GREEN ACCOUNTING PRACTICE IN CHINA

(Draft Report)

April 2008

United Nations Environment Programme
Regional Office for Asia and the Pacific
Tongji University
UNEP-Tongji Institute of Environment for Sustainable Development (IESD)

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ACKNOWLEDGEMENT

This study is supported by the Regional Office for Asia and the Pacific, United Nations Environment Programme.

The major part of the data of green accounting are cited from the reports of the national green GDP accounting projects.

During the study, a number of well-known officers and scholars provided tremendously important views and advices, especially those from the project work team, China People's University and Peking University, including Jinnan Wang, Fang Yu, Minxue Gao, Xiaomin Guo, and Ming Lei.

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ABSTRACT

China's recent growth has been dramatic and eyes-catching. In the 2007 Jan. 22 issue of TIME-Asia, "China – Dawn of a New Dynasty" was the cover, and the feature article was titled "The Chinese Century". However, it is also drawing attentions that the success of China's development is accompanied with severe environmental deterioration and resource degradation.

The unhealthy development has also been observed by the Central Government of China. During the opening of the National Environmental Protection Congress on April 17, 2006, while the ever-severest sandstorm was roaring over Beijing, Premier Jiabao Wen warned, "the environmental problems generated in developed countries during the hundred-year industrialization now are popping up in China collectively, damaging eco-system and environment, creating huge economic losses, threatening people's life and health…" It was reported that China failed in reaching the two environmental targets in the passed 10th Five-Year Plan, that the emission of SO_2 was increased by 27% instead of the expected 10% reduction, and COD discharge was decreased by 2% instead of the expected 10% reduction.

To tackle the problems of environmental degradation and resource depletion, China has made great efforts in recent years. One of recent efforts is the trial projects on green GDP accounting. From 2003, two state level projects were conducted on green GDP accounting, one by SEPA (State Environmental Protection Administration) and NBS (National Bureau of Statistics) and another by the World Bank. The projects led to a framework of green GDP accounting for China, and the experimental results for the data of 2004 were released to the public in 2006, which alerted that, with limited scope of cost estimates, the economic loss was found around 287.4 billion RMB, 1.80% of the China GDP in 2004 by pollutant treatment cost approach, and 511.8 billion RMB, accounted for 3.05% of the China GDP in 2004 by environmental degradation cost approach. Based upon the findings, the importance of integrating environmental protection and resource conservation has been further discussed and watched.

However, different voices were also heard even during the projects going. The debates involved broad aspects, such as theoretical, technical, institutional, and empirical etc. As a result, the release of the results of a similar accounting for 2005 data was officially claimed to postpone indefinitely. What are the difficulties and questions behind? Would the experimental green accounting continue in China? People ask such questions when watching China continues the development.

The present study is entrusted by the Regional Office for Asia and Pacific, United Nations Environment Programme. It is to survey the green GDP accounting experiment: the findings and problems; the debates and the possible solutions, as well as the future expectation.

This report starts with a brief review on China's rapid development and how the changes happened in China's environment. The great enthusiasm and potential for a better life by 1.3 billion of people released from planned economy are creating economic miracle but also severe problems in environment degradation and resource utilization. China has noticed experience of the developed world and made great efforts for sustainable development. But there are still many problems to be solved.

In the meanwhile, economic accounting in China obtained great progress from MPS (material production system) to SNA (System of National Accounts), then towards SEEA (System of Integrated Economic and Environmental Accounting), catching international standards for economic accounting.

The dimensions of environment and natural resource were also noticed by the scholars and officers in China. A number of studies were carried out along with the development of SEEA of the United Nations. Some of the results were obtained before 2004. However, the two state level projects were the first time to carry out country wide accounting study. The results should have the significance of a milestone, although limited sectors and limited items were considered, and the methods did not seem perfect. The projects established an framework for green accounting in China. Physical flow accounting, monetary accountings with pollution treatment cost approach (actual and imputed), and environmental degradation cost approach were applied. Unfortunately, resource depletion was not included in the case study for year 2004. Although with many shortages and missing terms, the results of the project are important: not only for the first time providing quantified information of the cost of development, but also claimed the feasibility of establishing such an accounting system.

There are many difficulties and problems with the green accounting system. Some of them are crucial. For example, GDP is based on market economy, that all calculations are based on market prices. It is the prior so as to be applied to international world, also the worst of not considering the cost by the environment and resource. Green accounting on the other hand is often very difficult to estimate the prices. How to harmonize GDP and green GDP will need time for research. Further, GDP is not only used for a simple indicator. It is also used as a basis in international negotiations, e.g., for carbon emission reduction. For green accounting, there were countries experimented such accountings, but there is not a country has officially used green GDP for international uses. There are many other difficulties. For the application and policy use of green GDP accounting system (SEEA), four important aspects are discussed in this report.

(1) Application of physical flow accounts to track the causes of environmental degradation and energy efficiency, including tracking the structural causes of low efficiency of energy and national uses, and understanding long-term environmental changes.

(2) Application of environmental expenditure and tax accounting, including: integration of environmental expenditure with the “circular economy” and application to policy analysis.

(3) Valuation of environmental degradation and policy use, including evaluating the costs of environmental degradation and resource depletion; how effectively applying the costs to the management and policy making; estimating the costs to lay down and implement the policy; and Pricing the non – market goods and environmental services.

(4) The role of underpinning in strategic planning, e.g. coordinating the relations of economic efficiency and sustainable development; sustainability and strategic plan; and socio-economic objectives.

In China, energy saving and pollutant emission reduction are now included in the evaluation of administrative achievements. Environmental and resource data are now routinely reported by NBS and MoEP. In the international, more people are worrying our surrounding and resource, the adaption of climate change. Sooner and later, green accounting will become popular, not only in China, but also in the international world.

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1 INTRODUCTION

As an economic star in the current world, China is also known of a huge population, restricted resources and severe environmental deterioration. The contradictory phenomena draw an ambiguous picture for the future of China. While Gross Domestic Product (GDP) is used as the most important index to measure China's economic growth**,** people have been arguing that the rapidness of the GDP growth is at the cost of severe environmental degradation and over consumption of resources. One of the attempts to tackle this problem is to set up a green accounting system in China, which follows the recent international progress in the aspect. The main purpose of the green accounting experiment may be considered as two-fold: It can be used to inform the government and public, how much has been expended in environmental degradation and resource depletion when the high GDP growth rate has been kept, and it alerts that it might not be appropriate to use GDP as the predominant indicator of the government achievement.

The importance of integrating environmental degradation and resource consumption into economic accounting system has been noticed by the international world. The United Nations and other international organizations studied the experience of economic accounting, and compiled the System of Integrated Environmental and Economic Accounting, SEEA, and introduced green accounting to the world with theoretical and technical guidance[1,2]. In recent years, over than 20 countries including Mexico, the U.S., EU, Japan, Norway, Mexico, Philippines, and Indonesia etc. performed green accounting with respect to different environmental concerns based on various theories and methodologies.

Along with the development of economic accounting system in the international world, scholars and officers in China began to study and introduce green accounting theory, framework, and methods from the late 1980s. Especially after UN's SEEA 1993, noticeable efforts were made to consider environment and resource dimensions into economic accounting. For example, a study in 1998 by Peking University applied input/ output analysis for green accounting[3] The then National Environmental Protection Agency (NEPA) and the research group of China Academy of Science carried out studies with the concept of World Bank's extended wealth concept to integrate environment and resource aspects in accounting[4]. Recently, an experiment was conducted in China from 2003 that included two major projects. One is the national project "Integrated Environmental and Economic Accounting of China", sponsored by State Environmental Protection Administration (SEPA) and National Bureau of Statistics (NBS). The other is the project "Establishment of Green National Accounting System of China", sponsored by the World Bank. The major outputs of the two projects came out from the September of 2006[5,6] that a national accounting result for the year of 2004 was released to the public[7].

However, the 2004 green accounting experiment was conducted with dramatic themes. For example, at the news press conference for the release of the national project report, it was heard that some of the provinces within the pilot green GDP project were considering withdrawing form the research. Different voices came out not only from the individual authors but also from NBS officers. Although all the ten

cities/provinces of the pilot project finally completed their research, a strong debating was continued. In the spring of 2007, voices from academic side supported the establishment of green GDP accounting system and it was heard that the result of a similar accounting for the year 2005 would soon be released. However, in July 2007, it was officially announced by NBS that the release of the 2005 green GDP accounting results will be postponed indefinitely[8], claiming the methods and data available to make such a calculation are too crude for the findings to be meaningful.

What is the situation that China experimented green accounting is going? What are the achievements of the pilot projects on green accounting? What are the different opinions related to green accounting? And What are the difficulties that led the pilot studies to a difficult position?

With the questions and doubts, the Regional Office for Asia and the Pacific of UNEP entrusted the authors in 2007 to carry out a study for the practice of green accounting in China.

In this report, we try to briefly summarize the development of China in these years, the progress of economic accounting, the methods and achievements of the two pilot projects, and then the questions, different views on green accounting. With the review on the views of dissenters and supports, challenges of green accounting in China are discussed. It is concluded that, to integrate the cost for environmental degradation and resource depletion into economic accounting is common, but how and when to be officialized as a routine reporting system are still open. Great efforts are needed to push forward the implementation of green accounting.

1.1 Economic Growth of China

Before getting into the discussion on green accounting, it should be beneficial to review the progresses of China's economic development so as to understand the features of economic development in the country.

China's industry was negligible before 1950. In the early years of the new China while the population was about 500 million, the main movements in the business sector were on institutional and political reforms. Some progresses were made in economy but rather limited. As in other developing countries, Chinese people kept low living conditions in those years. From the late 1950s to 1960s, the economy of China was entirely planned. Heavy industries were taken prior over other industries. However, because the country is large and the then industry scale and production were small, the pollution created by such heavy industries did not produce noticeable problems. During the "Great Leap Forward" of 1958, China was with a great enthusiasm for an economic development. One of the slogans said to catch up the "UK Empire" within 15 years. The main approach was to make use of China's great population (around 650 million), e.g., "All People Steel-Making" for industry and establishing "People's Commune" for agriculture. However, the movement did not have a sound basis so that it did not last long. There were some environmental losses but limited. The main difficulty of China's economy was the "Three Difficult Years (1959~1961)". Many people struggled from hunger in the period. Because of the poor living conditions, the synthetic reuse of "three-wastes (waste gas, wastewater and waste solids)" were often heard, which was mostly for living benefits rather than the consciousness of waste reuse.

During Cultural Revolution (1966~1976), political movements dominated the country. In the economic sector, there were Daqing Oil Field as the modal for industry and Dazhai County as the modal for agriculture. The economy was backward and grew slowly. In the beginning of 1970s, for the urgent need of agriculture, the governments promoted to build small-scale chemical fertilizer factories. Similarly, small-scale electric power plants, cement factories, paper mills and iron/steel plants were also built. These were named "Five Smalls" that are heavily polluting. The "Five Smalls" later spreaded all over the country especially after the 1980s, and extended to "Fifteen Smalls", that might be attributed as one of the "roots" of the current pollution sources that have turned China's environment into severe situation.

China's rapid development started from 1978 with the reform and open policy[9]. The government turned main attention to economic development. Science and technology were also recognized as productivities. While the economy began turning from completely planned to market adjusting, rigorous debating occurred across the country in the 1980s on whether the economic development is politically correct or had been too rapid. The Chinese phase, "Development is the Essential", recorded the determination of the government. It was after 1992, China started a new wave of development that pushed the GDP growth rate around and over 10% until the present.

