Discussion on the Shanghai Water Resources Accounting

Chen Kun and Liu Li Xia

***Abstract*—This paper adopts physical accounting and value accounting method to evaluate the value of water resources in Shanghai. And thinks, for a long time, Shanghai economic growth pay a larger environment cost with water pollution losses accounted for 0.1 to 0.5% or so of GDP. In order to accurately measure the economic growth level of Shanghai and realize Shanghai economic sustainable development, it necessary to accurately evaluate Shanghai water resources value and formulate relevant policies to reduce the environmental pollution.**

***Index Terms*—Water resources, the physical accounting, the value accounting, gross domestic product, sustainable development.**

I. Study Review

Since the 1980s, our country has begun the study of water pollution losses accounting. Earlier scholars in this kind of study have Guo Xiaomin, Zhang Huiqinetc. They regarded environment losses as study object during the 6th five-year plan, and calculated out the water pollution losses of China was 6.6 billion yuan [1], with market value method, opportunity cost method, engineering cost method and human resource cost method.

After this, scholars like Xu Gao ling and Zheng Yisheng have studied the late 90s environment pollution losses of China with the two-step method, which is first confirm the physical losses result from pollution, and then confirm the dose-response relationship between pollution and destructed things, final transform physical losses into the amount of money [2].

Xia Guang accounted out the water pollution losses of China in 1992 were 35.6 billion yuan [3]. Zheng Yisheng etc conducted correction research of environment pollution loss of China in 1993 [4].

Since the late 1960s, Western countries have begun the environment pollution losses accounting. Their research areas mainly focused on two aspects. One is to assess the value of environment pollution losses from the perspective of economics with market value method, replacement cost method and willingness to pay method. The other is faces on the loss assessment of human and biological by different pollutants. Among those the influential are American scholar VaclvaSmli, who accounted out the water pollution losses of China were 11.85 billion in his special subject research report about "China environment problem: economic loss estimation" (account year: 1990), and the World Bank, which accounted out the water pollution losses of China were 32 billion in his report about "facing the 21st century China environment" (account year: 1997).

So far, at home and abroad, the estimation of water pollution losses of Chine is mainly concentrates on an area or a basin, rarely involved in the nationwide.

The measurement results of these researches appeared large difference and influenced its credibility due to the difference of measurement methods. At the same time, the lack of basic data also influenced the accuracy of measurement results. Here, we shall account the Shanghai water resources value with recovery cost method which is high precision in traditional market approach.

Manuscript received October 9, 2012; revised December 11, 2012.

Chen Kun is with the East China University of Political Science and Law (e-mail: chenkunnn@sina.com).

II. The Cause Analysis of the Shanghai Water Resources Accounting

China is one of the 13 water shortage country in the world, with per capita amount of water resources reaches 2730 m^3– one-quarter of the world average and 1870 m^3 per mu, only three-quarters of the world average [5].

Shanghai is a high quality water shortage area, which result from many reasons mainly including unreasonable water pricing and improper water resources management. Water price not fully reflects the management cost of water pollution in price system of water resources. Then, water resources users use water at a lower price, thus causing the waste of water resources and seriously leading to water pollution, which seriously affect the sustainable use of the water resources and the sustainable economic and social development in Shanghai.

Meanwhile, the price of tap water and water conservancy engineering water supply also not consider the value of water resources itself which go against the effective use and conservation of water resources.

From the macro perspective, the lack of comprehensive assessment indicators of water resources in the current system of National Accounts of Shanghai results that the local administrative institutions do not pay enough attention to rational development and utilization of water resources, thus causing declining water quality and having a greater negative impact on the environment as well as on the sustainable economic growth of Shanghai.

By water resources value accounting, we can grasp in a specific way the status of water resources and the relationship between water resources and economic development in Shanghai. It helps to provide decision basis in pushing the sustainable use of water resources and the sustainable development of economic and social in Shanghai.

In microcosm, it prompts water users to use water resources more reasonable. And in macrocosm, it helps to establish a reimbursable usage system on water resources and to lay the foundation of establishing the charging

standard of water resources and economic compensation system of water resources in Shanghai. It also helps to make clear the property of water resource. All of mentioned above shall promote the administration to management the water resources more effectively.

III. The Method Choice of the Shanghai Water Resources Accounting

It's necessary to establish the basic principles of water resources accounting in order to account effectively. The first principle is useful. Water resources accounting is the basis of guaranteeing the compensated and sustainable use of water resources. Second is scarce. Shanghai will be water shortage sooner or later with the continued deterioration of water pollution, so to establish the idea of water scarcity would help the sustainable use of water resources in Shanghai. Third is difference. Establish price of different water quality. The last is policy. To establish water price reasonably should consider the water use and ability of different water body, so as to work out relatively scientific water use policy.

