THE PRESENT SITUATION, TYPES AND CHANGES OF CHINA'S ENVIRONMENT

Ren Wangbing(任望兵)

Institute of Industrial Development, State Development Planning

Commision, Beijing 100055, P.R.China

Wu Wei(武 伟)

Institute of City & Regional Development, East China Normal University,

Shanghai 200062, P.R.China

Li Ailing(李爱玲)

Beijing General Hydrology Service, Beijing 100038, P.R.China

ABSTRACT: Based on development level of regional society and economy, the paper attempts to analyze the present situation, types and change of regional environment in China through the definition of four conceptions environmental pollution index (EPI), social and economic comprehensive index (SECI), ——environmental comprehensive index (ECI) and social, economic and environmental comprehensive index (SEECI) and some mathematical calculation, and draws some conclusions to be worth referring: 1). There exists close relation between economic development and environmental situation. With high-speed development of economy, the discharge of the three wastes in China has been increasing, but its environmental social and economic benefit has also been improved at the same time. 2) In the course of economic development, regional environment situation in China has continuously been changing, and there exists the difference of environmental quality between provinces, which is bigger than that of economic development level between them. 3) Except very few provinces, regional EPI in China has risen in varying degrees since the 1980s, which shows that the task for China to prevent environment from polluting is still arduous.

KEY WORDS: regional environment, present situation of environment, environmental types, environmental change

1 INTRODUCTION

Essentially, environmental problem is an economic problem. At present, various environmental problems which man are being confronted is a direct and indirect man-effected result. Meanwhile, environmental problems are closely related to social problems, especially rapid growth of population (Qu, 1994). So, when environmental problems for one region are analyzed, it is necessary to consider its social and economic development level.

2 THEORY AND METHOD

2.1 Several Basic Conceptions

2.1.1 Environmental comprehensive index(ECI)

ECI expresses the change of total environmental pollution in one region for a period, the value of which is the sum of normalized quantities of the three wastes (waste gas, waste water and industrial residue)and be calculated by equation(1).

$$X_i' = \frac{X_i - \bar{X}}{\bar{X}} \qquad (1)$$

where X_i' represents normalized value, X_i represents original date, and $\bar{X}$ represents the average of the date.

2.1.2 Social and economic comprehensive index (SECI)

SECI expresses total produced material wealth and population load in one region for a period, the value of which is the sum of normalized total population (RK) and gross domestic product(GDP) and be calculated by equation (1).

2.1.3 Social, economic and environmental comprehensive index (SEECI)

SEECI is used to express the comparison of ECI and SECI, the value of which is calculated by equation (2). The smaller SEECI for one region, the better its environmental effect when economy and society are developed; Otherwise the worse.

$$F = \frac{X_{fsh} + X_{fq} + X_{fzh}}{X_{rk} + X_{gdp}} \qquad (2)$$

where F represents SEECI, and X_{fsh}, X_{fq}, X_{fzh}, X_{rk}, X_{gdp} respectively represent the normalized value of waste water, waste gas, industrial residue, population and GDP.

2.1.4 Environmental pollution index (EPI)

EPI expresses the extent of environmental pollution resulted from creation of GDP and some quantities of population in one region, the value of which is calculated by equation (3). Thinking about the difference of pollution extent resulted from waste gas, waste water and industrial residue, the method of weighted mean is used. Weight is calculated by equation (4).

$$p = \frac{\frac{1}{2}\{FSH(R_{11} + R_{21}) + FQ(R_{12} + R_{22}) + FZH(R_{13} + R_{23})\}}{PK + GDP} \qquad (3)$$

$$R_{jk} = \frac{\sum_{i=1}^{n}(X_{ij} + \bar{X}_j)(X_{ki} + \bar{X}_k)}{\sqrt{\sum_{i=1}^{n}(X_{ij} + \bar{X}_j)^2 \sum_{i=1}^{n}(X_{ki} + \bar{X}_k)^2}} \qquad (4)$$

where FSH, FQ, FZH, RK, GDP respectively represent the quantity of waste water, waste gas, industrial residue, population and GDP, all of which are dealt with dimensionless unit; and R_{11}, R_{12}, R_{13}, R_{21}, R_{22}, R_{23} respectively represent correlative coefficient of the three waste discharge to RK and GDP. The value of them are calculated by equation (4) and be regarded as weight there. P represents EPI.

