Green GDP Accounting in Yellow River Delta

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Abstract The economic losses caused by water pollution, air pollution and noise pollution in the Yellow River Delta are estimated, and the green GDP is calculated. The results show that water pollution caused economic losses of about 541.5814 million yuan in the Yellow River Delta in 2010; particulate matter caused health risk economic losses of 163.1369 million yuan, and excess mortality economic losses of 33.4742 million yuan; noise pollution caused economic losses of 594.2768 million yuan. The total losses reach approximately 2705.198 million yuan, accounting for 0.97% of the total GDP. After subtracting the total losses from the total regional GDP (541.58 billion yuan), the revised green GDP is about 536.3127 billion yuan. Obviously, environmental pollution has a certain impact on the economic growth. The coordinated development of environment and economy can be achieved by adjusting the industrial structure, developing circular economy and so on.

Key words Yellow River Delta, Pollution losses, Green GDP, Accounting

1 Introduction

The current GDP does not exclude the economic losses arising from environmental pollution, degradation of natural resources, low education, mushrooming population, mismanagement and other factors, so it can not truly reflect the real total national wealth. To truly reflect the level of regional economic development, it is necessary to correct the existing GDP data and make accounting of its green GDP. By estimating the economic losses caused by water pollution, air pollution and noise pollution in Yellow River Delta in 2010, this paper recalculates the green GDP in this typical region, to reflect the true level of economic development in the region, and provide a reference for local authorities to adjust economic development model and achieve coordinated development of environment and economy.

2 Data sources and estimation methods

Table 1 shows the environmental and economic data and methods for estimating the economic losses due to water pollution, air pollution and noise pollution.

3 Results and discussions

3.1 Water pollution loss estimation According to the discharge amount of domestic sewage and industrial wastewater as well as COD and ammonia nitrogen emission in Yellow River Delta in 2009[1-2], we use concentration-value loss factor[3] to estimate the water pollution loss in Yellow River Delta, as shown in Table 2. From Table 2, it can be found that due to COD and ammonia nitrogen pollution, the total waste water value losses in 2009 reached 477.78497 million yuan (domestic sewage, 304.23712 million yuan; industrial wastewater, 173.54785 million yuan), having a certain impact on the regional economic development. According to the product of share of pollution losses in GDP in 2009 and GDP in 2010, the economic losses caused by water pollution in 2010 were estimated at about 541.5814 million yuan.

3.2 Air pollution loss estimation According to the population data and PM_{10} concentration in Yellow River Delta in 2010, we use Poisson regression and proportional hazards model[4-6], to estimate the health risk economic losses and excess mortality economic losses caused by PM_{10} pollution. The results are shown in Table 3, 4. In 2010, the health risk economic losses caused by respirable particulate matter (PM_{10}, reference concentration of 40 $\mu g/m^3$) in Yellow River Delta reached 163.1369 million yuan, and the excess mortality economic losses reached 33.4742 million yuan, a total of 196.6111 million yuan.

3.3 Noise pollution loss estimation By WTP method[7], we study the residents' willingness to pay for improving noise environment pollution in Binzhou City, and estimate the losses caused by noise pollution. We calculate the residents' willingness to pay in other regions by adjusting the income level. The ratio of per capita willingness to pay for the two regions is equal to the ratio of per capita annual income. Through questionnaires and statistical analysis, it is found that 71.3% of residents are willing to pay for improving environmental noise, an average of 3.64 yuan/(person · month). The population data about Yellow River Delta in 2010 are obtained from the relevant statistical yearbook, and the residents' willingness to pay in other regions is adjusted by the per capita GDP. The ratio of per capita willingness to pay for the two regions is equal to the ratio of per capita GDP. The pollution loss estimation results are shown in Table 5. The economic losses caused by noise pollution in Yellow River Delta reached 594.2768 million yuan in 2010.