Meanwhile, establish water resources accounting content. Generally speaking, water resources (surface water and underground water) accounting includes physical accounting which uses physical unit measure water resources stock and flow, and value accounting which measures water resources wealth value in terms of currency and bring it into the national economic accounting account. This paper mainly studies the physical accounting and value accounting of surface water.

It's difficult and complicated to calculate water resources due to the liquidity and versatility features. Therefore, there are 3 steps in technology path choice. First is to do a physical accounting of water resources for both quality and volume. Second is to determine the price of different water resources with recovery cost method based on physical accounting. Third is to calculate the loss of water resources value and its impact on GDP.

IV. The Physical Accounting of the Shanghai Water Resources

Certainly in terms of total volume, Shanghai water resources include surface water, underground water and foreign transit water. For the sake of convenience, this paper only considers surface water. According to Shanghai water resources bulletin, the surface runoff water of Shanghai is 2.201 billion m^3 at 50% guarantee rate.

From years of statistical data, Shanghai total water resources remained roughly constant. So the focus is on the change of water quality. For the sake of convenience, this paper adopts the "Surface Water Quality Standard" (GN3838-88) enacted by State Environmental Protection Administration and divides the surface water into 5 grades. Among them I to III grade apply to drinking water sources, IV and V grade mainly apply to industrial and agricultural water, while super V grade losses using function.

According to the collected water volume and quality information, from 1998 to 2010, the changes of water quality and volume in Shanghai are shown in Table II.

TABLE I: The Status of Shanghai Water Resources Quantity

Items		years on average	wet year (p=20%)	normal year(p=50%)	dry year (p=75%)	Things dry years(p=95%)
Local water resources quantity	surface runoff	24.15	33.6	22.01	14.97	7.80
	allowable groundwater withdrawal	1.42	1.42	1.42	1.42	1.42
	total	25.57	-	-	-	-
Transit water quantity	Taihulake basin water	106.60	132.10	104.90	84.80	58.70
	Yangtze River transit water	9335.00	10570.00	9188.00	8232.00	7078.00
	total	9441.60	-	-	-	-

Unit: $10^8 m^3$ Data Source: Shanghai water resources bulletin 2005

TABLE II: The Main River Water Quality in Shanghai

years	water quality categories(%)						surface runoff(one hundred billonm^3)(normal year: p=50%)					
	Ⅱ	Ⅲ	Ⅳ	Ⅴ	Super Ⅴ	total	Ⅱ	Ⅲ	Ⅳ	Ⅴ	Super Ⅴ	total
1998		5.9	37.9	38.5	17.7	100		1.30	8.34	8.47	3.90	22.01
1999		10.1	30.9	31.2	27.8	100		2.22	6.80	6.87	6.12	22.01
2000		6.8	41.4	23.6	28.2	100		1.50	9.11	5.19	6.21	22.01
2001		7.8	38.5	38.0	15.7	100		1.72	8.47	8.36	3.46	22.01
2003	3.8	9.3	28.7	18.0	40.2	100	0.84	2.05	6.32	3.96	8.85	22.01
2004	10.5	2.6	17.2	16.3	53.4	100	2.31	0.57	3.79	3.59	11.75	22.01
2005		14.0	17.7	22.2	46.1	100		3.08	3.90	4.87	10.15	22.01
2006		12.5	17.5	14.3	55.7	100		3.455	4.837	3.95252	15.39548	27.64
2007		12.5	17.9	12.9	56.7	100		3.495	5.00484	3.60684	15.85332	27.96
2008		26.0	14.8	22.2	37.0	100		7.7974	4.43852	6.65778	11.0963	29.99
2009		28.7	27.2	8.5	35.6	100		9.9302	9.4112	2.941	12.3176	34.60
2010		23.5	28.6	13.7	34.2	100		7.25445	8.82882	4.22919	10.55754	30.87

Data source: according to Shanghai water resources bulletin (1998-2010) calculated out

The primary treatment cost of urban wastewater is 0.5 Yuan per cubic meter, and secondarytreatment cost is 0.77 Yuan per cubic meter, according to the World Bank to China's research.

As Table II shows, in general, Shanghai water resources quality tends to get better from 1998 to 2010, the water yield of III grade has increased and IV grade after a period time (from 2004 to 2008) of decline begins to increase, the V grade still has no increase trend, but the bad V grade accounts for a larger proportion and remains high yet. In total, III and IV grade have surpassed 50%, while V and super V grade have dropped to below 50%. In general, water quality has improved in Shanghai.

V. Shanghai Water Resources Value Accounting

Water resources value is closely related to water quality which mainly determined it. Therefore, the total value of water resources can be evaluated accurately by evaluating the value of different water quality. Water resources value accounting usually have three methods, they are traditional market method, substitute market method and contingent value approach. In this paper, we shall account the Shanghai water resources value with recovery cost method which is high precision in traditional market approach. The approach is to evaluate the value of different water quality, then add them up, that is the value of total water resources.