China is a large country. The reform and open policy greatly released the potential of the enthusiasm of Chinese people to develop the economy and to enjoy better life. Figures 1-1 and 1-2 illustrate the population growth and the economic development of China in terms of GDP increase.

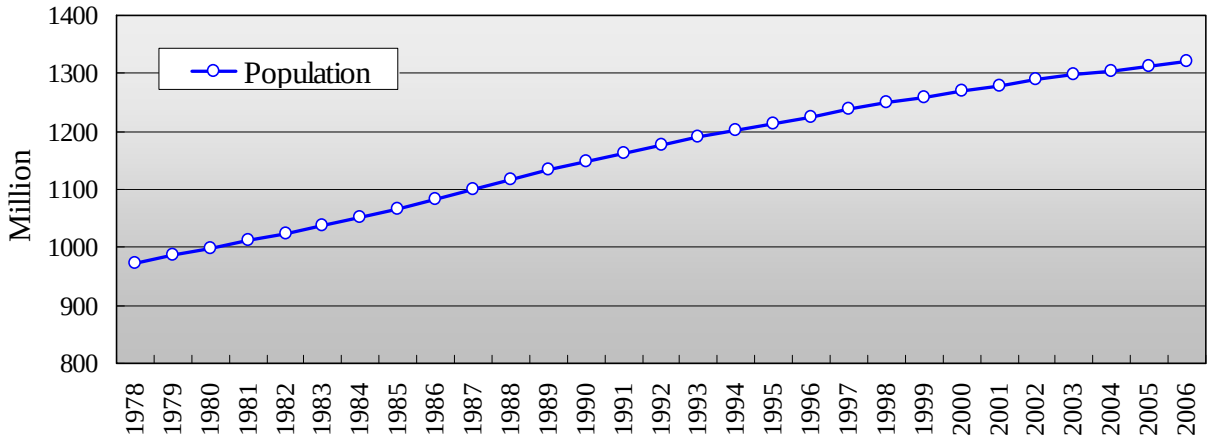

Figure 1-1 Population growth in China
Data from the NBS web site: http://www.stats.gov.cn/

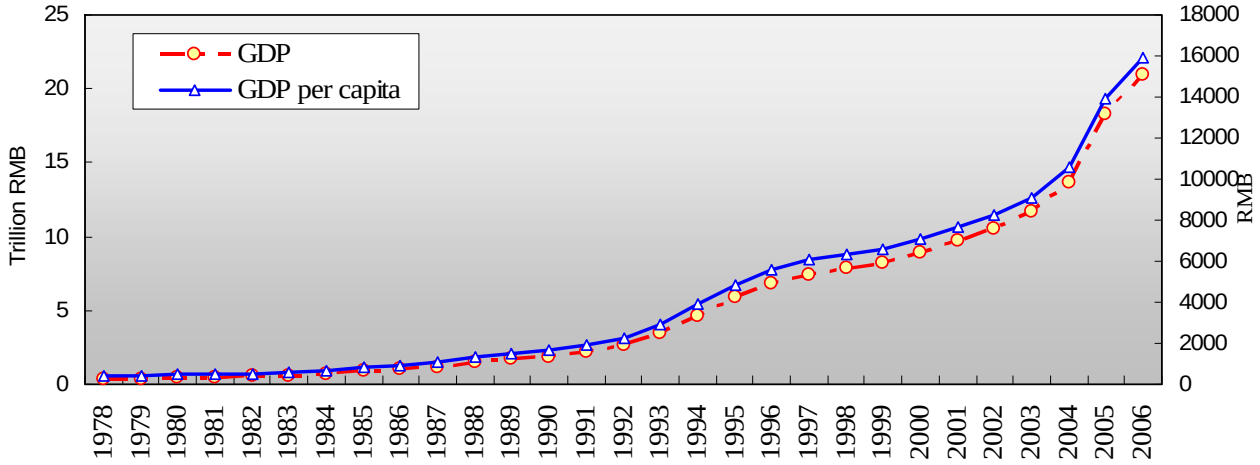

Figure 1-2 China's economic growth measured in GDP
Data from the web site of NBS: http://www.stats.gov.cn/

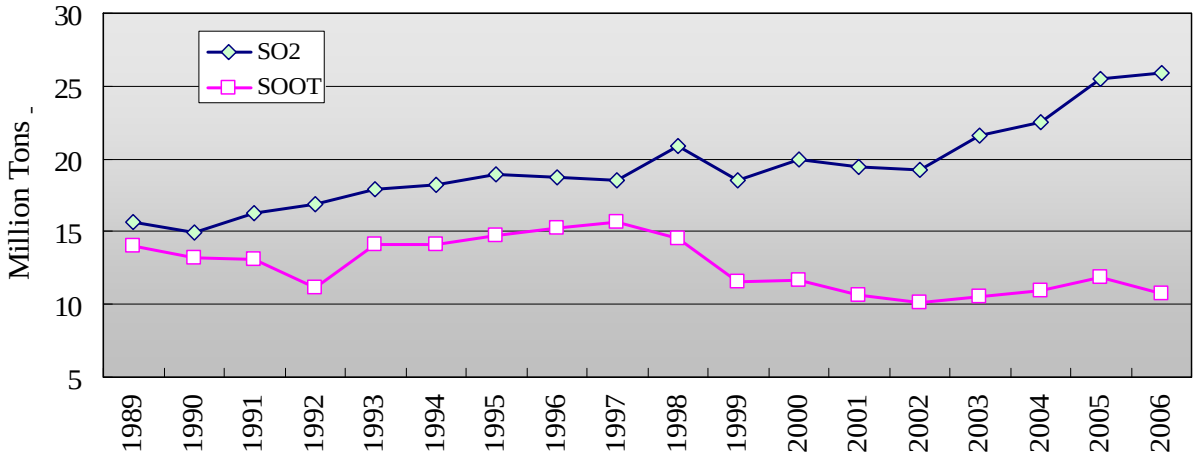

Figure 1-3 Industrial emissions of air pollutants of China
Data from the web site of SEPA: http://www.zhb.gov.cn/

1.2 Environmental Degradation and Resource depletion

As described, the severe environmental degradation of China has been accompanying the rapid economic development since the late 1970s.

Coal is the main energy source of China. Coal combustion, mainly by electric industry, other heavy industries, as well as house heating, is the main source of air pollution of China. Due to economic limitations and backward technology, sulfur dioxide and soot, the typical coal burning air pollutants feature the air pollution of the country. Low efficiency, lack of proper control devices, and poor management commonly exist in other heavy industries that make many Chinese cities heavily polluted that there are often the names of these cities on the list of world's top air polluted cities. Figures 1-3 illustrates the industrial emissions of SO_2 and soot of China[10]. It is shown that the SO_2 emission was leveling off before 2002, but an obvious increase from 2002. This is in consistent with the fact that after 2002, there has been a new rapid development of China. The features of air pollution in China: (1) particulate matter pollution is the most popular in Chinese cities, because of poor management and reduced precipitation; (2) In mega cities, Beijing, Shanghai, and Guangzhou etc. the air pollution is becoming mixed type, SO_2 and NO_2, risks in haze, fine particulate matter and photochemical smog. (3) Fine particulate matter, haze, etc., are shown as air pollution of multiple cities' phenomena; (4) Closely related to SO_2 emission is acid rain and acidic deposition. It is noted that the severe acid rain areas (pH<4.5) are expending to East China, such as Zhejiang, Jiangxi, and southern part of Jiangsu as shown in Figure 1-4[11]. This might be attributed to the rapid increase of the capacity of coal burning power stations in Yangtze River Delta. (5) China is with a huge population, a major portion of Chinese is still living with poor conditions. The increase of energy consumption can be expected. Although the per-capita CO_2 emission of China is still very low, it will soon become urgent in CO_2 emission to comply Kyoto Protocol.

Figure 1-4 Acid rain situation in 2006, cited from SEPA: http://english.mep.gov.cn/standards_reports/soe/SOE2006/200711/t20071105_112565.htm

Water resource shortage in terms of water quantity and quality is even more critical in China. Cities and large scale enterprises are built near water bodies. However, quite a portion of the wastewater is either directly or after simple treatment discharged into nearby water bodies. Lack of appropriate policies, sufficient financial input and technologies, oxygen depletion and eutrophication are common scenes in water bodies. The depletion of ground water resource is also serious in many areas especially where precipitation is insufficient. Industrial wastewater is gradually under control, but domestic wastewater and non-point source wastewater from agriculture are increasing quickly. Taihu, Chaohu and Tianchi are the three lakes with heavy pollution that the government is determined to cure their pollution. However, after huge investment was laid, the efforts did not receive expected progresses. Now a new round of efforts are started again.

Figure 1-5 summarizes the water quality of major rivers in China. Figure 1-6 illustrates the portions of Eastern, Middle and Western regions of China in discharging wastewater, and major pollutants.

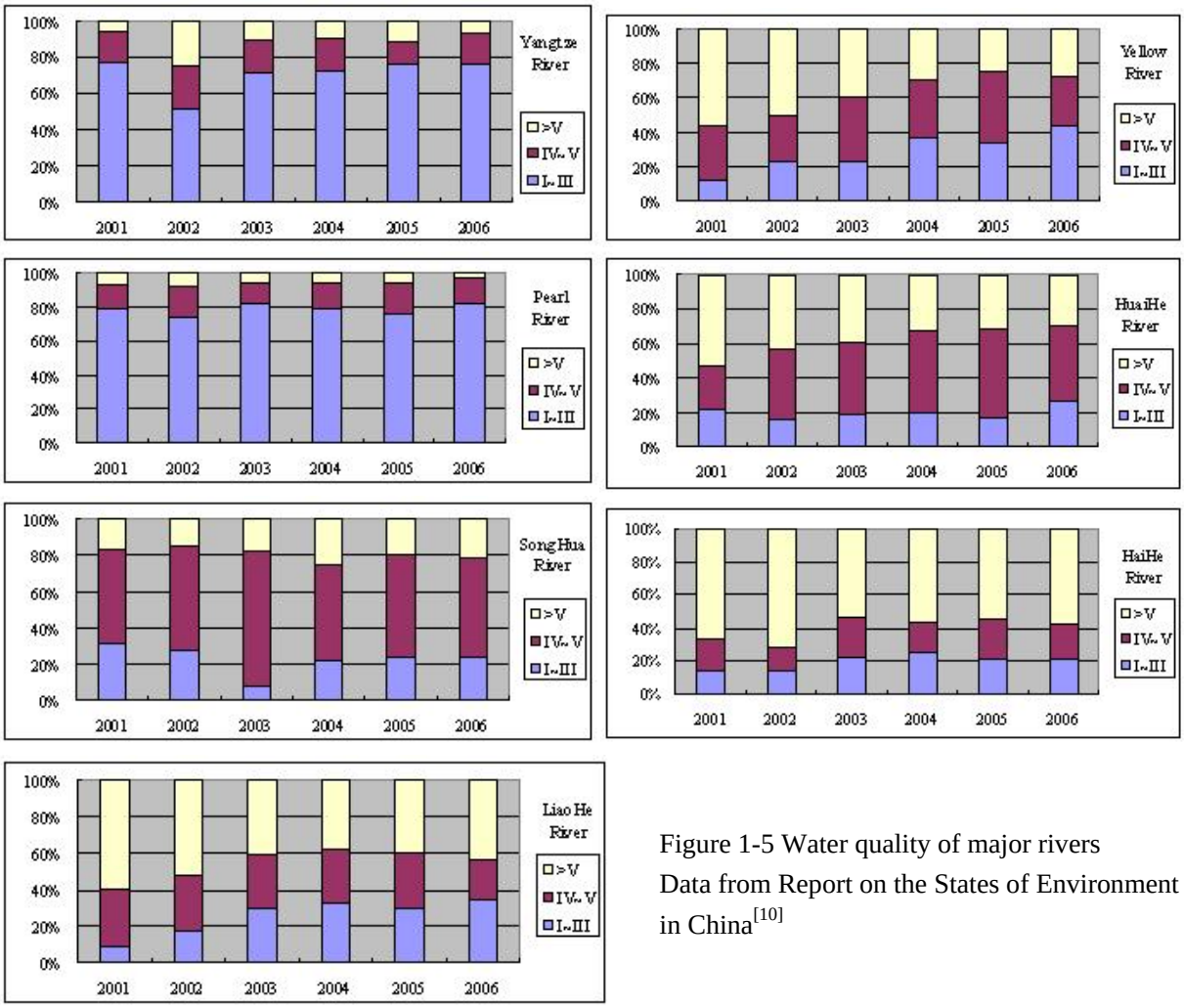

Figure 1-5 Water quality of major rivers
Data from Report on the States of Environment in China[10]

