Study on Urban Water Resources Sustainable Development of Public Evaluation Theory*

Li Cuimei[12] Wang Jianhua[2] Wang Hao[2] Zhang Shaoguang[3]
[1]department of Environmental Science and Engineering, Suzhou University of Science and Technology, binhe road 1701#, Suzhou, China, 215011, PH&FAX(086)0512-68247000, cuimeili@163.com;
[2]China Institute of Water Resources and Hydropower Research, Beijing 100044, China, PH&FAX(086)010-68785685；email：wanghao@iwhr.com;
[3] Suzhou 3－Tsing Environmental Science and Technology Co., Ltd, Suzhou, 215011, China, email:73220zsg@sina.com.cn;

ABSTRACT

Micro-scale urban water resources sustainable development evaluation system has always been gaps in the field of environment sustainable development theory. This study raised the concept of the public degree systems on sustainable development of urban water resources. Discussed the composed of public degree systems of urban water system, built the public degree evaluation index system, and give its method of calculation and evaluation level. Urban water resources sustainable development evaluation system includes four parts: public awareness, public capacity, public interest and public will. Public would promote their needs of the sustainable participation capacity with the strengthening of public awareness, public interest would be enhanced with the increasing of public capacity, and public will would be upgraded with the reinforcing of public interest. These four parts are interaction, we should study each of these four parts what and how to promote sustainable development of urban water resources in the role theory. In this study, we built 12 indexes and 7 dimensions to evaluate the public participation degree of urban water resources sustainable development. Polygon envelope method was proposed by the city's socio-economic evaluation method for evaluation of scientific and technological development level of calculation, as a means of verification testing the correctness of this theory and method. Finally, pointed out the public degree systems of urban water system important significance of urban scientific development.

KEYWORDS: urban water; sustainable development; public-oriented; evaluation; theory

1. INTRODUCTION

The notion of sustainable development used internationally is based on the so-called Brundtland Report, of 1987, also entitled “Our Common Future”, which defined sustainable development as one that satisfies our own present-day needs, without jeopardizing the capacity of future generations to satisfy their needs. In June 1992, the "World Conference on Environment and Development" organized by the United Nations in Rio de Janeiro, Brazil. Over one hundred government leaders gathered to

*sponsored by Qing Lan Project

discuss the environmental crisis response, especially the problem of water resources sustainable development.

This definition is adequate for use in political and diplomatic discourse, but it does not go far enough in allowing us to list, in order of the magnitude of their environmental impacts, different projects or undertakings with a common objective in mind. Before establishing this relationship, one should first highlight three categories of sustainability, which are economic sustainability, social sustainability and environmental sustainability.

A definition of environmental sustainability (and sustainable economic performance) puts quantitative, physical restrictions, as it implies limiting the supply of energy and raw materials to reserves of natural resources, and to the capacity of the environment to absorb and recycle the waste that is generated.

There are areas where economic sustainability overlaps with social sustainability, but clearly both ultimately depend on environmental sustainability, which, consequently, must be considered as our priority.

Until recently, GDP was considered the most relevant indicator of economic performance and social progress. However, due to the energy crisis, and, principally, to climate change, we have witnessed an increase in interest among governments in relation to the problem of environmental sustainability.

The effective compatibility of the growth of the use of natural resources, with the capacity of the environment to renew them and recycle waste, is an essential condition for sustainability. And we cannot hope that the market, alone, will create the necessary conditions for this compatibility. In order to achieve this, one should proceed with a decoupling between economic growth and the use of natural resources, so that production remains limited to reserves of natural resources, and by the capacity of the environment to reconstitute these natural resources and to recycle the waste that is generated.

On the other hand, as sustainability becomes an increasingly critical question, it would be most interesting to substitute GDP with a strong index of sustainability, one that is affected by parameters linked to a quantitative definition of sustainability related to measures of the physical production of goods and services, combined with the existing indices of quality of life.

2. THE CONCEPTION OF PUBIIC EVALUATUION THEORY

Water crisis is not entirely a result of the rapid development of modern industry, one of the mainly reasons is the result of mismanagement. How to ensure a relative fairly conditions of water resources is not entirely exclusive, that can be divided into nature externalities, configuration hierarchy and scarcity. At the same time with the index system to quantify, in order to lay the theoretical foundation for sustainable development of water resources for water provide a scientific basis for resource management decisions to address the national, regional, watershed initial water right allocation problems, sustainable development and management of water resources is an important research topic. The core idea of this study is how to achieve sustainable management of water resources and how to increase social participation and shared responsibility for the sustainable management of water resources and how to promote

community participation in sustainable management of water resources and improve efficiency to how to improve individual and collective right awareness of sustainable development of water resources.

