal. Local sludge is used to make bricks, whose price and environmental standard are both not completely transparent in the current market. It is doubtful whether the sludge can be safely disposed of or not. Therefore, in order to make sure the environmental health, anaerobic digestion technology is taken as the disposal standard, and the disposal cost of sludge is calculated according to the market price of 200 Yuan/ton. As a matter of experience, 31.55 million tons of sewage sludge (water content 80%) produces 22,000 tons of sludge, and the corresponding safe disposal cost is 4.417 million Yuan. The total cost of the two items amounts to 4.567 million Yuan. Labor and management costs in 2015 were 4.575 million Yuan and 14.69 million Yuan, respectively. The operating costs above totaled 14.69 million Yuan. In terms of the nonoperating cost, the depreciation cost of fixed assets and intangible assets of the sewage treatment plant is 5.74 million Yuan per year. According to local data, the average cost of land used for commercial services is at 6784 Yuan/square meters; plant S covers an area of 96,000 square meters, so the land cost is 650 million Yuan totally and 21.71 million per year on average under concession period of 30 years. Similar to drainage link, if the sewage treatment fails to meet the discharge standard, it will also cause environmental damage to the water body, which constitutes a part of the full cost. Therefore it is assumed that all the discharged sewage meets the applicable water body quality standards. The structure of city A's sewage treatment cost in 2015 was shown in Table 6. According to the size ratio of two sewage treatment plants S and W, the actual capacity of disposed sewage was about 47.32 million tons, and the corresponding cost is 63.2 million Yuan. If all 61.54 million tons of water is treated by the sewage treatment plants, the corresponding cost is 82.19 million Yuan. It can be found that the most important cost of sewage treatment is the land, which accounts for more than 50%. If the cost of land is excluded, the unit cost of sewage disposal will be reduced from 1.34 Yuan/ton to 0.65 Yuan/ton.

3.6 Total Cost of Urban Water Use

According to city A's urban water use situation, it can be found that pipe leakage is serious, for the leakage rates of water supply and drainage reach 25% and 23%, respectively. The specific urban water use cycle process is shown in Fig. 2.

The 61.54 million tons of water sold to urban residents plays an important role in city A's social economic activities. To maintain consistency of cost and benefit, the

Table 6 Structure of city A's wastewater treatment cost in 2015

Cost	Class	Detail	Total cost	Unit cost (Yuan/ton)
Sewage treatment cost	Operation	Electricity	495	0.16
		Pharmaceutical	32	0.01
		Tap water	2.3	0.001
		Sewage sludge treatment	457	0.14
		Labor	458	0.15
		Management	25	0.01
	Nonoperation	Depreciation of fixed assets and amortization of intangible assets	574	0.18
		Land	2171	0.69
Total	–	–	4214	1.34

Source: compiled by the authors

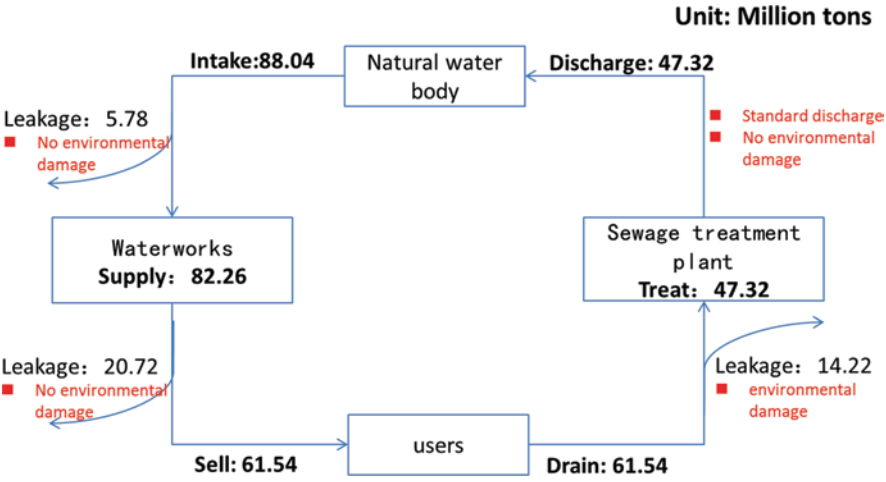

Fig. 2 Urban water recycling process of city A. (Source: compiled by the authors)

61.54 million tons of water sold is regarded as the standard of total full cost accounting in this article. The total full cost actually happened and the full cost meeting the assumption of no sewage leakage which accords with water material balance condition are calculated and shown in Table 7. It can be seen that the actual unit full cost of water use is 5.44 Yuan/ton in which the making and draining costs are important parts. Besides, 14.22 million tons of sewage was not discharged by sewage treatment plants, and these will cause environmental damage that needs to be taken into account in a full cost calculation extending to external cost. If the whole 61.54 million tons of water sold is completely drained and treated by sewage treatment plants, the investment will increase, and the unit full cost of the urban water use in city A will reach 6.23 Yuan/ton.