The value of super V grade is zero because it has no using function. If super V grade can be used to agricultural irrigation after primary treatment, this would be the equivalent of restoring V grade function, so the primary treatment cost is the value of V grade water resources. If super V grade can be used to industrial after secondarytreatment, this would be the equivalent of restoring IV grade function, so the secondary treatment cost is the value of IV grade water resources. And so on, the value of different types of water resources can be evaluated with different recovery cost.

According to the World Bank to China's research, primary treatment cost of urban wastewater is 0.5 Yuan per cubic meter and secondarytreatment cost is 0.77 Yuan.

In Shanghai, the average cost of producing tap water, which taken from III grade water, is 1.072 Yuan per cubic meter in 2005 [6].

On these grounds, assuming the super V grade water price is zero, the price of V grade water resources is 0.50 Yuan per cubic meter in Shanghai when it reached the requirement of agricultural irrigation after primary treatment, and the price of IV grade industrial water resources is 0.77 Yuan per cubic meter when it reached the industrial water requirement after secondary treatment. The price of III grade water resources is 1.03 Yuan per cubic meter same to life with surface water, so calculate the price of III grade domestic water is 1.03 Yuan per cubic meter. The water operation cost is 1.072 Yuan per cubic meter when it reached the requirement of drinking water after a certain processes, so the price of II grade drinking water is 2.102 Yuan per cubic meter. The water resources price determined here is the value of itself, equals to natural water resources.

After establishing the value of different water in Shanghai, add them up, that is the value of total water resources. As it is show in Table III.

TABLE III: Shanghai Total Water Resource Value

years	II grade		III grade		IV grade		V grade		Total value
	Water quantity (one hundred million cubic meters)	value quantity (one hundred million cubic meters yuan)	Water quantity (one hundred million cubic meters)	value quantity (one hundred million cubic meters yuan)	Water quantity (one hundred million cubic meters)	value quantity (one hundred million cubic meters yuan)	Water quantity (one hundred million cubic meters)	value quantity (one hundred million cubic meters yuan)	value quantity (one hundred million cubic meters yuan)
1998			1.30	1.339	8.34	6.4218	8.47	4.235	11.9958
1999			2.22	2.2866	6.80	5.236	6.87	3.435	10.9576
2000			1.50	1.545	9.11	7.0147	5.19	2.595	11.1547
2001			1.72	1.7716	8.47	6.5219	8.36	4.18	12.4735
2003	0.84	1.76568	2.05	2.1115	6.32	4.8664	3.96	1.98	10.72358
2004	2.31	4.85562	0.57	0.5871	3.79	2.9183	3.59	1.795	10.15602
2005			3.08	3.1724	3.90	3.003	4.87	2.435	8.6104
2006			3.455	3.55865	4.837	3.72449	3.95252	1.97626	9.2594
2007			3.495	3.59985	5.00484	3.853727	3.60684	1.80342	9.256997
2008			7.7974	8.031322	4.43852	3.41766	6.65778	3.32889	14.77787
2009			9.9302	10.22811	9.4112	7.246624	2.941	1.4705	18.94523
2010			7.25445	7.472084	8.82882	6.798191	4.22919	2.114595	16.38487

Unit:Cubic meters/Yuan

As Table III shows, since 1998, the value of water resources in Shanghai had a process of change that present a clear inverted U shape. From 1998 was 1.2 billion Yuan fell to its lowest level 861 million Yuan in 2005, and then picked up to 1.64 billion Yuan in 2010. These accorded with the Environment Kuznets Curve, and shown that water environment of Shanghai is improving gradually after

deterioration.

VI. Water Resources Value Losses and the Adjustment of GDP

Water environment improved or not is judged by how much III grade water has. For the sake of analysis, use the magnitudeof value when all water quality in Shanghai reached III grade in 1998 as standard value, and to judge the changes of water resources value in Shanghai after 1998. Then, bring them into the GDP accounting system and adjust the GDP. Corrected results see Table IV.

TABLE IV: The Proportion of the Loss of Shanghai Water Resources Value in GDP

Years	P	Reference value	ΔP	GDP	EDP	ΔP/GDP(%)
1998	11.9958	32.8062	20.8104	3801.09	3780.28	0.547485
1999	10.9576	33.446	22.4884	4188.73	4166.242	0.536879
2000	11.1547	33.0083	21.8536	4771.17	4749.316	0.458034
2001	12.4735	31.7301	19.2566	5210.12	5190.863	0.3696
2003	10.72358	33.9926	23.26902	6694.23	6670.961	0.347598
2004	10.15602	37.3907	27.23468	8072.83	8045.595	0.337362
2005	8.6104	36.128	27.5176	9247.66	9220.142	0.297563
2006	9.2594	47.50625	38.24685	10572.24	10533.99	0.361767
2007	9.256997	48.10993	38.85294	12494.01	12455.16	0.310973
2008	14.77787	42.07717	27.2993	14069.87	14042.57	0.194027
2009	18.94523	43.31782	24.37259	15046.45	15022.08	0.161982
2010	16.38487	40.98857	24.6037	17165.98	17141.38	0.143328

Annotate: P is water resource value stock; ⊿P is water resource Value loss; EDP is the value of GDP minus the ⊿P .