From the third requirement of the concept of sustainable development raised by Norwegian Prime Minister Mrs. Brundtland, we could see that, sustainable development including international, national, regional, tribal and family all aspects of human life. Sessions over the years, the international sustainable development forums and conferences, high-end also has been a long-term emphasis on improving "public participation", however, more than 20 years, this goal had not been well achieved. The reason is not difficult to discover: whether the theoretical research or countries to develop strategies for sustainable development and enhancing the "public participation" are basically at the just shouting slogans, there is not practical action. A long period of lacking of theoretical guidance and specific implementation measures state. So, study the micro-scale theory of water sustainable development is becoming more and more important and urgent. With the public series awareness of will, interests, rights increasing rapidly, how to turn these awareness into water sustainable development is the main content of the micro-perspective sustainable development.

Above all, we could give a conception of the micro-perspective sustainable development, what is the relationship between public (or each person) behavior, will and sustainable development. So, the conception of public participation degree of regional water resources sustainable development (PPDWRSD) is clearly, that is the relationship between public behavior and water resources sustainable development. Personal or public behavior is an object of study, and the relationship between behavior and water resources sustainable development is the main research contents. The relationship should be studied from four respects: first is how the public will impact on sustainable development; second is sustainable development could change what public interest; third is sustainable development would need what public behavior support, and the behavior requires the support of consciousness, and which is also gradually training and formation. So, the last is the public participation ability and training. We hope by this study could show: public participation would effectively promote the process of sustainable development; especially the process of regional water resources sustainable development, and public would play an increasing role in the process.

The objective of this issue is very simple and clear, that is how to improve the sustainable development of the "public participation", and the micro-scale theoretical research of sustainable development on water resources.

Public participation degree of regional water resources sustainable development (PPDWRSD) could be defined as: the public is the main body to achieve sustainable management and development of water resources in a country or region, public participation degree in the sustainable development and management of water resources is called the extent of "Public Degree". The degree contains three following meanings:

(1) Clearly, emphasizing the public is the status of the main body;

(2) Pointed out that the public should be involved in the sustainable development of

water resources, management of all aspects, even if the public authority, but also their obligations.

(3)Building a new indicator to measure the process of the water resources sustainable development from public participation, and the indicator also could be assessed the process of society sustainable development from city to regional, from country to all worlds.

3. THE EVALUATION INDEX SYSTEM OF PUBLIC EVALUATION THEORY

How to measure the public participation degree of water resources sustainable development is related to public life, study, work, production and all aspects. For the water carrying out in all aspects of any individual, community, society, and any country, city, enterprises, institutions, individual production, living and learning are inseparable from the water resources. Therefore, theoretically speaking, all water-related links can be used as a public system of indicators of the content.

However, given the features of water usage and drainage of public life, enterprises produce are quite different, so the index system public participation degree of water resources sustainable was divided into two main categories: first, take the public domestic water as the main target to study the regional evaluation indicators systems. Second is the industrial water, which should study the process of the industrial water usage and emission, to put up the public participation degree of industry water.

The main target of this paper is public domestic water, on the start of industrial water temporarily.

As the evaluation object is the domestic water, therefore all aspects related to the composition of domestic water features become the main content of evaluation systems. With the continuous improvement of the process of urbanization in the next period of time, number of urban residents in China will continue to increasing, the proportion of urban population continues to growing up. Therefore, it’s has the typical representation for taking public domestic water for the PPDWRSD.

The evaluation index system of PPDWRSD should include flowing contents:

(1) Public understanding extent of water resources

Science and technology are primary productive forces, is the ladder of human progress. Only some knowledge or understanding of the situation, it will be adjusted accordingly. Survey of public understanding of water-related profiles, and as a content evaluation, can reflect a region, state water-related knowledge, laws and regulations penetration, then evaluation. Based on the evaluation results can make more rational policy of policy, ways, methods, gradually increase public understanding extent of water resources, clearly learning water resource statue of their country or regional.