Table 7 Structure of city A's full cost of urban water use in 2015

Cost	Full cost actually happened			Full cost meeting the assumption of no sewage leakage		
	Total cost (10,000 Yuan)	Unit cost (Yuan/ton)	Percent	Total cost (10,000 Yuan)	Unit cost (Yuan/ton)	Percent
Intake	1581	0.26	4.73%	1581	0.26	4.13%
Making	10,051	1.63	30.05%	10,051	1.63	26.23%
Supply	5626	0.91	16.82%	5626	0.91	14.68%
Draining	9872	1.6	29.51%	12,839	2.09	33.51%
Sewage treatment	6320	1.03	18.89%	8219	1.34	21.45%
Total	33,450	5.44	100.00%	38,315	6.23	100.00%

Source: compiled by the authors

4 Conclusion and Discussion

1. The full cost of urban water in city A is at least 6.23 Yuan/ton. The cost didn't cover land cost for pipeline laying and capital cost; therefore, the actual full cost of water use is higher than 6.23 Yuan/ton. Local water price is 2.05 Yuan/ton (including average water supply price of 1.3 Yuan/ton and average sewage treatment fee of 0.75 Yuan/ton), which is far lower than the full cost. On one side, the price failed to reflect the true full cost of water use, and the price mechanism is disabled which leads to the lack of social water-saving incentive. On the other side, some cost such as pipeline laying cost is not reflected in the water price and paid directly by the local government. These hidden costs are lack of performance evaluation, so the expenditure and benefit are difficult to determine whether it is efficient, which may exacerbate the inefficient allocation of water resources.
2. Generally urban water supply price covers the cost of water intake and making and daily maintenance of the water supply pipe network (excluding water supply engineering construction and land cost). In 2015, the local average water supply price of city A was 1.3 Yuan/ton, and the three waterworks actually sold 61.54 million tons of water; therefore the waterworks got totally 80 million Yuan. According to the calculation, the cost keeping the same caliber of the water price is 118.93 million, indicating that the water price cannot cover the corresponding cost.
3. According to public information of city A's urban drainage PPP project, local government pays service fee of 70 million Yuan every year to enterprise to operate urban draining and sewage treatment system. Full costs of draining and sewage treatment (excluding the cost of sludge disposal and land) are included in the 70 million. According to the calculation, the cost keeping the same caliber of 70 million service fee amounts to 81.83 million Yuan, indicating that actual investment cost of drainage and sewage treatment process is also insufficient. If

assuming all drainage flows into the sewage treatment plant to avoid environmental damage caused by leakage, the actual spending gap becomes bigger.

4. Water price making should be based on full cost principle. All the costs happened in water intake, water making, water supply, water draining, and sewage treatment parts should be incorporated into water price to make full cost of urban water use explicit. Only in this way, it can be possible to completely change our traditional "welfare water" concept and improve users' water-saving incentives. At the same time, it will really make price mechanism comes into play in the allocation of water resources. Through urban water use full cost accounting, the costs of each part become transparent. Firstly, the information between government and enterprise get more symmetrical, which provides important support for both sides to come to PPP cooperation agreement. Secondly, it will do good to reduce malignant price bidding market phenomenon. Thirdly, the full cost of urban water use of different cities can be compared with each other, which will effectively promote urban water use related technology and management level.
5. It is recommended to further improve the scope of public information disclosure. Urban water belongs to public service, so the public has the right to know the full cost information of water use. At present the urban water use cost information in cities of China is still very limited. In order to strengthen the effectiveness of cost management of urban water use and promote the government's credibility and transparency, it is necessary to expand the scope of information disclosure. In addition, more information disclosure will help form water full cost benchmark to enable better enterprise standout and enhance the public understanding of the real cost of water use to avoid unnecessary waste.

References

Arpke A, Strong K (2006) A comparison of life cycle cost analyses for a typical college dormitory using subsidized versus full-cost pricing of water. Ecol Econ 58(1):66–78

Chen Y (2011) Water price of Dalian City based on full-cost water pricing model. J Econ Water Res 23(10):1585–1593

Fan Y, Ma J (2008) Research on the basic model of total cost water pricing. Water Conserv Construct Manag 09:90–92

Fu T, Zhang L, Chang C, Wei B (2006) Pricing goals, structure and principles of urban water price. China Water Supply Drain 22(6):15–18

Hansjuergens B, Messner F (2002) Water pricing in the EU Water Frame Directive: realizing full cost recovery and polluter-pays principles. Wasser Boden 54(7):66–69

Kanakoudis V, Gonelas K, Tolikas D (2011) Basic principles for urban water value assessment and price setting towards its full cost recovery – pinpointing the role of the water losses. Aqua 60(1):27–39

Liang R, Shen D, Wu J (2003) Water resources unified management. China Water Conserv Hydropower Press, Beijing

Ma Z (2014) Research on water price policy in China. China Environmental Press, Beijing

Mao C (1999) The water price system of the United States. Hydraul Econ 4:61–65

Ministry of Water Resources of the People's Republic of China (2001) Chinese water resources bulletin. 2000. China Water Power Press, Beijing
Ministry of Water Resources of the People's Republic of China (2015) Chinese water resources bulletin. 2014. China Water Power Press, Beijing
Rogers P, de Silva R, Bhatia R (2002) Water is an economic good: how to use prices to promote equity, efficiency and sustainability. Water Policy 4:1–17
Unnerstall H (2007) The principle of full cost recovery in the EU-Water Framework Directive – genesis and content. J Environ Law 19(1):29–42
Yang Q, Zeng X, Zhao X (2008) The research of setting down the full cost water price and the supply and demand of water resource of Ningbo. China Resources Comprehensive Utilization 2008-06
Zhang R (2002) Discussion on the issue of full cost water pricing. Jiangsu Water Conserv 1:45–46