2.2 Study Method

The study is based on two prerequisites: 1) The discharge of the three waste decides environmental quality in one region; 2) The composition of RK and GDP represents social and economic development level in one region. In the light of above two prerequisites, environmental quality of one region will be analyzed and studied through calculating by equations (1), (2), (3) and (4).

3 THE COMPARISON OF ENVIRONMENTAL SITUATION BETWEEN CHINA'S VARIOUS REGIONS

The paper divided China into three types of region : (1)administrative division, includes 22 provinces, 5 autonomous regions and 3 municipalities(except Chongqing); (2) the three big zones, namely, eastern zone(including Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Guangxi and Hainan), central zone(including Heilongjiang, Jilin, Inner Mongolia, Shanxi, Henan, Hubei, Hunan, Anhui and Jiangxi) and western zone(including Xinjiang, Gansu, Qinghai, Ningxia, Shaanxi, Sichuan, Yunnan, Guizhou and Tibet); (3) seven areas, namely, Northeast, North China, Northwest, Central China, East China, South China and Southwest. On the base of analyzing their economic development level and population load, environmental situation of China's various

regions is studied by calculating six indexes: waste water discharge per capita(t/p), waste gas discharge per capita(10 000 m³/p), quantity of industrial residue per capita (t / p) , waste water discharge per 10 000 yuan RMB GDP(t), waste gas discharge per 10 000 yuan RMB GDP(10 000 m³), quantity of industrial per 10 000 yuan RMB GDP(t).

When environmental situation of administrative division is analyzed, it is found that compared to China's mean level, provinces (including autonomous regions and municipalities, the same bellow)with higher waste water discharge per capita are Beijing, Tianjin, Liaoning, Heilongjiang, Shanghai, Jiangsu, Zhejiang, Hubei, Guangdong and Guangxi, which are basically situated on eastern coastal region of China; those with higher waste gas discharge per capita are Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Shanghai, Jiangsu, Shandong, Guangdong, Gansu, Qinghai, Ningxia and Xinjiang. This is to say, except for very few provinces, Northeast, North China and West China all possess a higher waste gas discharge per capita, part of provinces in east China and very few provinces in south China also higher, but provinces in West China and Central China lower; and those with higher industrial residue produce are Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Shanghai, Jiangxi,· Shaanxi, Gansu and Ningxia, all of which are situated in Northeast, North China and Northwest. Analyzing regional relation between economic development and environmental quality, it is found that, compared to China's mean level, when 10 000 yuan (RMB) GDP is created, provinces with higher waste water discharge are Beijing, Liaoning, Shanghai, Anhui, Jiangxi, Hubei, Hunan, Guangxi, Sichuan, Tibet, Shaanxi, Gansu and Ningxia, which are evenly distributed in seven areas; those with higher waste gas discharge are Beijing, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Henan, Guizhou, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang, all of which are distributed in Northeast, North China and Northwest; those with bigger industrial residue discharge

are Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Anhui, Jiangxi, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai and Ningxia, all of which are distributed North China, Northeast, Northwest, Central China and Southwest. Industrial residue discharge in North China and South China is smaller than China's mean level. As for the three big zones, when it is measured in terms of the number of population in a zone, environmental quality of the east zone is worse than that of the central and the west zones, and worse than China's mean level; but when in terms of GDP, better. It shows that the east zone possesses better economically environmental benefit but worse population-loaded environmental benefit. Meanwhile, it is also found, economically environmental benefit of the central zone is worst and that of the west zone is the best.

When SEECI of the three big zones is calculated and analyzed, it is found that environmental loss due to the increase of population and economic development is the biggest in the east zone, and its SEECI is 1.65; despite the slowest development, environmental loss in the west zone is the smallest(its SEECI is 1.36); SEECI of the central zone is 1.46, and its environmental loss is middle.

4   DIVISION OF REGIONAL ENVIRONMENTAL TYPES

Synthetically evaluating their economic developmental level, population load and environmental pollution (Table 1), China's provinces can be divided into five types according to their environmental quality: a)better environmental area(SEECI<0.5): Xizang; b)inferior environmental pollution area(0.5< SEECI<1.0): Zhejiang, Fujian , Hainan; c)environmental pollution area(1.0<SEECI<1.5): Tianjin, Anhui, Shandong, Henan, Hunan, Guangdong, Guangxi, Sichuan, Guizhou, Yunnan, Shaanxi, Qinghai, Xinjiang; d)worse environmental area(1.5 <SEECI<2.0): Hebei, Jilin, Heilongjiang, Jiangxi, Hubei, Gansu; e) worst environmental area (SEECI>2.0): Beijing, Shanxi, Inner Mongolia,

Liaoning, Shanghai, Ningxia.