(2)Public behavior on water resources

The study on individual and public behavior showed that individual behavior affect the organization's effectiveness in general, at the same time influenced by the organizational context; in the organization situations, behavior of individual citizens will be influenced by factors from different levels, therefore, to carry out different levels study of citizenship behavior is very significant.

Therefore, study the public behavior has great practical significance on the correct evaluation of water resources development and planning of sustainable development.

Combining above two aspects, we could build the evaluation index system of PPDWRSD, see in Table.1.

In the Table.1, the first overview of major items of public understanding of water resources set 12 indicators, separately from local water resources quantity, the number of local available water, personal satisfaction, water consumption and displacement per person per day, community daily water consumption and displacement, local industrial and agricultural water consumption, local water pollution to survey public understanding extent of water resources. The second largest item of public behavior set 8 indicators to measure the relationship between individual behavior and water resources sustainable development, especially pointed out the important of the individual participation.

4. THE CALCULATION MODEL OF PUBLIC EVALUATION THEORY

Each indicator's scores in Table.1 should be fully combined the realities situation, such as the scarcity of water resources, economic development level, cultural environment, living habits and etc. when determined. Also could assigned different weights to each indicator to express different importance. In this study, the index score is already taken into account the weight, so do not be singled out.

The individual scores in Table 1 can add up to drew each citizen's scores of PPDWRSD, then score value of a statistical area citizens can arrive at the average points score distribution, and standard deviation and other statistical data. These three data shows the level of public participation of water resources sustainable development in the region or country (PWSD), formula as follows:

$$PWSD = \sum_{i=1}^{n} PWSD_i = \frac{\sum_{i=1}^{n}(\sum_{j=1}^{12} A_i + \sum_{k=1}^{8} B_i)}{n}/100 \quad (1)$$

If the indicator set weight independently, then the score value is the weighted average of the indicators, formula as follows:

$$PWSD = \sum_{i=1}^{n} PWSD_i = \frac{\sum_{i=1}^{n}(\sum_{j=1}^{12} A_i \cdot W_j + \sum_{k=1}^{8} B_i W_k)}{n}/100 \quad (2)$$

5. CASE STUDY

Suzhou is located in the center of the Yangtze Delta, in the south of Jiangsu Province, with Shanghai to the east, Zhejiang Province to the south, Wuxi City to the west and the Yangtze River to the north. The total area of Suzhou is 8,488.42 km² with the population of 6,073,000. For get the data, we conducted a questionnaire survey which including 2800 questionnaires were sent in the west of the Suzhou city about 52km^2 , and get back 2400 questionnaires with full and usable information, the data and the

average score be calculated by the formula(1) about public on urban water sustainable development could be saw in the table 1.

Table 1 the public evaluation on urban water sustainable development

NO.	Index	evaluation index				average
		best	better	good	unknow	score
1	Know extent on water resources（A）	53	41	29	0	38.6
1.1	Local water resources quantity（A_1）	5	4	3	0	4.2
1.2	The number of local available water（A_2）	5	4	3	0	3.4
1.3	Personal satisfaction（A_3）	3	2	1	0	2.7
1.4	Water consumption per person per day（A_4）	5	4	3	0	4.3
1.5	Displacement per person per day（A_5）	4	3	2	0	3.2
1.6	Community daily water consumption（A_6）	4	3	2	0	2.9
1.7	Displacement of communities every day（A_7）	4	3	2	0	2.8
1.8	Local industrial water consumption（A_8）	4	3	2	0	2.6
1.9	Displacement of local industries（A_9）	4	3	2	0	2.7
1.10	Local industrial water pollution（A_{10}）	5	4	3	0	3.6
1.11	Local agricultural water（A_{11}）	5	4	3	0	3.5
1.12	Local agricultural water pollution（A_{12}）	5	4	3	0	2.7
2	Individual behavior（B）	47	35	24		31.6
2.1	select water-saving products（B_1）	7	5	3	0	6.7
2.2	set personal saving target（B_2）	7	5	3	0	4.4
2.3	water-saving habits（B_3）	7	5	3	0	6.1
2.4	participate in community water campaign（B_4）	5	4	3	0	2.7
2.5	local water resources promotional activities（B_5）	5	4	3	0	2.8
2.6	volunteers（B_6）	5	4	3	0	2.8
2.7	personal information saving activities（B_7）	5	4	3	0	2.8
2.8	stop the phenomenon of waste of water (B_8）	6	4	3	0	3.3
3	Individual scores of PPDWRSD	full mark:100				70.2

The average score is 70.2, showed that the survey area was middling level in the urban water sustainable development progress, the result is high consistent to the fact of the Suzhou city. But as a new method to evaluate the public on urban water sustainable development, it is need some scientific and well-rounded method to approve.

