A Study Report on China Environmental and Economic Accounting in 2004

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In order to set up and implement comprehensive, coordinated and sustainable concept of development, build an environmentally-friendly and resources efficient society of China, the research project of *Integrated Environmental and Economic Accounting (also called Green GDP Accounting) of China* was launched jointly by the State Environmental Protection Administration (SEPA) and the National Bureau of Statistics (NBS) in March, 2004. The survey and pilot work on environmental and economic accounting and environmental pollution cost evaluation were also conducted in ten provinces and municipalities of China in 2005. A leading group and consultant group was set up by SEPA and NBS. The technical team consisting of experts from Chinese Academy for Environmental Planning, Renmin University of China, Policy Research Center of Environment and Economy of SEPA and China National Environmental Monitoring Center was also set up to be in charge of establishment of environmental and economic accounting framework system, putting forward technical guideline for environmental and economic accounting, conducting environmentally-adjusted GDP accounting and providing guidance for local piloting survey and local environmental and economic accounting.

With nearly two-year arduous efforts, the technical team of the Project has made great achievements such as completion of *Framework for Chinese Green National Economic Accounting*, *Technical Guideline for the Integrated Environmental and Economic Accounting in China*, software platform of Chinese Environmental and Economy Accounting System and *The Report on the Integrated Environmental and Economic Accounting in China* and establishment of the technical methodology system of integrated environmental and economic accounting which had been applied into the national and local pilot environmental and economic accounting. Ultimately, *China Environmental and Economic Accounting Study Report 2004* was submitted by the technical team of the Project in September 2006[2]. The Report presented scientific physical accounting of water pollution, air pollution and solid waste pollution of different industrial sectors and 31 provinces and municipalities[3] in 2004. The related

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[2] This report in Chinese is called *China Green National Accounting Study Report 2004*, which was formally released to the public by SEPA and NSB on September 9, 2006.
[3] This accounting does not include Hong Kong, Macau and Taiwan. The Eastern Region includes Beijing and Tianjin (municipalities), Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan (provinces). The Central Region includes Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei and Hunan (provinces). The Western Region includes Inner Mongolia Autonomous Region, Guangxi Zhuang Autonomous Regions, Chongqing (municipality), Sichuan, Guizhou, Yunnan (provinces), Tibet Autonomous Region, Shannxi, Qinghai (provinces), Ningxia and Xinjiang Autonomous Regions.

imputed abatement costs and environmental pollution costs by adopting abatement cost approach and pollution damage cost approach of monetary accounting methods and the environmentally adjusted GDP were also calculated out.

1. Accounting Approaches and Its Scopes

On the basis of the *China Technical Guideline for Environmental and Economic Accounting*[4], *China Environmental and Economic Accounting Study Report 2004* are made up of three parts: i) Physical accounting of environmental pollution which means setting up accounts for physical quantification at different levels to describe generation amount, abatement amount and discharge amount of different pollutants corresponding to different economic activities by means of physical unit and can be concretely divided into physical accounts of water pollution, air pollution and solid waste pollution; ii) Monetary accounts of environmental pollution refers to making calculation on monetary value loss caused by various kinds of environmental pollution and ecological damage based on physical pollution accounts; iii) Calculation of environmentally adjusted GDP (also called EDP).

Physical accounting of environmental pollution is to make an integrated calculation on generation amount, abatement amount and discharge amount of main pollutants in proper use of computation methods based on environmental statistical data. Comparing with the available statistical data, the accounting data are more comprehensive which could reflect the main pollutants discharge situation of China in an all-round and objective way.

The imputed abatement cost, which refers to the cost to be expended for abatement of all the pollutants discharged into the environment in the light of current pollution control technologies, could be calculated out by using pollution abatement cost approach. The reason for applying pollution abatement cost approach in accounting of imputed abatement cost is that environmental degradation would not be caused if all the pollutants are controlled or treated very well. Therefore, economic value generated by the environmental degradation should be the cost spent for abatement of all the pollutants. Viewed from numerical value, the imputed abatement cost is the lowest limit of environmental degradation value.

The environmental degradation cost, which refers to different kinds of damages caused by environmental pollution such as effects on agricultural products yield, human health, ecological service function and etc., could be calculated out by using environmental pollution cost approach. Certain of value-measuring technique should be applied to evaluate economic loss caused by environmental pollution or damages. Comparing with the abatement cost approach, the cost valuation approach based on environmental damages, also called pollution cost, is more rational and could reflect damage caused by pollution.

The Integrated Environmental and Economic Accounting, also called “Green GDP”

[4] This guideline was developed by Chinese Academy for Environmental Planning in 2005, which was further revised by CAEP in 2006. In order to guide the piloting program of 10 provinces computable software was also developed by CAEP in 2006.

for short, is a system including accounting for resources and accounting for environment. The accounting mentioned in the *Report 2004* is not the Green GDP accounting in real sense, which just involves partial contents of environmental accounting without consideration of accounting for resources. In addition, the environmental accounting in this report is not complete and the missing items in the environmental accounting are as following: (1) The contents of accounting for environmental input and output, physical accounting and monetary accounting of ecological damage cost are absent in the report; (2)The scope of accounting for environmental pollution cost is quite extensive. Without the corresponding researches conducted on dose-response relationship and data support, many pollution cost items are not taken into consideration in the accounting such as number of patients suffering from infectious and digestive diseases caused by water pollution and costs for outpatient services, medical treatment in hospitals and loss of working time; cost for newly-established substitute water sources by water pollution[5]; loss caused by indoor air pollution; damage on human health caused by ozone; forest loss by air pollution; extra cleaning and labor cost by air dust; economic loss caused by noise, radiation and photo-thermal pollution; groundwater and soil contamination loss and etc.