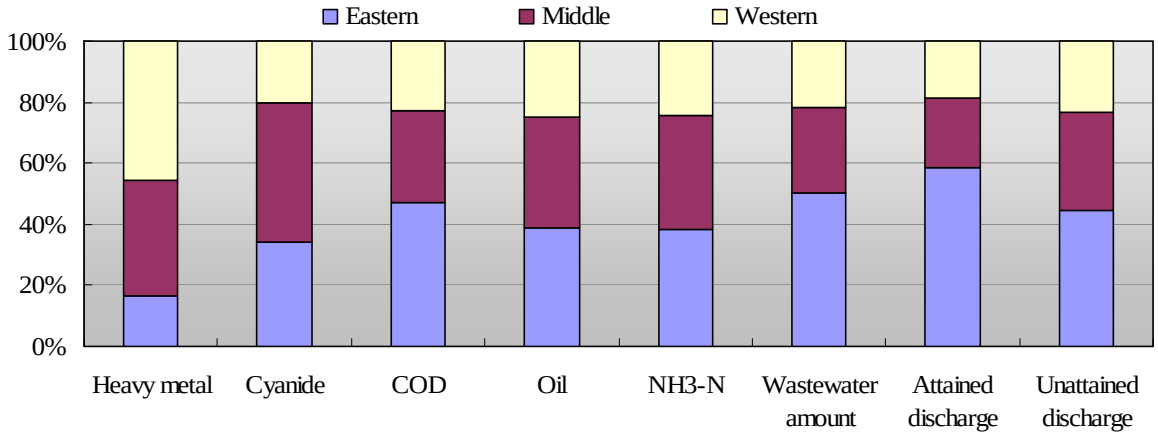

Figure 1-6 Comparison of wastewater discharges of three regions[10]

Air pollution and surface water pollution are just two examples of the environmental degradation in China. There are similar problems in other sectors, such and marine environment, ground water quality, soil pollution, etc.

Although China is with a large territory, the natural resources are limited. Forestry, arable land, grass field are typical examples. Along with rapid development, urbanization is turning considerable part of arable land into construction land. For example, in the report by Zhejiang Provincial Bureau of Statistics, "Cost Analysis on Zhejiang GDP Growth Process (2004)" [12], the major costs were sharp-descending of arable land, energy shortage, and environmental pollution. The report revealed that, from 1979 to 2004, the reduction of arable land was equivalent to the 30.4% of the total in 2004. Other problems of resource depletion are also heard. It is considered that desertification due to over breeding might be a reason that induced frequent strong sandstorms in northern China.

1.3 Government Policies, Institutions, and efforts for a Sustainable Future

China officially began note environmental problems from 1972, after a delegation attended the UN's Stockholm Conference on Human and Environment. The ***Provisional Environmental Protection Law of the People's Republic of China*** was promulgated in 1979. Articles on environmental protection were added to the 1982 ***State Constitution of China***. Since then, series of laws, regulations, standards, policies and movements have been formulated and promoted to combat pollution, such as the laws for air pollution control and prevention, water pollution control and prevention, marine environmental protection, desertification prevention, nuclear pollution prevention etc.

Recognizing that industries are the major polluters, from the late 1970s, China has practiced environmental impact assessment (EIA) for construction projects. The EIA system of China is with a feature called "Three Symultaneities", that environmental measures required by EIA for construction projects must be designed, constructed, and commenced timely with that for the projects being assessed. From recently, the EIA system has been extended to SEA, strategic environmental assessment, to regulate planning level activities.

Many other activities have taken to enhance environmental protection. For example, mass loading control for air and water pollutant emission to avoid accumulation of distributed pollution source impacts; “33211” movement to control the pollution of three (3) rivers (Liao, Hai, and Huai), three (3) lakes (Taihu, Chaohu and Dianchi), to set up two (2) areas for SO_2 and aid rain control, to enhance the environmental protection of one (1) city – Beijing, and one (1) sea – the Bohai Sea. To enforce mass loading control for the three lakes (Taihu, Chaohu and Dianchi), there were “zero point movements” at the end pf the year 2000. It was assumed that all the polluting factories around the lakes must either have taken measures or shut down pollutant sources for discharge attainment. However, the “33211” movement did not end up with expected results. As reported, the reduction rates in SO_2 emission and COD discharge were both unsatisfied. The reduction in the emissions of these two pollutants are now included in the indicator system of the administrative achievement evaluation of governments.

In 1994, Chinese Government approved "The 21st Century Agenda, China", and "Environmental Protection Action Plan of China", etc., that illustrate the adoption of the strategy of a sustainable development.

Recognizing that the rapid industrialization and urbanization in China have brought in many environmental problems, a new series of movements have been taken for urban environmental protection. Besides end-of-pipe control measures, it is promoted for the cities to compete honors, such as environmental model city, environmental healthy city, environmental friendly city etc. Among these honorable titles, it is worth noting eco-city development. The ration of ecocity is to pursue the harmonic balance among development and environment, resource, and social establishment. In June 2006, SEPA of China officially nominated a number of ecocities of different levels and sizes.

Another series of efforts made by Chinese government are shown in so called “EIA storming” movements. It was started in 2005. The targets were the construction projects that either did not implement at all or did not implement properly the law for environmental impact assessment. EIA might be considered as the most important instrument for SEPA to assume the importance of environmental protection and its legal power. This storming was continued for three years. For example, on Jan. 10, 2007, the State Environmental Protection Administration (SEPA) of China denounced severely 82 environmentally violated construction projects involving 112.3 billion RMB investment. The punishment suspended environmental impact assessment (EIA) approval on new construction projects in four cities and four major power groups of China. It is the first time that SEPA applied the “Regional or Group EIA Suspension” measure. It can also be seen as a new tide of EIA Storming in China since the one in 2005.

However, EIA storming does not solve the essential problem. A vice minister of MoEP recently told the media that MoEP does not like to promote another EIA storming. To let governments and public know the importance of environmental protection and sustainable development should be more significant. On March 14, 2008, a news broke from the 2008 People’s Congress of China, State Environmental Protection Administration (SEPA) is promoted to Ministry of Environmental Protection (MoEP). This is a milestone in the progress of environmental protection and sustainable development. It is expected that China is to pay much more attention to environmental protection and sustainable development.

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2. DEVELOPMENT OF THE NATIONAL ECONOMIC ACCOUNTING SYSTEM

As commented by Samuelson and Nordhaus (1995), GDP (Gross Domestic Product) is able to provide an overall picture of the state of the economy of a country (or a region), that the authorities can use it to make decisions on whether the economy needs a boost or should be reined in a bit, and whether a severe recession or inflation threatens[1]. GDP has become the most import indicator of development that it is currently used in almost all countries and all reports or negotiations when economic development is involved. At the end of 1999, by US Commerce Department, GDP was claimed as one of the greatest inventions of the twentieth century. However, it is also known that GDP does not take into account the actual scarcity of environmental capacity and the stock of natural assets[2]. As the consequence, this indicator often in turn gives improper signals on a nation's sustainability of economic growth, and is suspected to lead to environmental degradation and resource depletion in the course of economic activities. To improve economic accounting, a number of efforts have been made to integrate the economic and environmental accounting in a coherent national accounting framework since the Earth Summit held in Rio de Janeiro in 1992. The United Nations and the World Bank have been developing alternative macro-indicators for the accounting of environmentally adjusted GDP, e.g. sustainable national income, etc. As a result the statistical division of the United Nation (UNSTAT) published a handbook on the System of National Accounts (SNA) in 1993[3]. This is not only a complete system for national economic accounting, but also provided a conceptual basis for implementing green accounting, i.e. the System of Integrated Economic and Environmental Accounting (SEEA) as a satellite system. The SEEA 1993 expanded and complemented SNA with flow and stock accounts of natural resources in monetary units, and it also expanded the SNA asset boundary to natural assets not normally included in the 1993 SNA. SEEA 1993 allowed the calculation of environmental-adjusted GDP or Green GDP. Based on ten years' practice a new revision of the SEEA is the Handbook of National Accounting – Integrated Environmental and Economic Accounting (the SEEA 2003)[4].

China as the largest developing country in the world was one of the first two countries to present the Agenda 21[5] after the Rio Earth Summit. The establishment of a SEEA compatible accounting with the National Economic Accounting System (NEA, i.e. SNA) is one of the tasks to implement the sustainable development strategy. However the progress of the NEA itself has been an endeavor of transforming the traditional Material Product System (MPS) to the SNA since early 1980s. In 1992 the new national economic accounting system was just constructed in China. But the 1992 system was principally constructed based on the framework of the 1968 SNA, which did not consider the accounting of natural resources and environmental assets.

The actions in the reform and open policy have created miracle economic growth in terms of GDP and many industrial indicators. The question is whether China's economic miracle could be sustainable in the present and future. To answer this question many experts have been studying on the accounting of the costs concerning environmental degradation and resource depletion accompanied with the economic growth since the early 1980s.

In this Chapter, we introduce the development of the National Economic Accounting System, its framework, functions and defects, and then discuss the proceeding of green accounting studies from early

1980s to 2004.

2.1 Development of the National Economic Accounting System (NEA) in China

2.1.1 From MPS to SNA

There are two economic accounting systems that have been applied in China: one developed by the former Soviet Union for strongly central-planned economy, MPS – material product system， and the other developed by western advanced countries for market economy, SNA – system of national accounting. China's economic accounting has experienced the history transiting from the former to the latter, including three stages: setting up and developing a MPS system, co-existing of MPS and SNA systems, and progressing under a SNA system[6].

(1) Setting up and developing a MPS system

The national economic accounting of new China began from 1952, while a national census was conducted for industrial and agricultural productions. Then the census was extended to five sectors, including industry, agriculture, construction, transportation, and commerce and food service. From 1954, the National Bureau of Statistics (NBS) conducted a study on the statistical theories and methods of national income accounting based on the experiences of the former Soviet Union, and started the accounting practice for national products, distribution, consumption and accumulation. These work laid the foundation of the national economic planning and management.

The MPS was formerly implemented from 1956. Within the MPS framework, major tables were formulated including the social production, accumulation and consumption balance; the national income production, distribution, and redistribution balance; and the labor resource and distribution balance etc. the accounting work met with the first setback in the years of 'difficult time'. The second and more serious setback was in the period of Cultural Revolution. Almost all normal business of the statistical bureau was stopped in the period.

After Cultural Revolution, the MPS system was recovered from 1981. This accounting system was developed and played important roles in the early stage under China's reform and open policy. Meanwhile the NSB added annual input-output table on the MPS to extend its function in early 1980s.