Polygon envelope method is used in this study to approve the above method's correction. Society and economy science development level and standard in Suzhou from 1998 to 2003 in China is in table 2, which showed the all affect development state in the city. According to the table 2, by using the polygon envelope method we

can calculate the index of science development in Suzhou from1998 to 2003 which can be saw in table 3.

Table 3 the index of science development in Suzhou from1998 to 2003

subsystem's index	1998	1999	2000	2001	2002	2003
Economy development	46.4700	50.8527	58.4915	64.9844	69.3866	74.0222
society progress	54.1300	55.6726	56.7304	60.9428	73.3436	77.4167
environment improve	57.6400	61.7143	69.0193	66.8483	69.8488	71.5600
resource utilize	82.5900	83.5111	82.2647	70.3690	74.6343	71.5874
harmony development index	0.7080	0.7352	0.7804	0.9146	0.9500	0.9400
Science development index	50.1924	53.6649	58.8000	62.9138	69.9291	71.7371

We can see that the index of science development in Suzhou is 71.7371 in 2003 which is very closed to the average score: 70.2 if exclude the time difference, maybe we can drew the conclusion that these two methods can be used as evaluation method of urban water resources sustainable development, the former method is relatively simple and it's focus is the public participation in sustainable development of water resources. Polygon envelope method is reflected in all aspects of social development from economic to environment which need requires a lot of social and economic development data, the results can include the case of water resources development, but does not have exclusion, and focus reflects the status of the social sustainable development. Urban water resources sustainable development as a part of society sustainable development, its level of sustainable development should be consistent to the whole social sustainable development; our results conform to this rule.

6. FINAL REMARKS AND CONCLUSION

The micro-evaluation of the urban water resources sustainable development is almost blank and public's role, status to the water resources are still few studies. The paper described the public state in the water resource development by calculating the score of the public evaluation system. Polygon envelope method is used in this study to approve the correction of the study method. Above all, we could draw the following conclusions:

(1) The average score is 70.2 in Suzhou city which is a beautiful and high development region in the southeast of China, which showed a good condition of urban water resources sustainable development under the high investment about 100 hundred million RMB Yuan.

(2) The index of science development in Suzhou is 71.7371 in 2003 which is consistent to the result of the public evaluation system. As the GDP ranked fifth city in China, society and economy is in good and rising stage of development in Suzhou city.

Table 2 Society and economy science development level and standard in Suzhou from 1998 to 2003 in China

NO.	System layer	Rule layer	Indicators	Units	1998	1999	2000	2001	2002	2003	Standard
1			GDP per capita	USD$ / person	3238	3649	4201	4248	4842	5635	4000
2		Level of	the tertiary industry's proportion	%	35．01	37.11	37.83	37.73	36.31	37.1	58
3		development	Urban residents disposable income	RMB ￥ / person	9003	9578	11006	12114	13334	16080	29000
4	**Economic**		Annual per capita income of farmers	RMB ￥ / person	5171	5284	5466	5783	6192	6689	13600
5	**developme**	Potential	Industrial water recycling rate	%	20.02	18.58	29.08	32	35	37.6	70
6	**nt**		Overall Labor Productivity	RMB ￥ / person	47456	55429	66799	68687	84414	95387	80000
7			R & D expenditure's ratio of the GDP	%	0.45	0.53	0.59	0.97	1.03	1.21	1.36
8			Scale enterprises proportion	%	0	0	0.5	1	1.5	2	20
9			Human Development Index	——	0.8228	0.8489	0.8744	0.8781	0.9024	0.9261	0.8
10			Engel Coefficient	%	42	40	39	40	38	35	<40
11	**Ecological**	Quality of Life	The level of urbanization	%	27	34	38	40	41	50	60
12	**society**		Internet users of per thousands capita	Household	10	10	10	20	72	46	100
13			Urban per capita living space	m^2/person	17.75	18.45	18.89	18.1	24	24	30
14			Urban per capita public green area	m^2/person	5.73	6.16	7.05	7.78	9.27	10.36	12
15		Social security	Gini coefficient	——	0.22	0.24	0.22	0.26	0.3	0.35	0.3～0.4
16		and fair	Crime	‰	4	5	5	5	4	4	2
17			Unemployment rate	%	30	28	25	22	18	15	10
18		Environmental	wastewater discharge of per added value	RMB ￥ / ton.	430	369	388	459	483	406	400