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Table 1 The data and methods for estimating the environmental pollution losses

Category	The required data	Data sources	Estimation methods
Water pollution loss	Domestic sewage discharge amount Industrial wastewater discharge amount COD emissions Ammonia nitrogen emissions	*Shandong Statistical Yearbook* *Weifang Statistical Yearbook* *Dezhou Statistical Yearbook* *Zibo Statistical Yearbook* *Yantai Statistical Yearbook*	Concentration-value loss factor Restoration cost method
Air pollution loss	Population PM_{10} concentration Baseline mortality	*Shandong Statistical Yearbook* *China Health Statistics Yearbook*	Poisson regression and proportional hazards model
Noise pollution loss	Population data Per capita GDP	*Shandong Statistical Yearbook*	Contingent valuation method (CVM)

Table 2 The value losses caused by water pollution in Yellow River Delta Unit: 10^4 yuan

Regions	Value losses		
	Domestic sewage	Industrial wastewater	Total
Dongying City	8863.297	2641.998	11505.295
Binzhou City	10671.261	11477.239	22148.500
Hanting District	1101.177	640.543	1741.720
Shouguang City	2913.711	1205.218	4118.929
Changyi City	1818.031	44.210	1862.241
Leling City	371.004	397.823	768.827
Qingyun County	248.764	494.460	743.224
Laizhou City	3841.527	168.140	4009.667
Gaoqing County	594.940	285.154	880.094
Total	30423.712	17354.785	47778.497

Table 3 The health risk economic losses caused by PM_{10} in Yellow River Delta in 2010 Unit: 10^4 yuan

	Respiratory system disease	Cardiovascular disease	Acute bronchitis	Asthma	Outpatient clinic	Pediatric clinic	Total
Dongying City	843.60	2160.66	3.79	20.56	312.82	131.43	3472.86
Binzhou City	1525.92	3909.42	6.82	37.23	566.37	237.95	6283.70
Hanting District	137.87	353.00	0.62	3.36	51.07	21.46	567.38
Shouguang City	438.05	1121.62	1.98	10.67	162.28	68.18	1802.78
Changyi City	244.96	627.20	1.11	5.97	90.75	38.13	1008.10
Leling City	316.82	809.96	1.46	7.68	116.80	49.09	1301.82
Qingyun County	142.80	365.07	0.66	3.46	52.65	22.13	586.76
Laizhou City	144.60	374.21	0.55	3.64	55.41	23.24	601.65
Gaoqing County	167.59	428.46	0.77	4.06	61.79	25.97	688.64
Total							16313.69

Table 4 The excess mortality economic losses caused by PM_{10} in Yellow River Delta in 2010 Unit: 10^4 yuan

	Excess deaths				Excess mortality losses
	Respiratory system diseases	Heart disease	Cerebrovascular diseases	Total	
Dongying City	43	36	44	123	1431.77
Binzhou City	78	65	80	223	928.64
Hanting District	7	6	7	20	75.41
Shouguang City	22	19	23	64	289.70
Changyi City	12	10	13	35	138.74
Leling City	16	13	16	45	134.36
Qingyun County	7	6	7	20	59.72
Laizhou City	8	6	8	22	136.96
Gaoqing County	8	7	9	24	152.12
Total					3347.42

3.4 Green GDP accounting in Yellow River Delta For the economic losses caused by environmental pollution in Yellow River Delta, this paper mainly estimates the losses caused by water pollution, air pollution and noise pollution in 2010 (water pollution

loss of about 541.5814 million yuan; air pollution loss of about 1569.3401 million yuan; noise pollution loss of 594.2768 million yuan; total losses of 2705.198 million yuan). Due to the limited information, this paper does not consider the losses caused by solid waste pollution and radioactive pollution, and the estimated value is small, but it still provides a certain reference for understanding the impact of regional environmental pollution on economic development. In addition, the GDP correction in this paper is not overall correction, and it only estimates the value accounting part. By deducting environmental pollution losses from total GDP, we get a GDP value by the environmental correction, with certain reference value, and the specific accounting results are shown in Table 6, indicating that the environmental pollution losses have a great impact on the local GDP.