2. Physical Accounts of Environmental Pollution

According to the calculation result of physical pollution accounting, the total amount of discharged wastewater is 60.72 billion tons across the country in 2004, the discharged amount of COD is 21.093 million tons, the discharged amount of ammonia nitrogen is 2.232 million tons; the total emission amounts of SO_2, soot, dust and nitrogen oxides are 24.502 million tons, 10.955 million tons, 9.051 million tons and 16.466 million tons respectively; the discharged amount of industrial solid wastes is 17.608 million tons while the deposit amount of household wastes 66.675 million tons.

2.1 Physical accounts of water pollution

i. The discharge amount of wastewater from the secondary industry ranks first and the urban wastewater from households and public sectors and wastewater from agricultural non-point source have become the main sources of water pollutants.

The discharge amount of wastewater from the secondary industry reaches 22.11 billion tons, accounting for 36.4% of the total amount of the discharged wastewater in 2004. The discharge amounts of COD from the urban wastewater of households and public sectors and the primary industry account for 39.3% and 36.6% of the total amount of discharged wastewater while the discharge amounts of nitrogen oxides from that account for 40.7% and 36.1% of the total amount of discharged wastewater respectively.

ii. Water pollutants discharged from different industrial sectors vary

[5] The nearby water source is too polluted to be supplied to water plants and the new hydraulic engineering has to be built to draw water from father surface water or extract groundwater.

greatly and it is still an arduous task to achieve water pollution control in the key industries with heavy pollution such as paper-making, chemical, metallurgy, petroleum and coking industries.

In 2004, the chemical and paper-making industries are ranking the first and the second place both in the wastewater discharge amount and wastewater discharge amount violating the set national standard among all the industrial sectors, sums of which have accounted for 33.3% of the total amount of discharged wastewater and 40.4% of the total wastewater discharge amount violating the set national standard in China. The following industries with the discharge amount of wastewater ranking from the third to the sixth place were power, ferrous metallurgy, textile and food processing industries in turn.

2.2 Physical accounts of air pollution

i. Air pollutants emission is mainly from the secondary industry

The amount of SO_2 emission from the secondary industry is 21.856 million tons, accounting for 89.2% of the total amount of SO_2 emission in China, while that from primary industry and tertiary industry and urban household sources account for 6.3% and 4.5% of the total amount of SO_2 emission respectively. The emission amounts of soot and NOx from the secondary industry account for 81.8% of the total emission amount of soot and 80.0% of the total amount of NOx across the country.

ii. Power industry is the main industry of air pollution control

In 2004, the amount of SO_2 emission from industrial sources is 21.732 million tons, among which 63.3% of SO_2 emission is from power industry. About 86.6% of SO_2 emission generated in the combustion process is from power industry, which is absolutely an important producer of SO_2 emission. The total amount of soot emission from industrial sources is 8.866 million tons, among which the soot emission amount from power industry and nonmetallic manufacturing industry reach 5.59 million tons accounting for 87.5% of total amount of soot emission. The total amount of NOx emission from industrial sources is 13.093 million tons, which is mainly generated from power industry and ferrous metallurgy industry.

iii. Air pollution control is a hard task in the central and eastern region of China

In 2004, Shandong, Hebei and Shanxi are three provinces with the most SO_2 emission amounts, which are all located in the central and eastern region of China. But the SO_2 abatement rates of these three provinces are lower than the average level of China. Therefore, it is a very hard task to control air pollution in the central and eastern region of China. In addition, most of provinces with the most industrial soot emission are in the central region of China such as Shanxi, Sichuan and Henan. Hunan, Hebei and Henan are five provinces with the most industrial dust emission in 2004, whose abatement rate are also lower than the average abatement rate of China.

2.3 Physical accounts of solid waste

i. Industrial solid wastes are mainly generated from five industrial sectors and the eastern region of China is of greater generation amount of solid waste

In 2004, 1.19 billion tons of industrial solid wastes are generated across the country and the reused amount of industrial solid wastes total 674 million tons, among which 652 million tons is generated in 2004, and the disposal amount is 264 million tons, resulting in an integrated disposal and utilization rate of 78.8%. The top five industries with the most generation amount of solid wastes are power industry, ferrous metallurgy, coal mining, ferrous and non-ferrous metal mining industry. The generation amount of solid wastes from these five industries reached 76.9% of the total generation amount of that in 2004. The generation amount of industrial solid wastes in the eastern region is higher than that of other regions of China.

ii. Generation, disposal and utilization of hazardous wastes differ greatly in different industrial sectors and regions

The amount of hazardous wastes generated is 9.94 million tons across the country in 2004 and the reused amount of hazardous wastes reach 4.04 million tons, among which 3.79 million tons is generated in 2004, and disposal amount of hazardous wastes is 2.752 million tons, resulting in an average integrated disposal and utilization rate of 68.3%. The top five industries with the most generation amount of hazardous wastes are chemical industry, non-ferrous metal mining industry, non-metal mining, petroleum and coking industry and nonferrous metallurgy industry. The generation amount of hazardous wastes from these five industries account for 83.6% of the total generation amount of that in 2004. The disposal rate and utilization rate of hazardous wastes of the chemical and petroleum and coking industries are relatively higher, which are 90.9% and 98.5% respectively. The top five provinces with the most generation amounts of hazardous wastes are Guizhou, Guangxi, Jiangsu, Shandong and Qinghai. In Guizhou province, the disposal and utilization rate of hazardous wastes is 85.3% while that in Qinghai Province is only 0.22%.

iii. Environmentally-sound disposal rate of household wastes still need improvement.

The total amount of urban household wastes generated is 191 million tons across the country in 2004 with the disposal rate of 65.3% while the average environmentally-sound disposal rate of 42.0%. Among all the provincial administrative regions, Guangdong, Shandong, Jiangsu, Hubei and Heilongjiang are of the most generation amount of urban household wastes, sum of which has accounted for 36.7% of the total generation amount of that in China. The environmentally- sound disposal rate of 95.4% in Qinghai Province is the highest across the country. The following provinces or municipalities are Beijing, Zhejiang, and Shandong, of which the environmentally-sound disposal rate has reached up to above 60%. In Tibet, Shanxi and Anhui, the environmentally-sound disposal rates for household wastes are lower than 20%. Therefore, the environmentally- sound disposal rate of household wastes in China still remains to be improved.