Table 1   Normalized value of the three wastes, population and
GDP and SEECI for every province, autonomous region or municipality

Region	Waste water	Waste gas	Industrial residue	Population	GDP	ECI	SECI	SEECI
Beijing	0.408	0.424	0.283	0.146	0.371	1.116	0.517	2.158
Tianjin	0.178	0.207	0.129	0.121	0.248	0.515	0.37	1.393
Hebei	0.504	1.015	1.508	0.83	0.735	3.027	1.565	1.935
Shanxi	0.263	0.754	1.005	0.396	0.292	2.022	0.688	2.941
Inner Mongolia	0.167	0.630	0.527	0.294	0.233	1.323	0.527	2.511
Liaoning	0.958	1.279	1.699	0.528	0.884	3.954	1.413	2.799
Jilin	0.309	0.581	0.421	0.334	0.332	1.312	0.666	1.97
Heilongjiang	0.548	0.729	0.760	0.477	0.554	2.037	1.031	1.976
Shanghai	0.864	0.625	0.313	0.176	0.675	1.802	0.851	2.117
Jiangsu	1.301	0.914	0.685	0.912	1.388	2.899	2.3	1.26
Zhejiang	0.710	0.479	0.239	0.558	0.913	1.428	1.47	0.971
Anhui	0.520	0.432	0.698	0.774	0.509	1.65	1.283	1.286
Fujian	0.400	0.263	0.184	0.413	0.577	0.846	0.99	0.855
Jiangxi	0.441	0.314	0.881	0.522	0.353	1.636	0.875	1.87
Shandong	0.628	1.193	1.071	1.126	1.325	2.892	2.451	1.18
Henan	0.677	0.792	0.597	1.173	0.752	2.066	1.925	1.073
Hubei	1.221	0.586	0.502	0.743	0.643	2.309	1.386	1.666
Hunan	0.729	0.450	0.47	0.825	0.58	1.65	1.405	1.174
Guangdong	1.431	0.914	0.368	0.869	1.451	2.712	2.32	1.169
Guangxi	0.624	0.326	0.334	0.584	0.425	1.285	1.009	1.274
Hainan	0.086	0.025	0.026	0.092	0.113	0.138	0.206	0.67
Sichuan	1.259	0.879	0.992	1.457	0.951	3.13	2.407	1.3
Guizhou	0.173	0.323	0.314	0.449	0.178	0.81	0.628	1.291
Yunnan	0.324	0.262	0.421	0.512	0.333	1.007	0.845	1.192
Tibet	0.018	0.002	–	0.031	0.016	0.02	0.046	0.438
Shaanxi	0.318	0.3	0.45	0.444	0.29	1.068	0.734	1.456
Gansu	0.195	0.330	0.341	0.309	0.155	0.866	0.463	1.868
Qinghai	0.041	0.064	0.055	0.062	0.047	0.16	0.109	1.472
Ningxia	0.054	0.138	0.101	0.065	0.046	0.294	0.111	2.638
Xinjiang	0.152	0.246	0.124	0.212	0.231	0.522	0.443	1.179
China	15.5	15.504	15.5	15.568	15.401	46.504	30.968	1.502

5   ENVIRONMENTAL CHANGE OF CHINA

5.1   The Change of the Social and Economic Benefit of China's Environment Since the 1980s

Since reform and opening, China's economy has kept about 9% high speed increase. But meanwhile, the discharge of the three wastes in China has also been increasing, and environmental pollution is becoming more and more serious. On the other hand, when longitudinally analyzing social and economic development of China, social and economic benefit of China's environment has been improved (Table 2). Though China's ECI has increased since the 1980s, its speed of rise is slower than that of SECI. So, listed EPI keeps decline. This is to say, though total discharge of the three wastes is becoming bigger and bigger, social and economic benefit of China's envir-

onment has been improving. With economic development, and the implement of "the two-fundamental turns" and sustainable development strategy (SPC & SSTC, 1994) during the Ninth-Five Year Plan to 2010, it is certain for China to invest more capital in environmental protection, and it is also certain that economic development in China will bring fewer and fewer environmental loss. So, fall speed of China's EPI can be accelerated in the future.