Table 5 The economic losses caused by noise pollution in Yellow River Delta Unit: 10^4 yuan

Regions	Total population//10^4	Level of payment//yuan/month · person	Economic losses
Dongying City	203.7	10.17	24871.36
Binzhou City	375.2	3.64	16388.74
Hanting District	32.7	2.99	1175.10
Shouguang City	103.9	2.99	3733.74
Changyi City	58.1	2.99	2087.87
Leling City	69.0	2.61	2160.98
Qingyun County	31.1	2.61	974.01
Laizhou City	85.9	5.44	5609.20
Gaoqing County	36.5	5.54	2426.68
Total			59427.68

Table 6 Green GDP accounting results in Yellow River Delta in 2010

Regions	GDP//10^8 yuan	Water pollution loss//10^4 yuan	Air pollution loss//10^4 yuan	Noise pollution loss//10^4 yuan	Total pollution losses//10^4 yuan	Share of pollution losses in GDP//%	Corrected GDP 10^8 yuan
Dongying City	2359.94	13041.5400	58829.76	24871.36	96742.66	0.41	2350.26600
Binzhou City	1551.52	25105.8900	123034.10	16388.74	164528.70	1.06	1535.06700
Hanting District	110.00	1974.2840	15477.87	1175.10	18627.25	1.69	108.13730
Shouguang City	416.70	4668.9110	88496.56	3733.74	96899.21	2.33	407.01010
Changyi City	201.20	2110.8970	26391.58	2087.87	30590.35	1.52	198.14100
Leling City	131.03	871.4849	37099.14	2160.98	40131.60	3.06	127.01680
Qingyun County	88.00	842.4633	12822.31	974.01	14638.78	1.66	86.53612
Laizhou City	455.41	4545.0590	15323.65	5609.20	25477.91	0.56	452.86220
Gaoqing County	102.00	997.6089	35668.64	2426.68	39092.93	3.83	98.09071
Total	5415.80	54158.1400	413143.70	59427.68	526729.50	0.97	5363.12700

4 Conclusions

In this paper, through the estimation and analysis, it can be found that due to COD and ammonia nitrogen pollution, the water pollution caused economic losses of about 541.5814 million yuan in the Yellow River Delta in 2010; particulate matter caused health risk economic losses of 163.1369 million yuan, and excess mortality economic losses of 33.4742 million yuan; noise pollution caused economic losses of 594.2768 million yuan. The total losses reach approximately 2705.198 million yuan, accounting for 0.97% of the total GDP. After subtracting the total losses from the total regional GDP (541.58 billion yuan), the revised green GDP is about 536.3127 billion yuan. Obviously, environmental pollution has a certain impact on the economic growth. It is necessary to consider the carrying capacity of the environment, and achieve the coordinated development of environment and economy by adjusting the industrial structure, developing circular economy and so on.

References

[1] Shandong Provincial Statistics Bureau. Shandong Statistical Yearbook (2009)[M]. Beijing: China Statistics Press,2010. (in Chinese).

[2] Weifang, Dezhou, Zibo, Yantai Statistics Bureau. Weifang, Dezhou, Zibo, Yantai Statistical Yearbook (2009)[M]. Beijing: China Statistics Press,2010. (in Chinese).

[3] JAMES LD. Water resources planning economics [M]. CHANG XH, *et al*. (Translator). Beijing: China Water & Power Press, 1984. (in Chinese).

[4] HONG XJ, KAN HD, CHEN BH. Methods of health risk assessment of urban air pollution [J]. Journal of Environment and Health,2005,22(1): 62 – 64. (in Chinese).

[5] XIE P, LIU XY, LIU ZR, *et al*. Exposure-response functions for health effects of ambient particulate matter pollution applicable for China [J]. China Environmental Science,2009,29(10):1034 – 1040. (in Chinese).

[6] JING LB, QIN Y, XU ZY. Relationship between air pollution and acute and chronic respiratory diseases in Benxi [J]. Journal of Environment and Health,2000,17(5):268 – 270. (in Chinese).

[7] XU YH, SHAN HG. The estimation of economic losses of environmental pollution in Dalian City [J]. Liaoning Urban and Rural Environmental Science & Technology,2001,21(5):38 – 41. (in Chinese).