19		stress	industrial emissions of per added value	RMB ￥/10^4 *m^3	13192	12590	11484	3921	4274	4363	4200
20	**Environme**		solid waste discharge of per added value	RMB￥ / ton.	35039	42136	35062	19409	22362	28891	18700
21	**nt**		intensity of fertilizer application	Kg/Ha.	500	460	301	288	277	271	<150
22	**progressive**	State of the	water average COD of monitoring sections	mg/l	3.068	5.302	4.314	4.8	4.6	3.8	3
23		environment	air pollution index	——	1.67	1.91	1.19	1.77	1.72		<1
24			area percentage of noise standards	%	80	90	95	100	100	100	100
25		Environmental	Urban sewage centralized treatment rate	%	20.56	45.1	52.16	51.14	60.92	66.04	70
26		response	the proportion of enterprises which should be implementation of cleaner production	%	2	5	5	8	12	15	100
27		Level of	arable land per capita	acre/person	0.25	0.233	0.2183	0.207	0.207	0.207	0.133
28		resources	forest cover	%	8	9	10	10.8	11.8	12.8	Hills ： 45;
	Sustainable										Plain ： 15
29	**and**		protected areas' the proportion of total land	%	7.66	7.66	7.66	7.66	9.23	9.72	Hills ： 20
	efficient		area								Plain ： 15
30	**use of**	Efficiency	unit GDP energy consumption	t.coal/GDP（10^4U.S.$）	3.64	3.79	6.79	9.36	8.94	12.09	6.2
31	**resources**		unit GDP water consumption	m^3/ GDP（10^4U.S.$）	491	506	538	1476	1414	1414	1100

(3) The method which the paper studied is relatively simple and focuses the public participation in sustainable development of water resources.

Acknowledgments：

This work was supported in part by the Grant (50721006) from the National Natural Science Foundation of China, by the Grant (2010-K7-3) from the Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD), and by the Study on Leakage

Control and Key Technology for Water Distribution Systems (201006100005) funded from the department of Housing and Urban-Rural Development of Jiangsu Province. Special thanks to the Science Foundation of Suzhou University of Science and technology.

References:

UN Report of the World Commission on Environment and Development: Our Common Future; 1987.

Goodland R, Daly H. Environmental sustainability, universal and non negotiable. Ecological Applications 1996;6(November (4)):1002–17.

Daly, H. Economics in a full world. Scientific American 2005; (September):100–7.

van der Voet E, et al. Policy review on decoupling. Leiden: Universitair Grafisch Bedrijf; 2005. p. 17–20.

Simonovic S, P, Kundzewicz Z. Rosbjerg D.， Takeuchi K.， Modeling and Management of Sustainable Basin-Scale Water Resource Systems[M]，IAHS Press, 1995(231)

Rosbjerg D.，Nour-Eddine Boutayeb, Alan Gustard, Kundzewicz Z. W. & Rasmussen P.F., Sustainability of Water Resources under Increasing Uncertainty[C].IAHS Publish, 1997, No.240

Waling D.E. & Probst J.L.，Human Impact on Erosion and Sedimentation[C].IAHS Publish, 1997, No.245

Simonovic S.P.，Special Issue; Sustainable Development of Water Resources, IAHS Publish. August 1997, 1997.42(4)

C. A. Brebbia , P. Anagnostopolos. Water Resources Management(Ⅰ、Ⅱ) [M] . Boston: Wit press, 2002

J.C. Elnaboulsi, Nonlinear Pricing and Capacity Planning for Water and Wastewater Services, Water Resources Management, 2001(15):55-69

Merrett, Stephen； Deconstructing households' willingness-to-pay for water in low-income countries，Water Policy. 2002,4(2):157-172

Raymundo G., Price Setting for Water Use Charges in Brazil. Water Resources Development.2005 (1):99

Roberto G. A., Jay R. L, Derived willingness-to-pay for household water use with price and probabilistic supply. Journal of Water Resources Planning and Management.2006,132(6):424

Olmstead, Sheila M., Hanemann and ect., Water Demand under Alternative Price Structures. Journal of Environmental Economics and Management, 2007, 54(2):181