(2) Coexisting of MPS and SNA

Along with the development under reform and open policy, the economic system in China was transited from planned to market. The MPS system could not meet the needs of the country's macro economic management. With the MPS system still in action, China studied the SNA system and began GDP accounting from 1985. China has compiled the input/output table under the SNA system since 1987 and the monetary flow table since 1992.

From 1984, there was a special unit set under the State Council, to lead the research and design of a new national economic accounting system. In 1992, the "China Domestic Economic Accounting System

(Provisional)" was formulated, which adapted the accounting principles, contents and method of the SNA, but reserved some parts of the MPS system. Therefore, it is a mixed system of the SNA and MPS. From August 1992, this system was enforced in the whole country.

(3) Progress within the SNA System

Since 1993, the domestic income accounting of MPS has been deleted. This is a sign that China's economic accounting has shifted from the SNA/MPS mixed stage into the SNA stage. Over the years, the SNA system in China has continuously been improved. From 1999, the MPS part of the system was completely canceled, basic concepts were clarified and frameworks were modified. After comprehensive research and reviewing the new system, which is based on the 1993 SNA, the "China National Economic Accounting System (NEA2002)" has been promulgated and become a unified legal accounting system in China.

2.1.2 Major components and framework of the China's National Economic Accounting System (NEA2002)

2.1.2.1 Major Components

(1) National income and gross domestic product accounting

From the early 1950s to the 1980s, the core index of China's national economic accounting was the national income index of MPS system. This index reflected the production resulted in agriculture, industry, construction, transportation, commerce and food sectors. This accounting had been applied in China's First Five-Year Plan (1953-1957), and interrupted in the years of Cultural Revolution, adopted again in 1973, and modified from 1983 to 1993.

After implementing the reform and open policy, non-material production sectors, such as financial, real estate, social services, scientific research etc., stepped into a rapid development stage, and began to play roles in China's economy with more and more importance. To meet the needs of macro-economic management, from 1980s, the State Statistical Bureau (SSB i.e. former NSB) conducted the study on core index of the SNA--Gross Domestic Product (GDP). In 1985, the "tertiary industry (service industry)" is first time involved in the national accounting system, and meanwhile the China system of GDP accounting was established. However, the accounting in China was mainly based on the MPS system at the time. It was until 1993, the National Income Index and GNP (gross national product) were abolished and the GDP has become the main accounting index since then. Besides, the national economic accounting was extended to boarder areas including the expenditure with domestic product, i.e., expenditure approach to GDP Accounting. Other improvements included using original data for direct calculation, adjusting sector accounting to incorporate the tertiary industry (service sector) in particular, and citizen consumption expenditure etc. The accounting has been gradually normalized with the improvement of data sources and calculation methods. The system was also applied to recalculation for the data of the previous years before 1993.

(2) Input/output accounting

Input/output table is the core of the economic accounting. The 1974 Input/output table of physical flow type was the first pilot practice in China. The NSB (SSB) later worked out the 1981 and 1983 MPS value type Input/output tables. To meet the policy of promoting the tertiary industry development, the SNA input/output table was studied. Especially since early 1990s, the NSB has devoted to the completion of a series of input/output tables for every 2 to 3 years. The 2002 National Input-Output Basic-Table was completed later.

(3) Capital flow accounting

With the joint efforts in late 1980s by the SSB, CPB (China People's Bank), and NPC (National Planning Commission), a fundamental template of capital flow accounting table was designed. The capital flow accounting has been enforced since 1992. These tables have been improving since 1990s. The setting of standard formats and methods of formulation have been worked out yet.

(4) International income and expense accounting

In 1980, China resumed the membership in IMF (International Monetary Fund). In 1981, China established the international income and expense accounting system based on the 4th edition Handbook of International Income and Expense of IMF. This system was modified in the 1990s according to the 5th edition of the Handbook. The annual cash flow table of international investment has regularly been compiled.

(5) Asset balance accounting

The study on asset balance accounting was conducted in the mid 1980s. The actual accounting on asset balance table was started from 1997. The indictor setting, data sources and formulation methods of the asset balance table have been improving by the SSB since late 1990s.

(6) Domestic economic accounts

In late 1980s, NSB began to study the accounting methods of the SNA. The application was from 1997.

2.1.2.2 Framework of NEA (2002)

The framework of NEA 2002 is described in Figure 2-1 .

2.1.3 Function and defectives of NEA (2002)

2.1.3.1 The function

The establishment of NEA 2002 has played significant roles in macro-economic operation and management in China.

(1) Effective tool to reflect the situation of national economic running

Comparing to the MPS the NEA organizes not only material indictors in the agriculture industrial sectors but the more comprehensive indicators, including the activities in the tertiary industry, that portrays the complicated national economic process as a clear picture to help people understand the health of national economy and experts doing research.

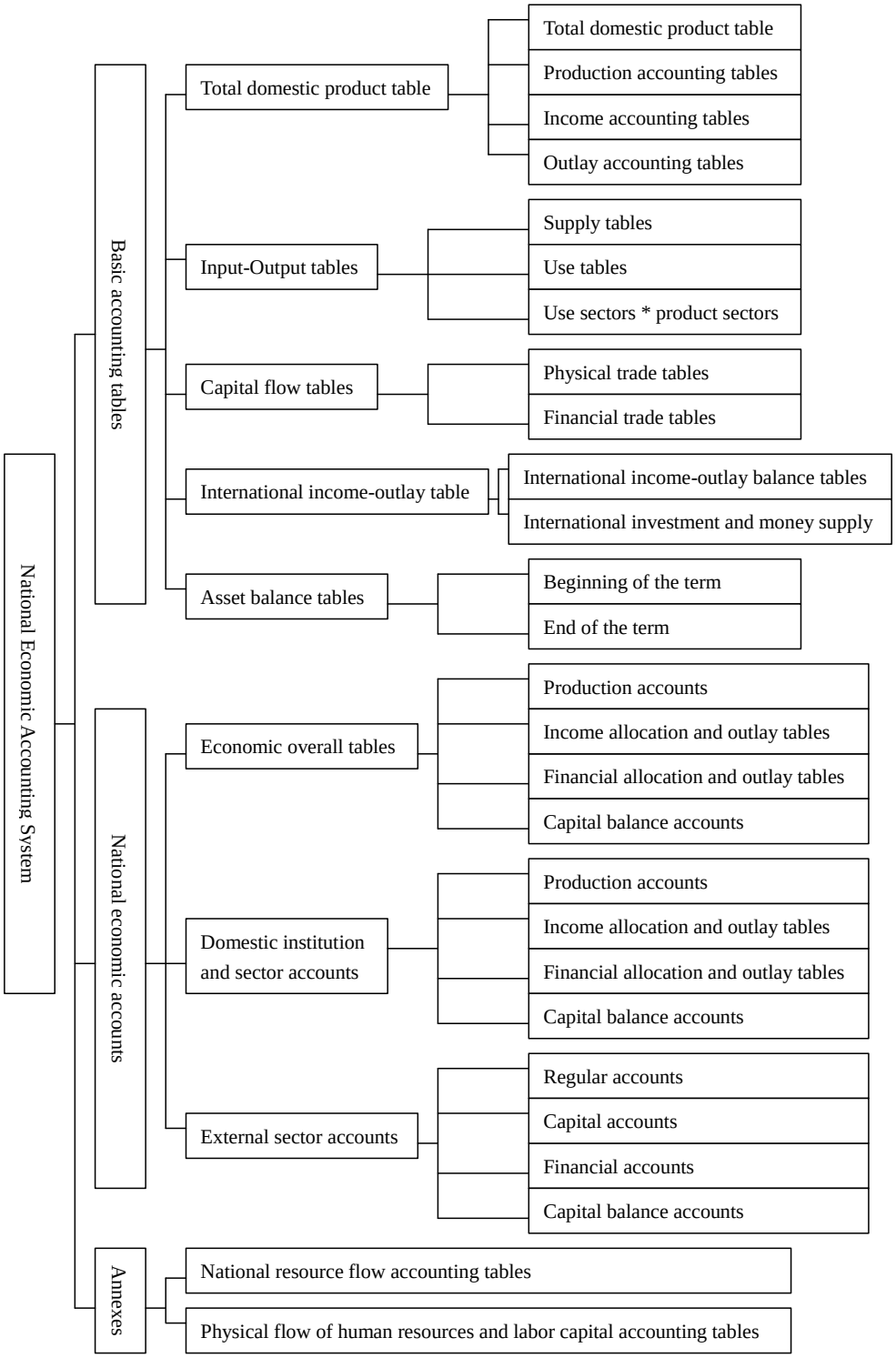

Figure 2-1 Framework of China's National Economic Accounting System (2002)

(2) The basis of macro-economic management

Under the institution of "socialism-market economy" the macro-economic management instruments to direct national economic development in sustainable, healthy, stable and quick way are through variant plans, programs and a series of economic policies. The NEA is just the basis to formulate these instruments. It is impossible to formulate long-middle term plans and annual plan, financial policy, banking policy, etc. without the underpinning data from the NEA system on production, income distribution, consumption, investment, international economic relationship, etc.

(3) The basis of micro-economic decision making

Within the condition of market economy the economic activities of company and individual in production, consumption and investment decision have to be based on the data provided by the NEA. The more accurate, plentiful and diversified information are provided by the accounting sector, the more reliable and correct decisions will be made.

(4) The NEA influences the economic and political benefits, and credit of the country

The data and results of the NEA influence a country's international obligation and treatment, and in addition the results of NEA demonstrate the political-economic performance of the government.

(5) The NEA is also the basis for the green GDP accounting in the country.

2.1.3.2 Defective and improvement

Because the history of national economic accounting system (NEA) is comparatively short, there has been a series of defectives remaining for improvement.

(1) The scope or comprehensiveness of gross domestic product

- The classification of industrial sectors and expenditure items was not sufficient detail to meet the requirements of analyzing the production structure and demand structure.
- The accounting basis of the tertiary industry (service sector) has been still weak and the accounting methodology are leaving for strengthening and improving.
- Seasonal domestic product accounting for production and consumption remains to be established.
- The price index of the service sector and the price index of service trade also remain to be established. and
- Many other contents of accounting need to be added through a series studies.

(2) Input-Output Accounting

To meet the requirements of the WTO on corporations' actual situation, and meanwhile reducing corporations' burden and increasing the quality of input-output tables it is necessary to further reform present survey and compilation methods, and further strengthen the links of input-output tables with gross

domestic product accounting.

(3) Asset balance accounting

As contrast with international standards the classification of fixed asset in Chinese asset balance accounting is not sufficient detailed, e.g. tangible assets were not classified as housing, other houses and building, machines and equipment, etc. as the 1993 SNA does. Therefore the NEA could not meet the needs of important macro-economic analysis, such as the analysis of fixed asset stock structure. Being limited in data resources the fixed asset stock accounting had to use the method of historical cost pricing instead of the reevaluation method of the 1993 SNA.

(4) Regional accounting

The international trade of goods must pass through the customs' examination, approval and register, and the data of goods are easily available. Because there is no special institution in charge of examination, approval and register, the trade of goods within the country usually flows freely but little data are available. To establish income and outlay flow accounting and asset balance accounting system for regional production factors, it is necessary to study the characteristics of diverse regional accounting methodology for a big country like China.

(5) Integrated economic and environmental accounting

Based on the actual condition in China the coordination of the green GDP accounting (SEEA) and the NEA, and making the green accounting system as a satellite system of the NEA (or SNA) has been a new mission over the years.

2.2 A Retrospect of Green Accounting in China Before 2004

The awareness of economic costs due to environmental degradation and natural ecosystem disruption coupling with the GDP growth had led to the studies on damage calculation, since early 1980s. But all of these studies were classified into one-off exercises and played only the role of alarm-bell and provided the data for discussion.

