Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2015, 7(3):502-505

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Comprehensive evaluation of water environment carrying capacity in Suzhou City, China

Zhang Yong* and Wang Si-wei

School of Environment and Geomatics Engineering, Suzhou University, Suzhou, Anhui Province, China

---

ABSTRACT

This paper selects 11 indicators to establish water environmental carrying capacity model of Suzhou City, China. Based on the analysis of the value change trend of water environment carrying capacity in Suzhou City from 2003 to 2010,it shows that the ecological carrying capacity of water environment rise sharply which the value is 0.30 to 0.67 and the carrying capacity level is in the general level. Population carrying capacity of water environment and economy carrying capacity of Water environmental increase slowly that carrying capacity values are 0.22 to 0.35, 0.56 to 0.75.The overall level of water environmental carrying capacity is low and the upward trend is slowly rising that carrying capacity value is 0.22 to 0.32.It indicates that the water environment of Suzhou City is relatively fragile.

Key words: economic development system; social governance system; SBM model; network effect

---

INTRODUCTION

In 21st Century, the main problem of the world water resources management is how to ensure the sustainable use of water resources, the water environment carrying capacity is an important index to measure the ability of sustainable development of region [1,2]. Coordinating the relationship between water environment and social economy development is the key to solve the problem of water environment [3]. Studying on water environmental carrying capacity is the organic combination of the two that can determine the maximum size of the sustainable development of population, economy and society which the water environment system can continue to support.

The water environment includes not only the quantity and quality of water resources, but also the interaction causing aquatic and water resources [4].The quality of water environment directly affects the survival and development of mankind, the water environment carrying capacity is natural combination of carrying capacity and water environment field. Its connotation is the largest sustainable development of the number of population, ecological water, economy and society in a particular time, a particular technology and the level of social and economic development conditions. And the environmental quality objectives must request, a river basin (regional) of water environment system is in good health [5].

In essence, the water environment carrying capacity is an objective property characterization of water environment system which is determined by the system structure. It is the water environmental system of material input and output，energy exchange with the outside world, the ability of information feedback and the performance of self-regulation. It reflects the water environment and human social economic development activities contact[6]. Water environment carrying capacity is limited. When human activities beyond this limit, qualitative changes have taken place in the structure and function of the water environmental system, thereby affecting the survival and development of human beings[7].

Suzhou City is an important city in huang-huai-hai plain of China thatlack of water resource and the water pollution problem is serious. This paper analysis the dynamic change of the water environment carrying capacity to ensure the situation and change tendency in Suzhou City, so as to realize the coordinated sustainable development of social economy and water environment.

EXPERIMENTAL SECTION

EFFICIENCY EVALUATION METHOD BASED ON SBM MODEL

1. The situation of studyarea

Suzhou City is located in the southern tip of huang-huai-hai plain of China, is an important part of the southern margin of the Huaibei plain. It is located in the southern margin of the warm temperate zone, the average annual rainfall is between 774 to 895.6mm, more than 70% natural precipitation resources is concentrated in the summer by rainstorm, the rainfall rate of change is big. Its area is 9787km2; the total water resource is 3.48billion m3 that account for 26% of the total water resources in Anhui Province. The amount of water resources per capita is 602m3, which belongs to the area of serious water shortage. Water resource shortage has already become the important restriction factors of Suzhou's economic development and social progress. Therefore, Suzhou's social and economic development must be compatible with the water environment carrying capacity.

2. The Comprehensive evaluation model of water environmental carrying capacity

The index of water environment carrying capacity plays an important role in the values .The index should include social, economic and the condition of water pollution, and these indicators can be measured. Water environment carrying capacity should include three components of the ecological carrying capacity of water environment, population carrying capacity of water environment and economy carrying capacity of water environment, and each item contains a number of sub-indexes of carrying capacity.

According to the principle of index selection, and combined with the research results of relevant scholars, 11 indicators are selected from the 3 levels of ecological, population and economy, and an index system including 3 layers structure is constructed. The target layer is water environment carrying capacity. The second criterion layer is the ecological carrying capacity, population carrying capacity and economy carrying capacity. The third index layer includes 11 indicators such as dilution ratio of water, per capita GDP and the Engel coefficient of city. The specific index is in Table 1.

Index of carrying water environment model is logarithmic function [8].The equation is below:
$y = a + b\lg x$ (1)

The parameters and b is determined by accounting standards on basis of the evaluation index of water environment carrying capacity.

According to the Chinese released the "National People's well-off living standard", referring to the recent condition of social population and economic development and the opinions of relevant experts, the accounting standard of the water environment carrying capacity evaluation index is final determined.The details data are shown in Table 1 and Table 2.