3. Imputed Abatement Cost

3.1 Abatement cost for water pollution

In 2004, the gross domestic product of all the industries (by production approach) amount to 15987.8 billion yuan in China. The actual abatement cost for wastewater across the country is 34.44 billion yuan, accounting for 0.22% of the GDP while the imputed abatement cost for wastewater is 180.87 billion yuan, accounting for 1.13% of the GDP in China. It can be concluded that the imputed abatement cost for wastewater is 5 times as much as the actual abatement cost.

i. The costs for water pollution control of the secondary industry and paper-making, food processing and chemical industries are relatively higher

The actual abatement cost for industrial wastewater account for 74.2% of the total actual abatement cost while the imputed abatement cost for industrial wastewater account for 55.5% of the total imputed abatement cost. Among 39 industrial sectors, ferrous metallurgy, chemical, paper-making, petroleum and coking, and textile industries are ranking from the first to the fifth place with the most actual abatement cost for wastewater, of which total 14.55 billion yuan accounting for 57% of the total actual abatement cost of all the industries; while paper-making, food processing, chemical, textile and pharmacy industries are ranking the first five places with the most imputed abatement cost, sum of which accounts for 70.1% of the total imputed abatement cost. Therefore, paper-making, food processing, chemical and textile industries are ranking the first four places in total abatement cost for wastewater.

ii. The actual abatement cost for wastewater is the highest in the eastern region of China while actual inputs in the central and western regions are insufficient.

In 2004, the actual abatement cost for wastewater is the highest in the eastern region of China, which reaches 21.28 billion yuan, accounting for 61.8% of the total actual abatement cost and equivalent to 1.6 times that the sum of that in the central and western region. The imputed abatement cost for wastewater is also the highest in the eastern region, which is 68.75 billion yuan, accounting for 38.0% of the total imputed abatement cost while that in the central and western regions are 56.66 billion yuan and 55.46 billion yuan respectively. Therefore, as the whole, the actual inputs for wastewater abatement in the central and western region are relatively insufficient.

3.2 Abatement cost for air pollution

In 2004, the actual abatement cost for air pollutants across the country is 47.82 billion yuan, accounting for 0.29% of the GDP of all the industries at that year. While the imputed abatement cost for air pollutants is 92.23 billion yuan, accounting for 0.55% of the GDP in China. In conclusion, the imputed abatement cost for air pollutantion is 1.93 times as much as the actual abatement cost.

i. The imputed abatement cost of air pollutants from industrial sources is relatively higher and power industry is the pivot of industrial air pollution control.

The imputed abatement costs are generally higher than the actual abatement costs in almost all the industries, which show that great gaps still exist in air pollution prevention and control. In 2004, the total abatement cost for air pollution control from industrial sources reach up to 88.29 billion yuan, among which abatement cost for air pollutants from power industry is 55.14 billion yuan accounting for 62.5% of the total abatement cost. It is clear that coal power industry is the pivot of industrial air pollution control.

ii. The actual input for air pollution control in the eastern region of China is the highest and the task of air pollution control in this region is also the most arduous.

The total abatement cost for air pollution reaches 140 billion yuan across the country in 2004 while that in the eastern region is 64.92 billion yuan, accounting for 1/2 of the total abatement cost. The imputed abatement cost across the country totals 92.23 billion yuan, accounting for 65.9% of the total abatement cost. Among of that, the imputed abatement cost for air pollution in the eastern region is the highest, amounting to 39.82 billion yuan while that in the central and western regions are almost the same, and both accounting for 28.4% of the total imputed abatement cost. The actual abatement cost in the eastern region accounts for 38.7% of the total abatement cost and actual abatement input in this region is also the highest in China.

3.3 Abatement cost for solid wastes

In 2004, the actual abatement cost for solid wastes across the country is 18.28 billion yuan, accounting for 0.11% of the GDP of all the industries at that year. While the imputed abatement cost for solid waste is 14.35 billion yuan, accounting for 0.09% of the GDP in China. In conclusion, the imputed abatement cost for solid waste is 0.79 times as much as the actual abatement cost.

The actual abatement cost for industrial solid wastes is 11.13 billion yuan across the country in 2004, accounting for 52.7% of the total abatement cost for solid wastes while the imputed abatement cost for industrial solid wastes is 9.99 billion yuan, accounting for 47.3% of that in China. The actual abatement cost for urban household wastes is 7.15 billion yuan, accounting for 62.1% of the total abatement cost while the imputed abatement cost for urban household wastes is 4.36 billion yuan, accounting for 37.9% of the total.

The total abatement cost for solid wastes in the western region of China is the highest in 2004, among of which its actual abatement cost only accounts for 41.4%, far lower than 67.3% of the eastern region and 62.7% of the central region. The major difference between the western region and the other two regions lies in the industrial solid wastes disposal. Due to the large-scale exploitation of mines and natural resources in the western region, its total abatement cost for industrial solid wastes equals with sum of that in the other two regions, and its imputed abatement cost

accounts for 61.9% of the total imputed abatement cost for industrial solid wastes. Hence, it is required to increase disposal input for industrial solid wastes in the western region of China.

3.4 Integrated analysis on imputed abatement cost

i. The input for environmental pollution control is insufficient seriously and great input gap still exist in waste water pollution prevention and control

According to the calculation result, the actual abatement cost and imputed abatement for environmental pollution total up to 387.98 billion yuan while the actual abatement cost accounts for 26% of the total abatement cost. It is shown that the input for environmental pollution control is insufficient seriously. Among of that, the total abatement costs for water pollution, air pollution and solid wastes are 215.3 billion yuan, 140.04 billion yuan and 32.63 billion yuan respectively, accounting for 55.5%, 36.1% and 8.4% of total abatement cost for environmental pollution.