2.2.1 Historical progress of measuring the costs of environmental pollution and eco-disruption in China

The studies on measuring the costs of environmental pollution and eco-disruption have had a history of twenty seven years since 1981, according to [8], it can be divided into three phases.

2.1.1.1 Phase 1(from 1981 to early 1990s) ---probe and primary evaluation

In phase 1, the environmental pollution, natural ecosystem disruption and resource depletion had become increasingly serious. Chinese experts began to probe the costs of pollution damage and the benefits of environmental protection. In the Sixth Five-Year Plan and Seventh Five-Year-Plan, some experts

launched several research projects on river basin prediction of the water pollution costs, evaluation of economic loss caused by industrial pollution, etc.

In mid-1980s China carried out a national project: Environmental Forecast and Countermeasures by 2000. Guo, X and Zhang, H, et al worked on the project: Studies of Economic Loss Caused by Environmental Pollution and Ecosystem Disruption[8]. Further, the national project for first time in China presented the result based on internationally used frameworks to calculate the economic losses[9]. A number of provinces estimated the economic loss within the provincial level, and a training program on the methodology of evaluating economic loss of environmental pollution and eco-disruption was given to more than one thousand personnel from the nation-wide. This has been the first nation-wide joint work on economic loss evaluation of pollution and eco-disruption[9] In mid-1980s Jing, J.[10] took charge of the project: Economic Loss of Eco-disruption in China's Typical Eco-Regions and the Methods for Calculation. They obtained the results that economic loss was accounted for 8.74% of 1986's GDP. Meanwhile, the theory and methodology on green accounting, environmental-economic and cost-benefit analysis of environmental policy, etc. have been introduced into China[11,12].

In phase 1, several theses on the evaluation of economic loss of environmental pollution and eco-disruption were published.

2.2.1.2 Phase 2(from early 1990s to early 2000s) --- Succeeding practice

The results of economic loss caused by pollution and eco-disruption were demonstrated the serious situation in China and attracted the attention of the government and social consensus to combat environmental degradation and resource depletion. More and more experts and scholars have been interested in extending the calculation or estimation of "economic loss" to "green accounting". International research institutes, organizations and experts have also paid great attention to these issues.

In mid-1990s, Zheng, Y. and Xu, S., Xia, G. and Shun, B. completed the projects of "Estimation of Economic Loss by Environmental Pollution and Eco-disruption in 1990s"[13] , "Research on Economic Measurement of Environmental Pollution Loss in China", and "Estimation , Forecast and Consideration of Cross Century Pollution Loss in China" respectively. International Organizations as the World Bank, the U.S. East-West Center, etc. completed the projects of "Clean Water and Blue Sky: Perspectives of China Environment in 21st Century", "China's Environmental Problems: Estimate of Economic Damage", etc. Unfortunately the results of these projects were discrepant each other, that demonstrated the weakness of data base and lack of experiences in green accounting. In 1997, the Research Center of Environmental Economics under SEPA organized the "Expert Forum on the Measurement of Pollution Costs". The Forum made a retrospect and analysis on the proceeding and problems concerning the calculation or measurement of the costs or losses caused by environmental pollution. The experts pointed out that we had got great progress in the "economic loss studies" and obtained valuable results but which lacked necessary depth, scope, and systematic. They presented that establishing a set of normalized methodology for pollution damage accounting was necessary and feasible. They also suggested setting a prolonged research project on "Normalized Methodology of Economic Evaluation for the National Pollution Damage". Fortunately in this phase, a series of dose-response studies on pollution-damage was developed, and obtained some useful results that provided the scientific basis for later evaluation or accounting of the economic loss.

In this phase, the State Statistical Bureau (SSB) launched the parallel studies on green GDP accounting, and focused on the economic loss of natural ecosystem disruption. The SSB's studies greatly promoted the natural resource accounting and opened up many projects in the area. For example, Li, J. and Kong, F.[14], and Hou, Y. et al.[15] worked out the projects of "Forest and Water Resource Accounting" and "Environmental Accounting for China's Forest Resources" respectively. The ITTO (International Tropical Territory Organization) worked out the project: Environmental Value Accounting for China's Tropical Forest. These achievements contributed to further work in the area of methodology and connotation.

2.2.1.3 Phase 3 (since 2000) --- Further development to normal green accounting

Along with the practice of strategic environmental assessment and the promulgation of "Environmental Impact Assessment Law", since 2002 the measurement of externality caused by policy, plan and project in terms of economic costs has become the legal requirements. The major condition to meet the requirements rests with a complete data foundation of integrated environmental and economic accounting system and pertinent data base as the relationship of dose-response in economic pressure and environmental response. The one-off experiment of the studies on economic loss or costs caused by pollution and eco-disruption from early 1980s to 2003 had experienced the defects of sketch and "getting half the result with twice the effort."

Many Chinese experts and scholars have worked on the green accounting in the phase. Lei, M. and Xing, Y. presented the first attempt to design China's SEEA (CSEEA) in the project titled 'SEEA and Green GDP for China[16]. Later other studies concerning green accounting in China have been launched and obtained much new experiences.

Based on the accumulation of knowledge and experiences in calculation of economic losses or costs caused by pollution and eco-disruption in China is described in above sub-section a state level research project was approved in March 2004. The project was jointly sponsored by the SEPA and SSB: "Establishment of the integrated Environmental and Economic Accounting (Green GDP Accounting) System of China". Within this project, ten provinces/cities were selected for pilot studies on green GDP accounting, and a national level green GDP accounting was the target. The selected provinces/cities were Beijing, Tianjing, Chongqing, Hebei, Liaoning, Anhui, Zhejiang, Sichuan, Guangdong, and Hainan. Investigations covered over 30% key industries, all wastewater treatment plans, solid waste treatment plants and scaled stock breeding plants, as well as over 30 thousand households. Besides SEPA and SSB, multiple governmental departments provided helps to the projects, e.g. Ministries of Sanitation, Agriculture, Water Conservation, Urban Construction, Communication and other ministries.

2.2.2 The monetary measurement of pollution and eco-disruption had revealed great economic losses or costs since early 1980s to 2000s.

Because of the complexity, protraction and uncertainty of environmental degradation and resource depletion the valuation of monetary losses can only reflect a part of true costs, but its results are valuable and important in integrated environmental and economic policy making.

Despite these calculations of economic losses or monetary costs of pollution, and eco-disruption were with the nature of one-off experiments, and diverse in contents of factors, methods and information basis, the conclusions that the nation had paid great economic losses and given big negative value on the GDP and people's health were clear and definite. These calculation or valuation are collected and presented in Table 2-1 and Table 2-2.

From Table 2-1 and 2-2, we may draw three observations:

(1) Because of the limitations of data available for different researchers, the factors involved in loss calculation were disparate. Therefore it is necessary to establish a national, provincial and local data base to support the regular loss calculation based on a system of integrated environmental and economic accounting in China.

(2) Health damage is a significant part in economic loss of pollution. International organizations used to apply the methods of "willingness to pay for life risk" or contingent valuation, but in above domestic studies experts usually applied the method of human capital which often obtained the value lower than that from former two methods.

(3) From the information provided by these early studies it was clear that the economic losses of pollution and eco-disruption in China were tremendous sufficiently persuading governmental officials to lead off regular accounting and monitoring the environmental consequences of economic activities.

Table 2-1 Results of selected studies on economic costs caused by eco-disruption in China

Author / Item	[8](1983)		[10]				[13](1993)		SEPA(late 1990s)[17,18]	
			Guangdong and other eleven provinces (1985-1986)		Whole country (1986)				Middle & East China	West China
	Billion RMB	%	Billion RMB	%	Billion RMB	%	Billion RMB	%	%	%
Frost	11.36	22.9	9.75	28.7			75.8	30.9		
Pasture	0.22	4.6	1.56	4.6			58.0	23.7		
Farmland	26.3	73.0	19.16	56.3	-----		86.4	35.3	-----	----
Water resources	1.85	3.7	2.42	7.1			24.8	10.1		
Others	---	---	1.13	3.3						
Total	49.76	100	34.02	100	89.13-100		24.5	100		
Percent of GDP %		8.9		5.36 - 86.4		8.74			15---12	13

Table 2-2 Results of selected studies on pollution damage costs in China

Item \ Source / Year	[8][9] 1983		[19] 1990		[20] 1992		[13][21] 1993		[21] 1994		[13][21] 1995		[9] 1997(1)		[9] 1997(2)		[22] 2004	
	Cost	%	Cost	%	Cost	%	Cost	%	Cost	%	Cost	%	(USD)	%	(USD)	%	Cost	%
Air Pollution Damage	123.9	32.5	151.0	41.1	578.9	58.7	346.0	33.6	903.3	57.5	301.0	15.2	197.0	83.5	489.0	92.6	2189.0	100
Health	37.6	9.9	51.5	14.0	201.6	20.4	169.5	16.5	412.5	26.3	171.0	8.6	113.0	47.9	323.0	61.2	1527.4	69.5
Crops	20.2	5.3	32	8.7	72.0	7.3	49.0	4.8	78.7	5.0	45.0	2.3					537.8	24.4
Livestock Husbandry	0.006	0																
Forestry	---	---	12.5	3.4			45.0	4.4	54.3	3.5	50.0	2.5						
Corrosion and Deterioration	46.1	12.1	30	8.2	140.0	14.2	22.5	2.2	201.9	12.9	35.0	1.8	44.0	18.6	44.0(3)	8.3	132.8	6.1
Cleanser	20.0	5.2	25	6.8	165.3	16.8	60.0	5.8	155.9	9.9								
Lead Poison	---	---											3.0	1.3	106.0	20.1		
Indoor Pollution	---	---											37.0	15.7	16.0	3.0		
Water Pollution Damage	156.7	41.0	118.5	32.3	356.0	36.1	495.6	48.2	652.9	41.6	1431.8	72.2	39.0	16.5	39.0	7.4	2862.8	55.9
Health	83.2	21.8	54	14.7	192.8	19.6	165.1	16.0	328.7	20.9	81.5	4.1					178.6	6.2
Crops	2.4	0.6	12	3.3	13.8	1.4	108.6	10.6	19.8	1.3	150.0	7.6					468.4	16.4
Water Shortage by Pollution																	1478.3	51.6
In industrial sectors	65.0	17.0	29	7.9	137.8	14.0	138.1	13.4	270.6	17.2	750.0	37.8						
In agriculture	---	---	12								59.5	3.0						
Livestock Husbandry	1.2	0.3	2.5		7.0	0.7			21.2	1.4								
Increase of Treatment Costs	2.3	0.6	5.5	1.5													737.5	25.8
Tourism	---	---									50.2	2.5						
Fishery	2.6	0.7			4.6	0.5	187.6	18.2	12.6	0.8	340.6	17.2						
Other Pollution Damage	100.9	26.5	97.5	26.6	51.2	5.2	187.6	18.2	13.7	0.9	249.9	12.6					57.4	1.8
Agricultural Chemicals	95.2	25.0					144.4	14.0			104.7	5.3						
Solid Waste and Others	5.7	1.5	97.5	26.6	51.2	5.2	43.2	4.2	13.7	0.9	145.2	7.4					57.4	100
Total	381.5	100.0	367	100.0	986.1	100.0	1029.2	100	1569.9	100	1982.7	100	236.0	100	528.0	100	5118.2	100
Proportion in Total GDP(%)		6.75		2.17		4.04		3.16		5.8		3.29		3.4		7.7		3.05

* Cost in 10^8RMB, (USD) in 10^8USD

2.2.3 Technical barriers

Technical barriers were great challenges these early studies encountered. The measurement of economic losses of pollution and eco-disruption is a trans-disciplinary task with strong academic and technological background, concerning environmental economics, chemistry, physics, ecology, medicine, informatics, statistics and environmental monitoring and survey. In fact these tasks essentially are a part of work in the SEEA, and need the underpinning of information-data and normalized methodology, which just are weak links in China.