Table .1 Evaluation of water environment carrying capacity of the accounting standards

The target layer	The criterion layer	The index layer	The worst value	The pass value	The optimal value
			(0)	(60)	(100)
Water environment carrying capacity	The ecological carrying capacity	Dilution ratio (%)	100	4	
		The utilization of water resources (%)		40	10
		The water resources supply and demand ratio (%)	60	100	
	Population carrying capacity	Per capita GDP（yuan）	2200	24000	
		Average per capita water resources (m^3)	100	1700	
		Urbanizationlevel (%)	31	55	
	Economy carrying capacity	Attainment rate of the industrial waste water treatment (%)	30		100
		Industrial water recycle rate (%)	30		100
		Rural per capita net income (yuan)	1200	3500	
		The Engel coefficient of city (%)		40	20
		Urban sewage treatment (%)	10		100

Table.2 Indexes of carrying water environment model

Index	Model
Dilution ratio (%)	y = - 0. 4292 lgx + 1.16
The utilization of water resources (%)	y = - 0. 6644 lgx + 0. 3356
The water resources supply and demand ratio (%)	y = 2. 7045 lgx + 0. 6
Per capita GDP（yuan）	y = 0. 4827 lgx - 1. 1107
Average per capita water resources (m^3)	y = 0. 4876 lgx - 0. 9753
Urbanizationlevel (%)	y = 2. 4096 lgx + 1. 2256
Attainment rate of the industrial waste water treatment (%)	y = 1. 9125 lgx + 1
Industrial water recycle rate (%)	y = 1. 9125 lgx + 1
Rural per capita net income (yuan)	y = 1. 5078 lgx - 4. 6427
The Engel coefficient of city (%)	y = - 1. 3288 lgx + 0. 0712
Urban sewage treatment (%)	y = 1. 4307 lgx + 1

Water environment carrying capacity model is equation (2)[9].

$$E = \sum W_i \cdot E_i \quad (2)$$

Which E is divided value of the water environment carrying capacity; Ei is the i index; Wi is the the weight of the i index.
The calculation model for the total water environment carrying capacity is equation (3).

$$|E| = \left(\sum (W_i \cdot E_i)^2\right)^{1/2} \quad (3)$$

Which $|E|$ is the value of the total water environment carrying capacity.

RESULTS AND DISCUSSION

According to the relevant statistical data in Suzhou City during 2003-2010,water environment carrying capacity index values is obtained (Seen in Table 3).Then according to the index calculating model, The each index value of water environment carrying capacity is calculated and the results is in Table 4.

Table.3 Indexes of the water environment carrying capacity from 2003 to 2010

Index	2003	2004	2005	2006	2007	2008	2009	2010
Dilution ratio (%)	0.32	0.32	0.33	0.32	0.31	0.32	0.32	0.32
The utilization of water resources (%)	0.80	0.84	0.79	0.49	0.59	0.57	0.58	0.58
The water resources supply and demand ratio (%)	90	80	82	76	75	70	68	68
Per capita GDP（yuan）	1050	1226.1	1821.7	2115	2606	3597	4298	5202
Average per capita water resources (m^3)	502.3	501.15	505.88	604.4	603.4	605.1	604.16	604
Urbanizationlevel(%)	0.50	0.51	0.51	0.51	0.51	0.51	0.51	0.51
Attainment rate of the industrial waste water treatment (%)	0.59	0.84	0.84	0.81	0.85	0.89	0.87	0.88
Industrial water recycle rate (%)	0.65	0.66	0.67	0.63	0.64	0.66	0.65	0.66
Rural per capita net income (yuan)	2539	2561	2822	3169	4005	4308	4631	5308
The Engel coefficient of city(%)	0.44	0.40	0.41	0.36	0.41	0.40	0.41	0.41
Urban sewage treatment (%)	0.42	0.41	0.43	0.43	0.43	0.42	0.43	0.43

Table.4 The index degrees of water environment carrying capacity

Index	2003	2004	2005	2006	2007	2008	2009	2010
Dilution ratio (%)	0.38	0.27	0.37	0.24	0.33	0.24	0.15	0.22
The utilization of water resources (%)	0.29	0.15	0.28	0.12	0.22	0.15	0.08	0.26
The water resources supply and demand ratio (%)	0.17	0.20	0.13	0.21	0.24	0.26	0.18	0.18
Per capita GDP（yuan）	0.35	0.38	0.46	0.49	0.54	0.61	0.64	0.68
Average per capita water resources (m^3)	0.12	0.11	0.12	0.21	0.21	0.21	0.21	0.21
Urbanizationlevel(%)	0.51	0.52	0.53	0.53	0.52	0.53	0.53	0.54
Attainment rate of the industrial waste water treatment (%)	0.56	0.85	0.85	0.82	0.81	0.90	0.88	0.94
Industrial water recycle rate (%)	0.64	0.65	0.66	0.62	0.63	0.65	0.66	0.66
Rural per capita net income (yuan)	0.49	0.50	0.56	0.64	0.79	0.88	0.97	1.07
The Engel coefficient of city (%)	0.54	0.60	0.58	0.66	0.59	0.60	0.63	0.63
Urban sewage treatment (%)	0.46	0.45	0.48	0.48	0.47	0.46	0.47	0.48