In 2004, the actual abatement cost for environmental pollution reaches 100.53 billion yuan, among which actual abatement costs for water pollution, air pollution and solid wastes pollution are 34.44 billion yuan, 47.82 billion yuan and 18.27 billion yuan respectively, accounting for 34.3%, 47.6% and 18.2% of the total actual abatement cost; while the imputed abatement cost for environmental pollution totals up to 287.44 billion yuan, among which imputed abatement costs for water pollution, air pollution and solid wastes pollution are 180.87 billion yuan, 92.23 billion yuan and 14.35 billion yuan respectively, accounting for 62.9%, 32.1% and 5.0% of the total imputed abatement cost. The imputed abatement cost for water pollution accounts for 84.0% of the total abatement cost for water pollution, 5.3 times that its actual abatement cost. In conclusion, greatest input gap exists in the water pollution control comparing with air pollution and solid waste control.

ii. The task of pollution control for secondary industry is arduous and environmental input for urban wastewater pollution control has to be improved urgently

The calculation result shows that the imputed abatement cost for pollution of secondary industry is 179.03 billion yuan, 2.9 times that the actual abatement cost, among which the input of 100.37 billion yuan is required for industrial wastewater pollution control, accounting for 56.1% of the total imputed abatement cost for the second industry while the input for the industrial air pollution control is relative lower only accounting for 38.4% of the total imputed abatement cost, but its absolute amount is quite big reaching up to 68.67 billion yuan. Comparing with urban air pollution control, the disposal capacity for urban household wastewater in China still lags behind. At present, the actual abatement cost for urban household wastewater is 4.76 billion yuan accounting for 47.1% of the actual abatement cost for air pollutants. Therefore, environmental input for urban household wastewater pollution control has to be improved urgently.

iii. Stresses of industrial pollution control vary in different industrial

sectors and great gap exists in environmental inputs for industrial pollution control

In 2004, power industry is of the highest abatement cost of 59.35 billion yuan among 39 different industrial sectors, which also ranks first in the actual abatement cost list and imputed abatement cost list of industries. Paper-making, chemical, ferrous metallurgy industry and food processing industries are ranking from the second to the fifth place in the list of total abatement cost. The ranking of the above-mentioned four industries in the list of imputed abatement cost are basically same with that of total abatement cost, which shows that pollution control level of these four industries is relatively low and they require greater environmental input for pollution control.

iv. The inputs for pollution control in the central and western regions are severely insufficient and input for the eastern region should still be increased.

The eastern region of China is of dense population, high industrialization level and rapid economic growth, so its environmental pollution is also more severe. In 2004, the actual abatement cost for the eastern region is 54.51 billion yuan, accounting for 54.2% of the total actual abatement cost across the country. While the imputed abatement cost for the eastern region amounts to 112.55 billion yuan, 2 times that its actual abatement cost. It shows that the input for the pollution control in the eastern region should still be increased. The situation in the central and western regions is much worse. The imputed abatement costs in the central and western regions account for 77.0% and 81.4% of their respective total abatement costs. The actual abatement costs and imputed abatement costs in the eastern, central and western regions are as shown in Figure 1.

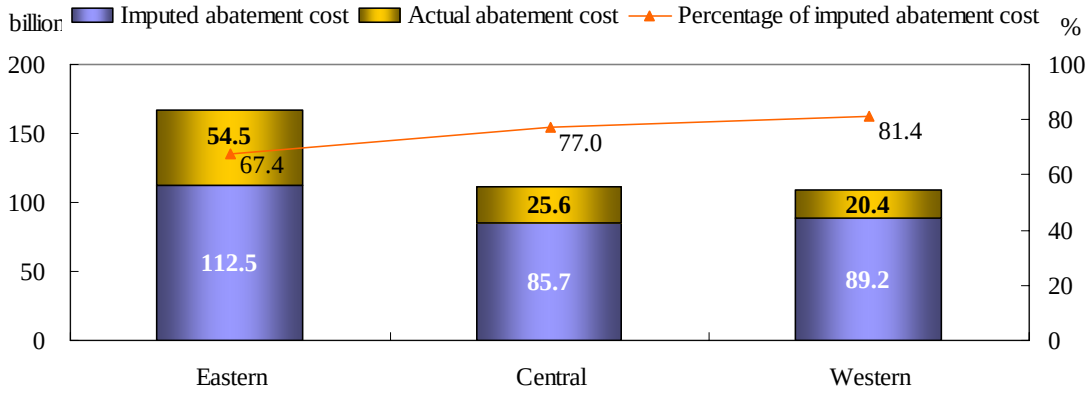

Fig. 1 Actual abatement costs and imputed abatement cost in three regions

4. Environmental Degradation Cost

4.1 Environmental degradation cost by water pollution

The environmental degradation cost caused by water pollution is 286.28 billion yuan in 2004, accounting for 55.9% of the total environmental degradation cost and 1.71%

of the GDP of all the provinces and municipalities at that year, among which damage cost of human health in rural areas by water pollution reach 17.86 billion yuan, economic loss of water shortage caused by water contamination is 147.83 billion yuan, additional abatement cost for industrial water use is 46.26 billion yuan, economic loss of agricultural yield decrease by water pollution is 46.84 billion yuan, and additional abatement and prevention cost for urban household water is 27.49 billion yuan.

In 2004, water environmental degradation cost in the eastern region of China amounts to 151.77 billion yuan, which is the highest among the three regions and accounts for 53.0% of the total environmental degradation cost by water pollution and 1.5% of the GDP in the eastern region. The water environmental degradation costs in the central and western regions are 77.75 billion yuan and 56.75 billion yuan, accounting for 27.2% and 19.8% of the total water degradation cost respectively, but their percentages in the local GDP are near 2.0%, higher than that in the eastern region.