(1) Normalize the scope of measurement

The scope of the measurement on economic losses of pollution covers broad spectra of factors. It may be impossible to measure all factors owing to two huge work loads, so that only major factors can be valuated. The scope of factors covered in the individual measurement of calculation were different each other, and hence the result were different each other.

The normalization in scoping the factors of measurement is necessary condition for further establishment of the Green GDP Accounting System (SEEA) in China.

(2) Build the data base of dose-response with Chinese practice

The relationship of dose response reflects the numerical links of intensity or extent of pollution and eco-disruption with physical and social-economic damage, that is the basis either for calculating economic losses or the SEEA. However, building the data base of dose-response relationship has to apply two approaches, referring to existent literature and studying innumerable specific topics through laboratory work and social survey. In China, the base of dose-response studies has been less financial support and weak in technical capability over the years. The studies are particularly needed focusing on following areas.

- Relations of pollution dose and health response are deficient and blank in many topics, e.g. the relations of integrated dose of common water pollutants in China and cumulated health damage of water pollutants were almost a blank. The criteria for calculating economic losses of health damage by water pollution were discrepant each other, consequently the results of calculation were different each other.

- Despite we have known much more data on the relations of air pollutant dose and human health response than that of water, these data mostly were obtained in many individual cities, e.g. Beijing, Shanghai, etc., and can not represent the relations of other cities particularly west cities.

- There were several research projects on the dose-response of acid rain or acid gas, i.e., SO2 and NOx and material corrosion in Guandong and Guangxi and Yunnan-Guizhou-Sichuan regions and some cities as Shanghai from mid-1980s to 1990s, but these results are not correct for other areas, especially north China. Furthermore, the situation of acid gas pollution has been changed over time. Therefore dose-response research in this area is one of great challenges for practicing the SEEA in China.

- The dose-response relations of water pollution with agriculture, fishery, aquaculture, industries, etc. have still been blank or know well.

- Much more dose-response relations of various cases of eco-disruption with various damage of soil erosion, agricultural harvest, industrial production, human health, etc. contain a broad spectra of specific topic with local characteristics, and remain to be investigated and studied for future establishment of the SEEA in China.

(3) Standardize the monetary valuation of health damage

Valuation of health damage is a problem of risk assessment and management. The scientific data on toxicology, hazard identification, dose-response assessment of different chemicals and physical factors, human exposure assessment, risk characterization, risk reduction and management can be obtained through

literature investigation. Most of these data have been provided by scientific research or observation contributed by developed countries, especially the US. Monetary valuation of the damage internationally has been based on the methods of "willingness to pay", "contingent valuation", "willingness to accept compensation", etc. We have often used the human capital method to valuate the economic loss due to health damage. The results of valuation between Chinese experts and foreign experts were usually discrepant and the results of former were usually much lower than that of the latter. The causes of discrepancy may attribute to:

- the discrepant results from "willingness to pay " and "willingness to accept compensation" may be rooted from different living standards, values, cultural tradition, etc. these conditions are different in China and western countries; and
- even in developed countries the acceptance and rejection of available data were sometimes arbitrary.

However standardization of the methodology and data base for evaluation of health damage was the barrier for early valuation of economic losses or costs, and hence will be a part of work ofr establishing the SEEA in China.

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3 THE CHINA GREEN ACCOUNTING PROJECTS

3.1 Introduction

With several years' preparation, the proposal of a national level project was approved in March 2004. It was jointly sponsored by SEPA and NBS: "Integrated Environmental and Economic Accounting of China" (National Project). With this project, ten provinces/cities were selected for pilot studies on green GDP accounting, and a national level green GDP accounting was the target. The selected provinces/cities were Beijing, Tianjing, Chongqing, Hebei, Liaoning, Anhui, Zhejiang, Sichuan, Guangdong, and Hainan. The investigations covered over 30% key industries, all wastewater treatment plants, solid waste treatment plants and scaled stock breeding plants, as well as over 30 thousand households. Besides SEPA and NBS, multiple governmental departments provided helps to the projects, e.g., Ministries of Sanitation, Agriculture, Water Conservation, Urban Construction, and Communication, etc.

In order to support the establishment of China's green economic accounting system and to carry out scientific assessment on China's economy development, World Bank, based on the aid from Italian Trust Fund, also launched a project in China: "Establishment of Green National Accounting System of China" (WDBK Project). This Project was supervised by SEPA and NBS, and taken charge by the Chinese Academy for Environmental Planning (CAEP), and cooperated by People's University of China, Policy Research Center for Environmental and Economic of SEPA, and local environmental protection and statistics sectors in four places: Anhui, Guangdong, Beijing and Shennongjia Forest District in Hubei.

The above said two Projects were of consistent objectives, overlapped pilot study selections, same implementing agencies and similar schedules. The two Projects were completed at the end of 2006. The main output of the WDBK Project is included in two reports: ***Framework of Green National Accounting System in China***[1] and ***Establishment of China Green Accounting System – Final Report***.[2] The major output of the National Project is the report ***China Green Domestic Economic Accounting Report 2004***[3,4]**,** the public version of which was released to the public on September 7, 2006, by SEPA and NBS. These reports brought forth the following information: (1) A provisional framework has been established with corresponding theories and methods for green national accounting in China. (2) For the 2004 data, by physical accounting, the discharged wastewater was accounted 60.72 billion tons with 21.093 million tons of COD, which are respectively of 126% and 158% as that of the earlier statistical surveying, and SO_2 emission was accounted 24.50 million tons, as 109% as the earlier statistical data. (3) With the imputed pollution treatment cost approach, the cost was found 287.44 billion RMB, with 180.87, 92.23, 14.35 billion RMB for water pollutants, air pollutants and solid waste treatments respectively. It was also found that, with the current technical conditions, if all the wastes were treated, a direct investment about 1080 billion RMB and an operation cost about 287.4 RMB would be demanded, which are about 6.8% and 1.80% of the GDP of 2004. This reveals that environmental input is far from enough for a green economy. (4) With environmental degradation approach, it was found that the cost was 511.82 billion RMB, accounted for 3.05% of the China GDP of the year; and within the loss, water, air, and solid wastes/pollution accident shared 55.9%, 42.9%, and 1.2% respectively.

It is important to note that, the reports claimed, although there are problems in technical methods and

available data, and ecological degradation was not included, the treatment cost method was proved applicable. It is feasible to apply the treatment cost method to find the imputed cost. Then an environmentally adjusted GDP can be calculated. This can be used in local statistical institutions and environmental protection departments. Further, the pollution degradation method can be applied to the state level to provide important information for decision making.

In the following sections, the framework, methods, and major findings of the two Projects are summarized. The data and explanations are mostly drawn from the two reports for the WDBK Project. The text and materials are simplified, re-edited, and combined with the achievements of the National Project for easier understanding.

3.2 Framework and methods

3.2.1 The framework

As shown in Figure 3-1[4], the proposed China System of Integrated Environmental and Economic Accounting (CEEA) includes four main components: environmental physical accounting, environmental monetary accounting, environmental protection input/output accounting, and environmentally adjusted domestic product (EDP) accounting. Both physical and monetary accountings are composed of environmental pollution and ecological degradation parts. The environmental pollution part refers to the emissions and discharges of pollutants, so that it is "source-oriented" and the accounting can be carried out for different regions as well as for different industrial sectors. However, the ecological degradation part refers to the economic loss due to the impact of environmental pollution, so that it is "receptor – oriented" and the corresponding accounting can only be implemented for different regions.

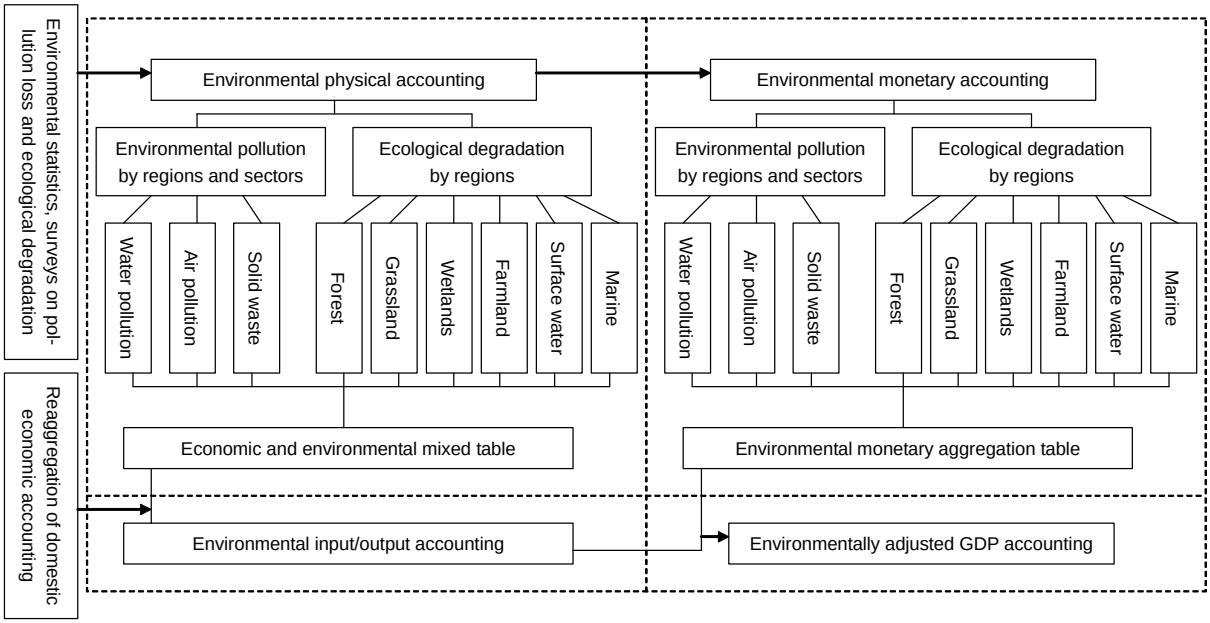

Figure 3-1 Framework for China Environmental and Economic Accounting (CEEA)

Due to the limitations of research conditions, for the projects on China 2004 data, the physical and monetary accountings were carried out with water pollution, air pollution and solid waste. The results were used for environmentally adjusted GDP accounting. But the environmental protection input/output accounting, and the accountings of ecological degradations were not considered temporarily. Further, ecological degradation noted in Figure 3-1 should include direct impacts by pollution such as human health, material loss or agricultural yield loss etc., and indirect ecological losses. However, due to limited conditions, the indirect loss accountings were not considered in the two Projects. Therefore, the framework for projects 2004 can also be drawn as Figure 3-2[1].