According to the carrying capacity calculation model (The Equation (2)) and comprehensive evaluation model of water environment carrying (The Equation(3)),the each branch value and total value of water environmental carrying capacity are calculated from 2003 to 2010,the results is in Table 5.

There are larger differences changes between in 3 branch carrying capacity. The economic carrying capacity values steadily increase, rising from 0.56 in 2003 to 0.75 in 2010. This indicates that the economy of Suzhou City has a rapid development. The ecological carrying capacity values rise from 0.30 in 2003 to 0.67 in 2010 that show a significant upward trend and growth range is bigger. This shows that the ecological protection in Suzhou city has achieved excellent results. The population carrying capacity values is the trend of steadily, but the amplitude of variation is not obvious, so in the future, we must try our best to improve this work to the increase in per capita GDP value and improve the level of city.

Water environment carrying capacity value is among 0-1, the index is closer to 1, and the carrying capacity is stronger. According to the value of water environmental carrying capacity, the water environment carrying capacity degree can be divided into 4 levels. It is worse (0-0.2), bad (0.2-0.5), general (0.5-0.8) and good (0.8-1). As shown in Figure 1,the water environment carrying capacity value is 0.22 to 0.34 that the degree is in bad level during 2003 to 2010.So the water environment status is relatively fragile. The overall level of water environmental carrying capacity is low and has no obvious change, but the overall trend is mainly to rising.

Table.5The results of water environment carrying capacity in Suzhou City

Carrying capacity	2003	2004	2005	2006	2007	2008	2009	2010
The ecological carrying capacity	0.30	0.37	0.35	0.43	0.46	0.45	0.58	0.67
Population carrying capacity	0.22	0.22	0.24	0.31	0.32	0.34	0.34	0.35
Economy carrying capacity	0.56	0.67	0.68	0.68	0.68	0.72	0.72	0.75
Water environment carrying capacity	0.22	0.26	0.27	0.28	0.31	0.32	0.34	0.32

CONCLUSION

In this paper the water environment carrying capacity in Suzhou City is calculated for the first time. From 2003 to 2010, theecological carrying capacity increase significantly, the carrying capacity value rise from 0.30 to 0.67 and the level is in the general level.

Population and economycarrying capacity have an little changes and increase slowly, the carrying value respectively is 0.22 to 0.35, 0.56 to 0.75.The overall water environmental carrying capacity is low, the change trend of values increase slowly that just from 0.22 to 0.32.It is in bad level and which indicates that the water environment in Suzhou city is relatively fragile.

The conclusions of this paper can be planted to provide basic data and technical guidance for water resources protection in Suzhou City, China.

Acknowledgments
This work was supported by the funds “The Suzhou University outstanding young talents project (2014XQNRL004)”, “The regional development center of Suzhou Universityproject (2014SZXTQP10)”and “AnhuiProvince University leading talent project (2014LJ01)”.

REFERENCES

[1] Pollard, Sharon; du Toit, Derick;*Water SA*, **2008**,34(6),671-680
[2] Leidel, M.; Niemann, S.; Hagemann, N.;*Environmental Earth Sciences*, **2012**, 65(5), 1415-1421
[3] Parker, Elissa;*Environmental Forum*,**2011**,28(1),55-62
[4] Henriksen, Hans JΦrgen; Refsgaard, Jens Christian; HΦjberg, Anker Lajer; Ferrand, Nils; Gijsbers, Peter; Scholten, Huub;*Water Resources Management*,**2009**,23(12),2539-2547
[5] Schulze, F. H.; Wolf, H.; Jansen, H. W.; Van der Veer, P.;*Water Science & Technology*, **2005**, 52(9), 21-27
[6] Laughlin, James; *WaterWo*rld,**2012**,28(5),4-16
[7] WANG Zhi-liang et al;*Journal of Anhui Agricultural Sciences*,**2010**,5(2),25-32
[8] L. H. Feng, C. F. Huang;*Water Resources Management*,**2008**,22(5),621-633
[9] Yonghua Zhu, Sam Drake, HaishenLü, Jun Xia;*Water Resources Management*, **2010**,24(6),1089-1105.