4.2 Environmental degradation cost by air pollution

The environmental degradation cost caused by air pollution is 219.8 billion yuan in 2004, accounting for 42.9% of the total environmental degradation cost and 1.31% of the GDP of all the provinces and municipalities at that year, among which damage cost of human health in urban areas by air pollution reach 152.74 billion yuan, economic loss of crops reduction caused by air pollution is 53.78 billion yuan, and material loss by air pollution is 13.28 billion yuan.

In 2004, the environmental degradation cost by air pollution in the eastern region is the highest, which reaches 131.16 billion yuan and accounts for 60.0% of the total atmospheric environmental degradation cost while that in the central and western regions amount to 54.16 billion yuan and 34.47 billion yuan, accounting for 24.6% and 15.7% of the total atmospheric environmental degradation cost. The percentages of air environmental degradation cost in local GDP are 1.4%, 1.3% and 1.2% respectively in the central, eastern and western regions.

4.3 Environmental degradation cost by solid waste pollution

In 2004, the deposit amount of industrial solid wastes amounts to 17.62 million tons across the country, approximately occupying the land of 6.177 million square meters, resulting in the opportunity cost for land loss of 91 million yuan. At the same time, the deposit amount of urban household solid wastes amounts to 66.675 million tons while that of rural household solid wastes to 64.58 million tons across the country in 2004, sum of which occupied the land of 35.769 million square meters, leading to the opportunity cost for land loss of 556 million yuan. To total up, the environmental degradation cost caused by solid waste pollution amounts to 650 million yuan across the country in 2004, accounting for 0.1% of the total environmental degradation cost and 0.004% of the GDP of all the provinces at that year.

In 2004, the eastern region is of the highest environmental degradation cost by solid

wastes, which amounts to 248 million yuan; the next is the central region with 213 million yuan of degradation cost by solid wastes; the western region is of the lowest, which reaches 186 million yuan. The environmental degradation costs caused by solid wastes in the eastern, central and western regions account for 38.3%, 33.0% and 28.8% of the total degradation cost by solid wastes respectively.

4.4 Environmental degradation cost caused by pollution accidents

There are altogether 1441 environmental pollution accidents taken place in China in 2004 with direct economic losses over 333 million yuan. In accordance with the *China Fishery Ecological Environmental Condition Bulletin* 2004, 1020 fishery pollution accidents occurred in China in 2004 causing direct economic losses of 1.08 billion yuan while economic losses of natural fishery resources by environmental pollution amount to 3.65 billion yuan. Therefore, the environmental degradation cost caused by pollution accidents total up to 5.09 billion yuan accounting for 1.1% of the total environmental degradation cost and 0.03% of the GDP of all the provinces at that year.

4.5 Integrated analysis on environmental degradation cost

i. Analysis on total amount of environmental degradation cost

The total environmental degradation cost in 2004 calculated by pollution cost approach is 511.82 billion yuan, accounting for 3.05% of the GDP of all the provinces at that year, among which the environmental degradation cost caused by air pollution, water pollution, depositing solid waste and pollution accidents are 219.8 billion yuan, 286.28 billion yuan, 650 million yuan, 5.09 billion yuan, accounting for 42.9%, 55.9%, 0.1% and 1.1% of the total degradation cost respectively.

ii. Analysis on environmental degradation cost of different provinces and municipalities

The environmental degradation costs in 11 provinces or municipalities of eastern region, 8 provinces of central region and 12 provinces of western region reach up to 283.1 billion yuan, 132.2 billion yuan and 91.8 billion yuan respectively, accounting for 55.8%, 26.1% and 18.1% of the total environmental degradation cost across the country. The environmental degradation costs of three regions[6] and their percentage in local GDP are as shown in Figure 2.

[6] There are no statistical data by provinces of pollution cost for fishery pollution accident. So the total environmental degradation cost of three regions is less than the total one, 511.82 billion yuan.

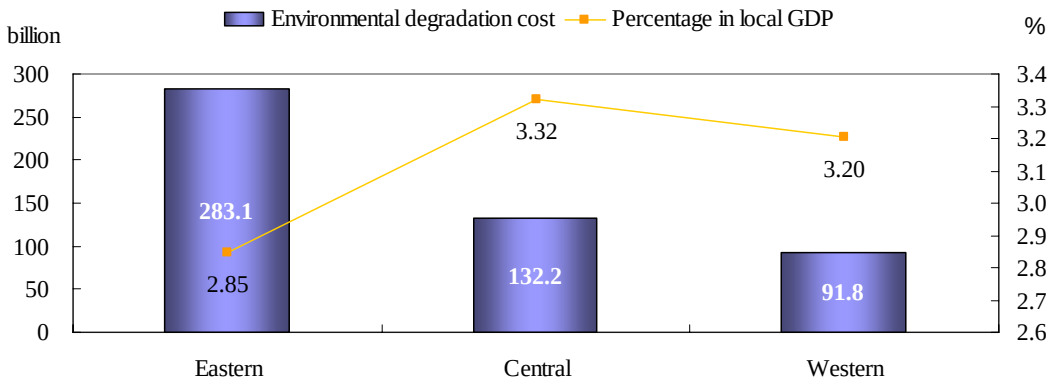

Fig.2 Environmental degradation costs and their proportions in local GDP in three regions

5 Environmental Pollution Adjusted GDP

5.1 Environmentally adjusted gross values of production by region

Regards the sequence of GDP and I_{EDP}^{a} of different regions of China, the I_{EDP}^{a} of the eastern region is the lowest, which is 1.13%. The next is the central region with the I_{EDP}^{a} of 2.17%. The western region is of the highest I_{EDP}^{a}, which is 3.12%. Therefore, it is shown that economic level and pollution control level of the western region are relatively low. To take a panoramic view of China, there are 21 provinces or municipalities with I_{EDP}^{a} higher than the average level of 1.8% and 10 provinces or municipalities with I_{EDP}^{a} lower than the average level. The I_{EDP}^{a} of different regions is shown as Figure 3.