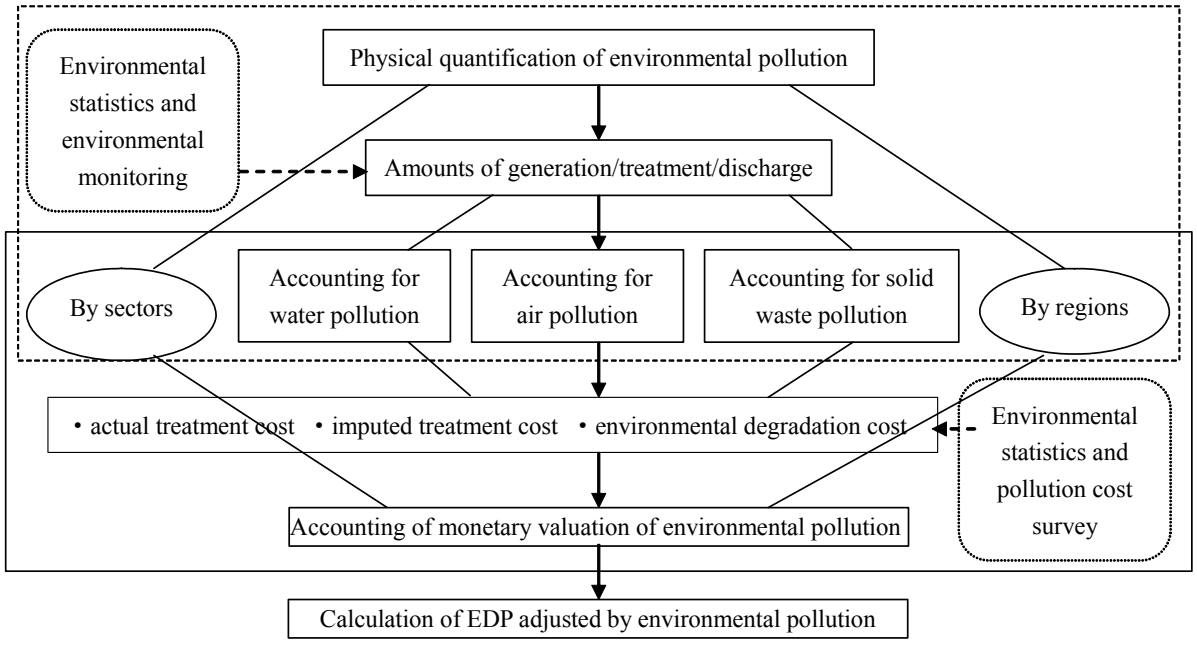

Figure 3-2 Framework of CEEA for the 2004 green accounting projects

It is also noted that, shown in Figures 3-1 and 3-2, natural resource accounting has not yet been included in the current framework. Therefore, as the Reports said, the current proposed framework is for "short term". A more comprehensive framework for green economic accounting is to be designed for further studies.

3.2.2 Approaches and methods

As shown in Figure 3-3, two approaches were adopted for environmental accountings: ***Pollution Treatment Cost Approach*** and ***Environmental Degradation Cost Approach***. The Pollution Treatment Cost Approach is based on the ***physical accounting*** for pollutants, which includes treated and untreated parts. The ***monetary accounting*** for treated pollutants leads to a percentage that has been included in GDP, but the monetary accounting for untreated pollutants leads to a reduction in GDP that ends up with environmentally adjusted GDP, or EDP. Even if the pollutants are discharged after treatment, there should still be impacts on environment leading to environmental degradation. The Environmental Degradation Cost Approach supplements the first approach. It is based on environmental monitoring or surveying data.

With experimental experience or other sources, the corresponding monetary accounting quantifies environmental degradation cost and leads to the figure that should be reduced from GDP.

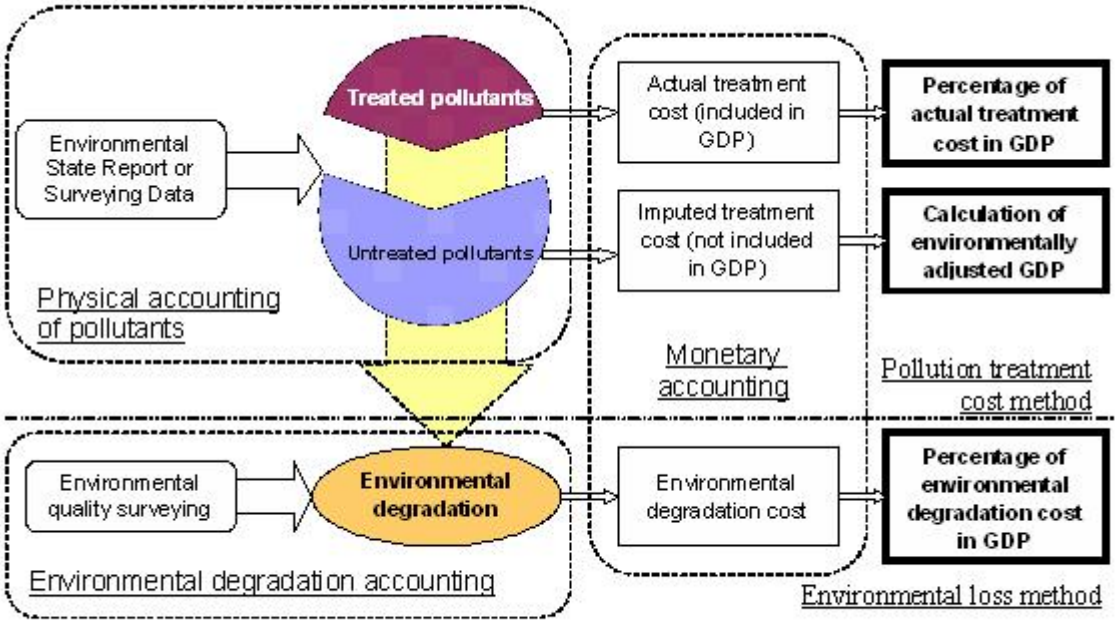

Figure 3-3 Technical approaches for China Environmental and Economic Accounting

It is noted that, "pollutant treatment" commonly refers to "end-of-pipe" method, i.e., the pollutants are already generated, but by means of best available technologies to reduce their amounts in the effluents. There are discharge or emission standards in discharge concentrations, or other requirements, e.g. "mass-loading" requirement etc. Meeting these requirements, the discharge or emission in considered as "attained", or "treated". Therefore, "treatment" does not mean pollutants-free. Therefore, Figure 3-3 is a modified version of the respective figure in the final report for the World Bank Project[2]. In the present figure, it indicates that, no matter the pollutants are discharged with or without treatment, there will be some pollution generated, only of different severities, to lead to environmental degradations of different degrees.

3.2.2.1 Physical accounting

In physical accounting, the environmental sectors included water, air, and solid waste. The corresponding scope, objects, indicators, methods and data sources are listed in Table 3-1.

In the project, the CEEA framework and methodology were applied to the 2004 data of Beijing City, Anhui Province, and Guangdong Province, to obtain necessary experience. Then the system was applied to the whole country to obtained the 2004 data. In the work, there were 39 sectors of the agriculture, secondary industries, and 42 sectors of tertiary industry taken into account.

3.2.2.2 Monetary accounting

(1) Actual pollution treatment cost approach

The monetary accounting for this approach was performed including water pollutants, air pollutants, industrial solid wastes, and urban domestic wastes, as well as the economic loss by accidental releases of chemicals. This approach might be referred to as "source-oriented" so that it can be applied to both different regions and different industrial sectors.

Actual treatment cost refers to the cost by polluters, say by industrial enterprises that had been expended in pollution control to make effluents meet emission standards or mass loading control requirements. These costs include that for the treatments of industrial wastewater, waste gas, and solid waste, livestock wastewater, urban household wastewater and solid waste. Formula (3-1) was used for the calculation:

Actual pollution treatment cost =

Pollutant treatment (abatement) quantity × per unit actual treatment cost (3-1)

The amounts of treated pollutants were found by the physical accounting. The per unit actual treatment cost was worked out based on the survey data in the pilot regions. This part of expense should already be included in GDP accounting. Therefore, the target of this monetary accounting is its portion in GDP.

(2) Imputed pollution treatment cost approach

Practically in China, not all the pollutants are treated before discharging. The accounting method for imputed treatment cost then refers to the cost that would have been used if the untreated pollutants also got treated. Therefore, Formula (3-2) looks like Formula (3-1).

Imputed pollution treatment cost =

pollutant discharge quantity × per unit imputed treatment cost (3-2)

However, since the treatment did not really happen, so that the cost was not accounted in GDP. Therefore the target of this calculation is to reduce the figure of GDP so as to obtain EDP, environmentally adjusted GDP.

It is noted that, based on the note for Figure 3-3, pollution cost approach has the shortage that the part of environmental degradation by the pollutants discharged after treatment is not accounted..

(3) Environmental degradation cost approach

The accounting for both actual and imputed treatment costs cannot cover all the costs in environmental deterioration. The second approach, environmental degradation cost approach, is from the other end to supplement the above two approaches. This approach is based on comprehensive surveys on pollution losses, and utilizes special methods to attach monetary values on the physical impacts, such as the costs of drop in crops output, impaired health, ecological disturbance, and then identifies the environmental degradation cost that should be subtracted from the GDP.

Table 3-1 Elements of the physical accounting

Elements	Scope	Objects	Indicators	Methods	Data Sources
Water pollution	• Waste water from: - Agriculture, - Livestock farming, - Industrial sectors, - Tertiary industries. • Domestic sewage	• Pollutants from industrial sectors: COD, NH_3-N, heavy metals and oil • Pollutants from agriculture, livestock farming, tertiary industries, and sewage: COD, and NH_3-N.	• Amount of sewage and wastewater discharge which was: - meeting the standards, and - violating the standards. • The amount of pollutants which was - generated - treated, and - directly discharged from the sources.	• Industrial wastewater and municipal sewage were based on the environmental statistics, and water consumption coefficient and wastewater generation coefficient were used as amendment. • Agricultural, livestock and rural domestic wastewater were used the unit source discharge coefficient, and per capita pollutant generated coefficients.	• China Annual of environmental statistics, • China Annual of Urban Construction Statistics, • National and provincial Water Resource Bulletins, • China Statistical Yearbook, • China Livestock Yearbook.
Air Pollution	• Waste gas from: - agriculture, - industrial sectors, - tertiary industries - households.	• Major pollutants: - SO2, - Soot, - industrial dust, and - NOx	• The amount of pollutants (SO2, soot, dust and NOX), which was - generated - treated, and - directly emitted from the sources.	• Using the data from environmental statistics; energy consumption balance, and discharge coefficients.	
Solid waste	• Solid waste form industrial sectors and urban households	• General industrial solid wastes, • Household wastes and • Industrial hazardous wastes.	• The amount of: generation, comprehensive utilization, storage, and disposal and deposit of industrial wastes, including hazardous wastes. • The amount of: generation, landfill, compost, incineration, etc of urban domestic wastes.	• Using the data form national and local statistic yearbooks	

For environmental degradation cost approach, more than twenty items are supposed to be considered. However, limited by conditions, in the 2004 Projects, the environmental degradation cost composed only ten items：(1) health cost caused by air pollution; (2) agricultural loss caused by air pollution; (3) material losses caused by air pollution; (4) economic losses caused by water scarcity due to pollution; (5) health influences by water pollution; (6) agricultural losses by water pollution; (7) defense expenses of industrial sectors caused by water pollution; (8) urban households economic losses by water pollution; (9) losses caused by land occupation due to solid wastes deposit; and (10) losses by pollution accidents.

3.2.3 Accounting for environmentally adjusted GDP

As described above, the environmentally adjusted GDP (or EDP) in the Project refers to the value of GDP by reducing imputed treatment cost of pollutants and environmental degradation costs. The calculation formula are (3-3) and (3-4)

$$EDP_1 = GDP - \text{Imputed treatment cost} \quad (3\text{-}3)$$

$$EDP_2 = GDP - \text{Environmental degradation costs} \quad (3\text{-}4)$$

Since the valuing system of environmental degradation cost differs from that of traditional GDP, in the 2004 Projects, only the proportion of environmental cost in the GDP was calculated, instead of directly deducting environmental degradation cost from GDP.