Table 2   The change of China's environmental situation since the 1980s

Year	ECI	SECI	EPI
1980	–	0.924	–
1981	–	0.941	–
1982	1.560	0.963	1.620
1983	1.641	0.987	1.664
1984	1.780	1.030	1.728
1985	1.952	1.082	1.803
1986	2.068	1.124	1.840
1987	2.062	1.178	1.751
1988	2.177	1.258	1.730
1989	2.168	1.316	1.648
1990	2.197	1.366	1.609
1991	2.310	1.447	1.596
1992	2.425	1.569	1.545
1993	2.457	1.756	1.399
1994	2.510	2.000	1.255

5.2   The Characteristics of Regional Environmental Change of China

With economic development, regional environmental situation also continuously changes. Analyzing its change process in some west major developed countries, the curve of environmental change is upper parabolic. That is to say, environment hasn't been almost polluted by man before a region is developed, and with the begin of regional development, environmental pollution brought by men becomes more and more serious, and then, with the progress of science and technology, the increase of material wealth and the urgency of environmental protection, environmental quality becomes better and better.

China is a developing country, at present the

most important task in China is to develop economy. At the same time, because of the differences of history, nature and economic development level , regional environmental change have their own characteristics (Table 3). Analyzing Table 3, except for few

Table 3   The change of China's regional environmental situation since the 1980s

Region	EPI in 1980	EPI in 1994	Change rate of EPI (%)
Beijing	1.16	1.52	31
Tianjin	0.734	0.975	32.9
Hebei	0.991	1.229	24
Shanxi	–	1.878	–
Inner Mongolia	0.958	1.655	72.8
Liaoning	2.139	1.904	– 11
Jilin	–	1.366	–
Heilongjiang	1.005	1.33	32.4
Shanghai	0.937	1.542	64.6
Jiangsu	0.678	0.898	32.5
Zhejiang	0.503	0.70941	
Anhui	0.649	0.855	31.7
Fujian	–	0.614	–
Jiangxi	0.89	1.233	38.6
Shandong	0.615	0.791	28.6
Henan	0.716	0.741	3.5
Hubei	0.785	1.201	53
Hunan	0.967	0.823	– 14.9
Guangdong	0.671	0.864	28.7
Guangxi	0.931	0.903	– 3
Hainan	–	0.491	–
Sichuan	0.832	0.9	8.2
Guizhou	0.807	0.86	6.6
Yunnan	–	0.794	–
Tibet	–	0.344	–
Shaanxi	0.724	0.97	33.9
Gansu	1.147	1.243	8.4
Qinghai	0.491	0.998	103.3
Ningxia	1.06	1.778	67.8
Xinjiang	0.434	0.829	90.9

Note: "–" represents deletion

provinces, regional EPI in China has risen in varying degrees, and when they are put in order of from big to small, provinces whose EPI increased by above 50% are Qinghai, Xinjiang, Inner Mongolia, Ningxia, Shanghai and Hubei. Provinces with increase of

smaller or negative EPI are Hunan, Liaoning, Guangxi, Henan, Guizhou, Sichuan and Gansu. The bigger EPI increases, the worse environmental social and economic benefit and the more serious environment deterioration. Otherwise, the smaller EPI increases, the better environmental social and economic benefit and environment is deteriorated slightly. It shows that the environmental social and economic benefit of those provinces has been improved when their EPI are negative.

6 CONCLUSION

There exists close relation between economic development and environmental situation. With high-speed development of economy, the discharge of the three wastes in China has been increasing, but its environmental social and economic benefit has been improved at the same time. In the course of economic development, regional environmental situation in China has continuously been changing, and there exists the difference of environmental quality between provinces, which is bigger than that of economic development level between them. Except for very few provinces, regional EPI in China has risen in varying degrees since the 1980s, which shows that the task for China to prevent environment from polluting is still arduous.

REFERENCES

Qu Geping, 1994. The situation of environment and resource in China and the way to deal with. *China Population*, *Resources and Environment*, 4(3):4 - 6. (in Chinese)

State Environmental Protection Administration (SEPA), 1988. *Environmental Statistics Data Collection* 1981 - 1985. Beijing: China Environment & Science Press, 1 - 80. (in Chinese)

State Planning Commission & State Scientific and Technological Commission, 1995. *China Environment Yearbook* - 1995. Beijing: China Environment & Science Press, 1 - 16. (in Chinese)

SPC & SSTC, 1994. *China's 21st Agenda*. Beijing: China Environment & Science Press, 1 - 60. (in Chinese)