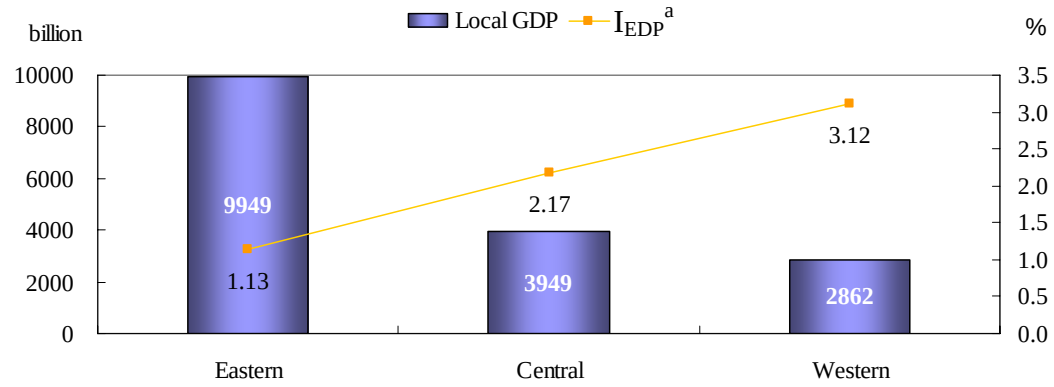

Fig. 3 GDP and Index of Pollution Adjusted Index to GDP (I_{EDP}^{a}) in three regions

5.2 Environmentally adjusted added values of industries

i. Three major industries

According to the calculation result of environmentally adjusted GDP of three major industries, the imputed abatement costs of the primary industry, secondary industry and the tertiary industry are 33.07 billion yuan, 179.03 billion yuan and 75.34 billion yuan respectively. The I_{EDP}^{a} of three major industries are 1.58%, 2.42% and 1.16% respectively. The imputed abatement cost of three major industries and their proportions in the added values are shown as Figure 4.

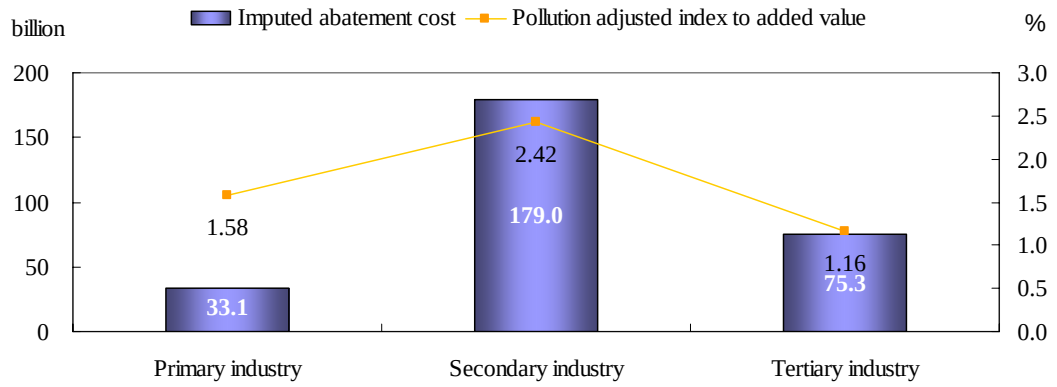

Fig.4 Imputed abatement costs and their proportions in the added values of three industries

ii. 39 industrial sectors

Regards different industrial sectors, in 2004, the industry of water supply is of the lowest pollution adjusted index to added value, which is 0.04%. The following are tobacco industry and furniture manufacturing with pollution adjusted index of 0.05% to added value. The pollution adjusted index to added value of printing industry, communication industry, electrical and mechanical industry, and industry of manufacturing cultural and educational articles are not exceeding 0.1%, which shows that those industries are with less pollution discharge and cause less pollution impact. However, the pollution adjusted index to added value of paper-making and nonferrous metal mining industries are the highest, reaching 30.13% and 11.63% respectively, which illustrates that the ratio between economic benefits and environmental effects of these two industries are the lowest and could cause severe pollution. I_{EDP}^{a} of 39 industrial sectors is as shown in Figure 5.

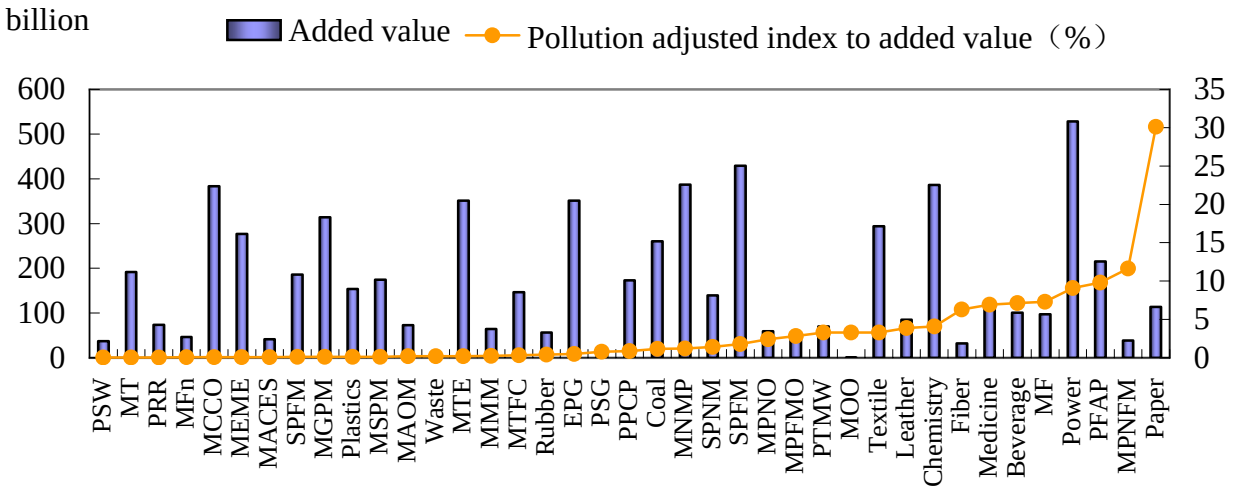

Fig.5 Added value and Index of Pollution Adjusted Indies to Added Value of 39 industrial sectors