As Table IV shows, water resources value losses are great in Shanghai due to water pollution. From 1998 to 2010 the average water resources value losses is 0.34% of GDP.

VII. Conclusions and Policy Recommendations

There are some deviations with the traditional methods when measured economic growth with GDP after the surface water resources value accounting in Shanghai. It does not take the environmental losses into account and overestimate the actual level of economic growth. From 1998 to 2010，the losses value of surface water resources in Shanghai was 0.34% to the GDP. At the same time, we could see that from the 1990s the value of water resources total losses as a proportion of GDP has been declining, dropped from highest year 0.55% in 1998 to 0.14% in 2010.The large decline states that the water quality of Shanghai environment has improved significantly.

Relatively speaking, due to the proportion of water pollution is still large; the quality of water has a direct influence on the economic and social sustainable development in Shanghai. So, it is necessary to formulate some relevant policies to further improve the quality of water environment.

At first, we should pay attention to the environmental accounting. Environmental accounting is an important way and content to realize the green GDP and the certain choice to promote economic and social sustainable development. It requires the transformation of economic growth mode, adjusting the industrial structure, and finding the way to balance the development of economic growth and environmental improvement.

The Second is to apply market mechanisms, and through the price means to improve water resource allocation. The serious water pollution trend in shanghai has something to do with the water price. Due to the cost of water pollution is not fully borne by the users of water resources, on the one hand caused excessive use of water resources on the other hand increased the pressure for environmental governance. Therefore, we could regulate the use of water resources through the price leverage.

The third is to strengthen the water resources management system construction. Because of the fluidity of water resources that water pollution has obvious characteristics of the cross-border. Addressing trans-boundary water pollution in the administrative division system efficiency is low. Therefore, from the system construction point of view, it is necessary to strengthen management cooperation in cross-boundary water pollution and establish collaborative model of cross-boundary water pollution prevention, mechanisms and systems. One of the most important is legal system construction. In the long run, it is very necessary in Taihulake basin water resources management uniform legislation. In the short run, we could establish a coordinating body of water laws and regulations to coordinate the Yangtze River Delta region water management laws and regulations. Coordination mechanism can be non-permanent institutions. Members can be the government officials, scholars, businessmen and other personnel of the Yangtze River Delta region, so it has broad representation. Its function is to promote the coordination of the central and the Yangtze River Delta region, promote the improvement of the water environment of the Yangtze River Delta region, enhance the governance capacity of the water environment of the Yangtze River Delta region, and improve the water environment management system of the Yangtze River Delta region.

References

[1] X. M. Guo and H. Q. Zhang, *China's Environmental Forecast and Countermeasure Research in in A.D 2000 Years*, Tsinghua University Press, 1990, pp. 25.

[2] H. L. Xu, *The Economic Loss Measurement of China's Environmental Damage*, China Environmental Science Press, 1998, pp.105.

[3] G. Z. Xia, *The Economic Measurement and Research of China's Environmental Pollution Loss*, China Environmental Science Press, 1998, pp. 68.

[4] Y. S. Zheng, Y. Lin, and Q. Re, "China's environmental pollution economic loss estimates in the mid 90s," *Management World*, pp. 189-197, February 1999.
[5] G. D. Zhang, "China's water resources problems and their solutions," *Journal of Hydraulic Engineering*, pp. 22-29, April 1991.
[6] The water price in Shanghai doesn't match with the cost and the reform of water price is imperative. (2005, May 12). [Online]. Available:http://finance.sina.com.cn/chanjing/b/20050512/16301582368.shtml
[7] S. M. Wang and F. T. Qu, "Water accounting and correction of GDP —The illustration of economically developed regions of eastern China," *Nanjing Agricultural University*, pp. 115-118, February 2001.

Chen Kun was born in Huarong, Hunan, China on March 1, 1966. In 1984-1988, he studied in East China Normal University and got a Bachelor's degree; in 1991-1994, in East China Normal University and a Master's degree; In 2000-2003, in Shanghai Academy of Social Sciences and a Doctor's degree. His major research is on industrial economics and economicsofenvironmentalresource. He is the professor of East China University of Political Science and Law from 2003, which is located in Shanghai, China, and as the vice president of Business School in ECUPL. Moreover, he has published more than 4 books and papers.