5.3 Environmentally pollution adjusted GDP (EDP)

The Gross Domestic Product of all the industries calculated by production approach is 15987.8 billion yuan in 2004 in China while the imputed abatement cost is 287.44 billion yuan. Therefore, the pollution adjusted index to GDP （I_{EDP}^{a}）is 1.8%, which means the proportion of the imputed abatement cost in the whole GDP is 1.8%. Viewed from abatement input for environmental pollution, that one-off direct investment of 1080 billion yuan (excluding investment which has been made), accounting for 6.8% of the GDP at that year, should be required if all the discharged pollutants were abated or disposed in 2004 with the current available technologies.

Annex 1: Abbreviation of 39 Industries in Figure 5

Coal	Mining and Washing of Coal
EPG	Extraction of Petroleum and Natural Gas
MPFMO	Mining and Processing of Ferrous Metal Ores
MPNFMO	Mining and Processing of Non-Ferrous Metal Ores
MPNO	Mining and Processing of Nonmetal Ores
MOO	Mining of Other Ores
PFAP	Processing of Food from Agricultural Products
MF	Manufacture of Foods
Beverage	Manufacture of Beverages
MT	Manufacture of Tobacco
Textile	Manufacture of Textile
MTFC	Manufacture of Textile Wearing Apparel, Footwear, and Caps
Leather	Manufacture of Leather, Fur, Feather and Related Products
PTMW	Processing of Timber, Manufacture of Wood, Bamboo, Rattan, Palm, and Straw Products
MFn	Manufacture of Furniture
Paper	Manufacture of Paper and Paper Products
PRR	Printing, Reproduction of Recording Media
MACES	Manufacture of Articles For Culture, Education and Sport Activity
PPCP	Processing of Petroleum, Coking, Processing of Nuclear Fuel
Chemistry	Manufacture of Raw Chemical Materials and Chemical Products
Medicine	Manufacture of Medicines
Fiber	Manufacture of Chemical Fibers
Rubber	Manufacture of Rubber
Plastics	Manufacture of Plastics
MNMP	Manufacture of Non-metallic Mineral Products
SPFM	Smelting and Pressing of Ferrous Metals
SPNM	Smelting and Pressing of Non-ferrous Metals
MMP	Manufacture of Metal Products
MGPM	Manufacture of General Purpose Machinery
MSPM	Manufacture of Special Purpose Machinery
MTE	Manufacture of Transport Equipment
MEME	Manufacture of Electrical Machinery and Equipment
MCCO	Manufacture of Communication Equipment, Computers and Other Electronic Equipment
MMM	Manufacture of Measuring Instruments and Machinery for Cultural Activity and Office Work
MAOM	Manufacture of Artwork and Other Manufacturing
Waste	Recycling and Disposal of Waste
Power	Production and Supply of Electric Power and Heat Power
PSG	Production and Supply of Gas
PSW	Production and Supply of Water

Annex 2: Definition of Related Terms

1. Green National Accounting System/Resources, Environmental and Economic Accounting System/System of Integrated Environmental and Economic Accounting

Green National Accounting System is also called as the Resources, Environmental and Economic Accounting System or the System of Integrated Environmental and Economic Accounting (SEEA), which refers to a set of theoretical method for green national economic accounting.

In order to merge the environmental impact into economic analysis, UN established the System of Integrated Environmental and Economic Accounting (SEEA) which is a satellite system of the System of National Accounts (SNA). The interim version of the SEEA came up in 1993. The subsequent operational manual (UN and UNEP 2000) of the SEEA were also released in 2000. At present, the SEEA-2003 were also issued in due form. In the report, the Chinese system of Environmental and Economic Accounting is abbreviated as CEEA.

SEEA-2003 is the revision of SEEA-1993 and summarizes practical experience of SEEA-1993. It makes an overall elaboration on integrated environmental and economic accounting system, defines concepts, approaches, classification and basic guidelines to bring resources consumption, environmental protection and environmental degradation into national accounting system, and constitutes the basic framework for integrated environmental and economic accounting. It aims at providing support to comprehensive decision-making on society, economy and environment by environmentally-adjusted wealth of nation, GDP, domestic net output, capital accumulation and other macro-economic indices. SEEA-2003 is also the basic means to measure sustainable development and provide information support for implementation of sustainable development strategy.

2. Green National Accounting

Green national accounting, also called “Green GDP” for short, includes accounting for resources and accounting for environment, which brings together economic and resources and environmental information in a common framework to measure the contribution of the environment to the economy and the impact of the economy on the environment, and provides policy-makers with indicators and descriptive statistics to monitor these interactions as well as a database for strategic planning and policy analysis to identify more sustainable paths of development.

3. Environmental and Economic Accounting

Environmental and Economic accounting is a part of green national accounting, while environmental and economic accounting includes environmental pollution accounting and ecological damage accounting. China’s practice on environmental and economic accounting is only focusing on environmental pollution accounting by now with methodologies and data constraints of ecological deterioration. Environmental pollution accounting mainly includes physical quantification and monetary valuation of waste water, water pollutants, air pollutants and solid wastes pollution.

4. Accounting of Environmentally Adjusted Domestic Product (EDP)

Objectively, it is required to develop an indicator with similar function of GDP, namely as green GDP, in green national accounting. So accounting of environmentally adjusted domestic product (EDP) is to deduct environmental costs caused by economic activities including environmental degradation cost and ecological damage cost from GDP, and make some adjustments, and then educe a set of comprehensive indices centering on “Environmentally Adjusted Domestic Product”. **Of note, the definition of EDP based on GDP in CEEA is different from that based on NDP in**

SEEA 2003 by UNSD.

For the pilot work of national environmental and economic accounting jointly conducted by National Statistic Bureau and SEPA, the calculated "green GDP" is a partial one with many restrictions in the scientific sense. It is the GDP deducting environmental pollution cost and adjusted by maintenance cost without deducting ecological damage cost. Therefore, green GDP in true sense is a utopian accounting goal which requires long-term and joint efforts of related resources sectors, environmental protection sector and statistical sector.

5. Green GDP

The concept of green GDP is put forward officially for the first time in *"The System of Integrated Environmental and Economic Accounting (SEEA)"* issued by UN Statistical Commission in 1993. According to the concept and accounting method of green GDP by UN Statistical Commission, the relation of green GDP and GDP could be explicated as following in theory: green GDP = GDP －depreciation of fixed assets－resources and environmental costs = NDP-resources and environmental costs.

Of which, NDP refers to net domestic product. The formula shows that green GDP is corresponding to NDP not to GDP. In this project, we adopted the total value concept of green GDP corresponding to GDP instead of net value just because GDP is used more commonly than NDP when considering practical application. So in our project, green GDP=GDP－environmental costs. Therefore, the environmental cost in this report was measured by both imputed abetment cost and pollution damage cost.

Green GDP is a kind of popular wording corresponding to traditional concept of GDP, which is more suitable to be accepted by government officers, public and media. Simply speaking, green GDP is one that deducting resources consumption cost and environmental damage cost from traditional GDP. Just like traditional GDP is an important indicator of traditional national economic accounting, green GDP is also an important indicator of green national economic accounting which is widely recognized by the public.

6. Physical Accounting of Environmental Pollution

Green National Economic Accounting System consists of two aspects, physical accounting and monetary accounting. The so-called physical accounting of environmental pollution is to set up accounts for physical quantification at different levels and describe generation, treatment and discharge amounts of pollutants corresponding to economic activities in terms of physical unit under the framework of national economic accounting,

7. Monetary Accounting of Environmental Pollution

Monetary Accounting of environmental pollution is to estimate monetary value loss caused by various kinds of environmental pollution and ecological damage based on accounting for physical quantification. It consists of accounting for maintenance cost and environmental degradation cost (damage cost), so treatment cost approach and damage cost approach are applied respectively in the monetary accounting of environmental pollution, which mainly includes the following aspects: monetary accounting of water pollution, air pollution, industrial solid wastes, urban household wastes and economic loss by pollution accidents in different regions; and monetary accounting valuation of water pollution, air pollution, industrial solid wastes and economic loss by pollution accidents in different sectors.

8. Pollution Treatment Cost Approach

Pollution treatment cost approach and pollution damage cost approach are two major methods to make environmental monetary valuation. In the framework of SEEA, treatment cost approach

mainly refers to making calculation of cost to be expended in order to avoid environmental pollution in the point of view of “defense” on the basis of cost evaluation method.

It is rather simple and clear to apply pollution treatment cost approach in accounting of maintenance cost, which means that environmental degradation would not be caused if all the discharged pollutants are controlled or treated very well. Therefore, economic value for environmental degradation should be the cost paid for treatment of all the pollutants.

Pollution treatment cost approach is characterized by the simplicity and intelligibility of value accounting process and objectivity of accounting basis (which is based on the physical quantification of pollution and then multiply treatment cost of per unit pollutants). Hence, it is much easier to be used by environmental protection and statistical sectors. Environmental costs calculated by pollution treatment cost approach can be divided into two parts: environmental protection expenditures and maintenance cost for environmental pollution.

9. Pollution Damage Cost Approach

In the framework of SEEA, damage cost approach refers to environmental cost valuation based on the environmental damages, which makes cost calculation of different damages caused by environmental pollution, such as effects on crops production, human health and ecological service function, in virtue of a certain technological means and pollution cost survey, and conducts economic loss evaluation of pollution by means of a certain price setting techniques. At present, the major price-setting methods are as following: human capital approach, travel cost approach, willingness-to-pay method and etc. Comparing with treatment cost approach, pollution cost approach based on environmental damages is more rational and could reflect harmfulness of pollution.

10. Actual Pollution Abatement Cost

Actual Abatement Cost (Environmental Protection Expenditure) refers to actual pay out or that have paid for pollution control, which should include depreciation cost of fixed assets, medicament cost, labor cost, electricity cost and other operation cost in the process of pollution prevention and control.

11. Imputed Abatement Cost（Maintenance Cost）

Imputed Abatement Cost (Maintenance Cost) refers to the cost to be paid for treatment of all the pollutants discharged into the environment in accordance with current pollution control technologies. It differs from pollution control investment which is the concept of expenditure (operation cost) for environmental protection and could be deducted from GDP. Maintenance Cost could be calculated out by treatment cost approach..

12. Environmental Degradation Cost/Damage Value

Economic value calculated for environmental loss through estimation on pollution cost is called environmental degradation cost, which refers to damages on environmental function, human health, crops production and etc. caused by pollutants discharge in the process of production and consumption with the current pollution control level. In the report, environmental degradation cost is called pollution cost, termed as damage values in SEEA as well.

13. Pollution Adjusted Index to GDP, I_{EDP}^{a}

To present the percentage of maintenance cost to GDP, an index of pollution adjusted GDP short for I_{EDP}^{a}, i.e. the percentage of imputed abatement cost to GDP, is introduced in the report. It becomes easier with the index to analyze pollution control and abatement expenditure of different industries and different regions.