3.3 The 2004 Green GDP Accounting Report

Although there are problems and shortages, the 2004 China Green GDP Accounting (CCGDPA) Report is a milestone of China's economic accounting. It not only provides a quantified assessment of the cost in environmental degradation along with economic development, but also shows the resolution of the country in measuring economic development with the cost of environmental degradation and resource consumption.

According to NBS, respective to the geographic distribution and natural conditions, the 31 provinces and cities directly under the central government of the mainland China are divided into three regions: eastern, middle, and western, shown in Figure 3-4. The eastern region includes Beijing, Tianjing, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan. The middle region refers to Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan. The western region composes Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Xizhang (Tibet), Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang. Because of favorite conditions, the eastern region is the most developed and the western is the most backward, e.g. Figure 3-5. In view of the different natural conditions, different level of technologies, and different development statuses, it should be beneficial to compare the green accounting results among the three regions. In the follow up sections, the 2004 Project results are summarized referring to these three regions.

3.3.1 Physical accounting

In physical accounting, of 2004 China, the surveyed total amount of discharged wastewater, COD and NH_3-N were found 60.72 billion tons, 21.093 million tons, and 2.232 million tons respectively；the total emissions of SO_2, soot, industrial dust and NO_X were 24.502 million tons, 10.955 million tons, 9.051 million tons and 16.466 million tons respectively；the discharged industrial solid wastes was 17.608 million tons while domestic wastes 66.675 million tons.

Figure 3-4 The three economic regions of mainland China
Yellow – Eastern, Green – Middle, Violet - Western

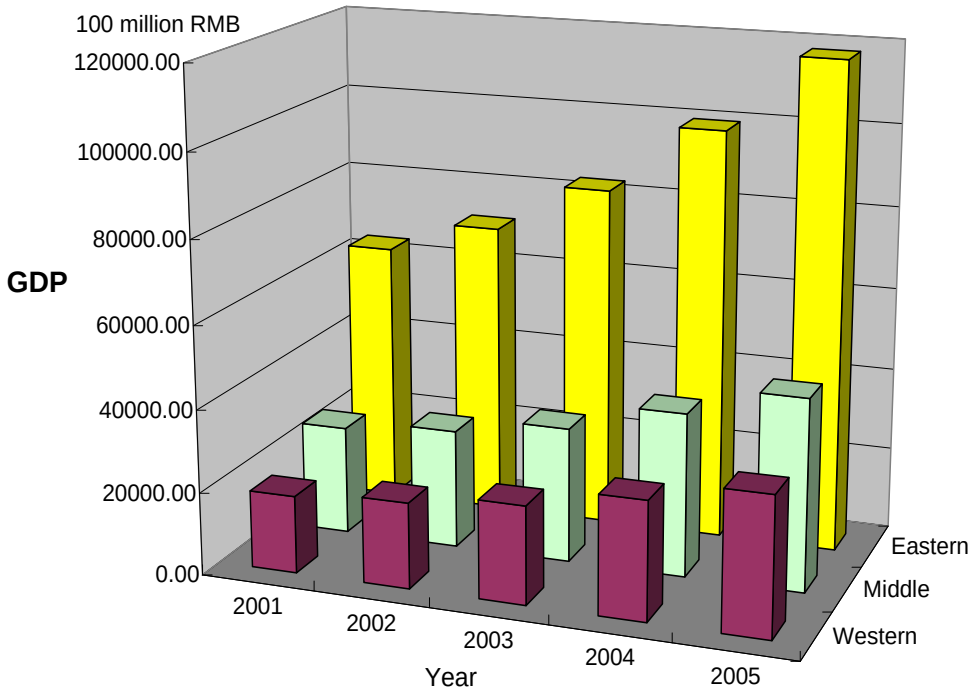

Figure 3-5 Economic development in the three regions of mainland China
(Data taken from NBS website: http://www.stats.gov.cn/)

(1) Water pollutants

The surveyed amount of wastewater discharged from the industrial sectors reached 22.11 billion m^3, accounting for 36.4% of the total amount of the wastewater discharged in 2004. The discharge amounts of COD in urban sewage from households and public sectors and in that from primary industry accounted for 39.3% and 36.6% of the total discharged COD, while the discharge amounts of nitrogen oxides from that accounted for 40.7% and 36.1% of the total respectively. The leading water pollution industries were found: chemical engineering, pulp and paper-making, power plant, ferrous metallurgy, textile, and food processing. An example is shown in Figure 3-6 which illustrates the sectoral discharge of COD in industrial wastewaters. Figure 3-7 is the comparison of wastewater discharge and water pollutants discharged by eastern, middle and western regions of China.

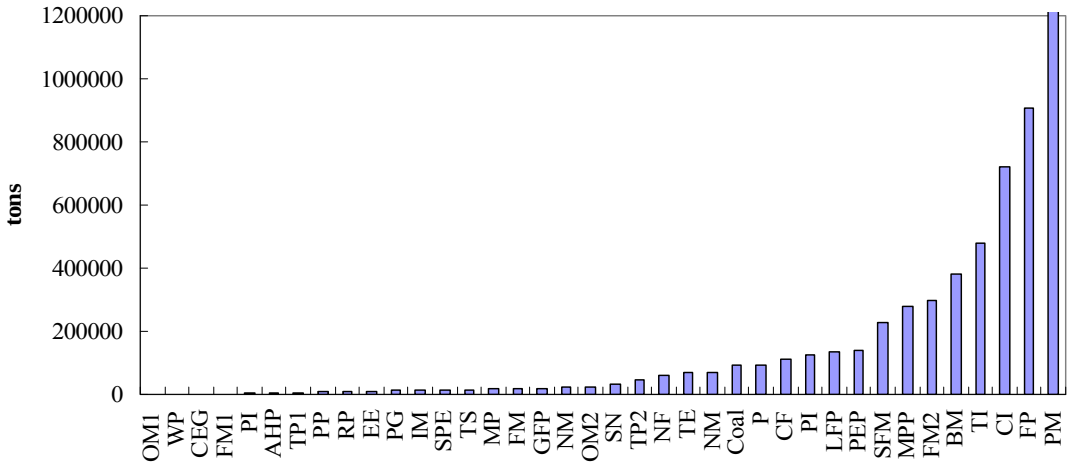

Figure 3-6 Comparison of COD discharges by different industrial sectors in 2004

OM1	Other Mining	TS	Telecommunication Services	CF	Chemical Fiber
WP	Waste Processing	MP	Metal Products	PI	Petrochemical Industry
CEG	Cultural and Educational Goods	FMM	Ferrous Metal Mining	LFP	Leather, Furs Products
FM1	Furniture Manufacturing	GFP	Garments and Fiber Products	PEP	Production of Electric Power
PI	Printing Industry	NMM	Nonmetal Minerals Mining	SFM	Smelting of Ferrous Metals
AHP	Arts and Handicraft Products	OM2	Ordinary Machinery	MPP	Med. & Pharmac. Products
TP1	Tobacco Products	SNM	Smelting of Nonferrous Metals	FM2	Food Manufacturing
PP	Plastic Products	TP2	Timber Processing	BM	Beverage Manufacturing
RP	Rubber Products	NFM	Nonferrous Metal Mining	TI	Textile Industry
EE	Electric Equipment	TE	Transport Equipment	CI	Chemical Industry
PG	Production of Gas	NM	Nonmetal Manufacturing	FP	Food Processing
IM	Instrument Machinery	Coal	Coal	PM	Paper Making
SPE	Special Purpose Equipment	P	Petroleum		

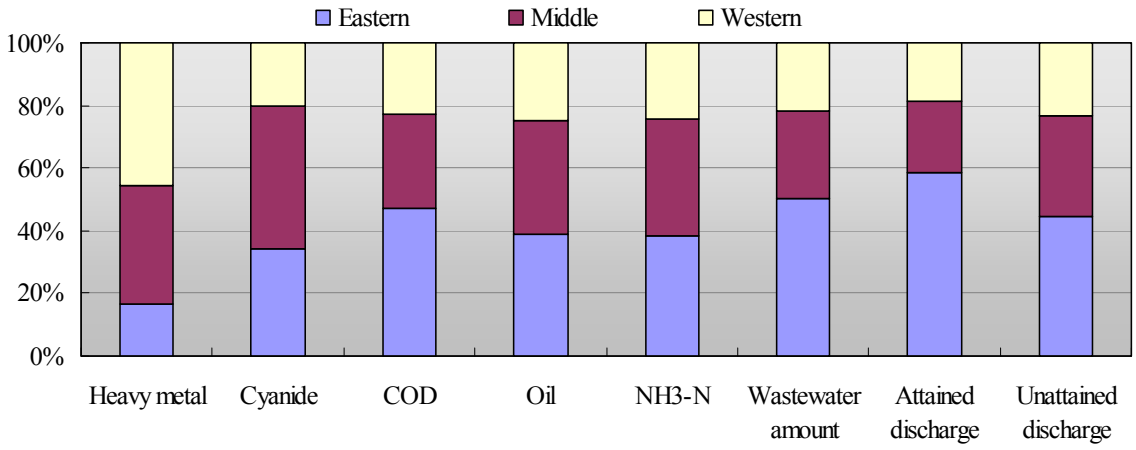

Figure 3-7 Comparison of wastewater discharge and the discharges of major water pollutants by eastern, middle and western regions of China

(2) Air pollutants

In 2004, the emissions of SO_2, soot and NO_x from the second industry were found 21.856, 13.093, and 8.866 million tons which accounted for 89.2%, 80%, and 81.8% of the total emissions in China respectively.

SO_2 was mainly emitted from power industry, 63.3% of the industrial emission. NO_x was mainly emitted from power and steel/iron industries, while soot was mainly emitted from power industry and nonmetallic manufacturing.

Figure 3-8 provides a comparison of air pollutant emissions from major industrial sectors. Figure 3-9 provides a comparison of air pollutant emissions from different regions. However, according to Figure 3-10, the treatment statuses at the three regions are similar, but desulfurization for SO_2 emission reduction seems more difficult than dust and soot removal.

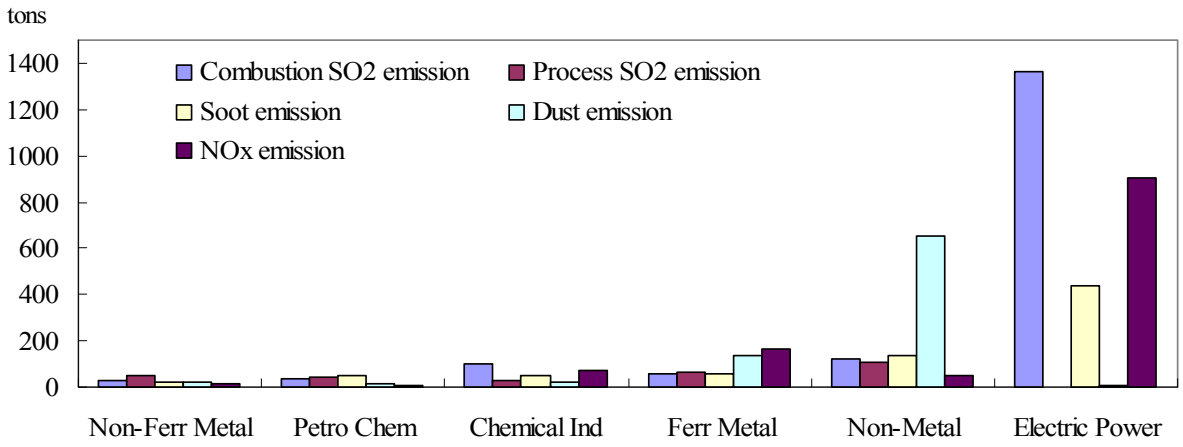

Figure 3-8 Air pollutant emissions from major industries

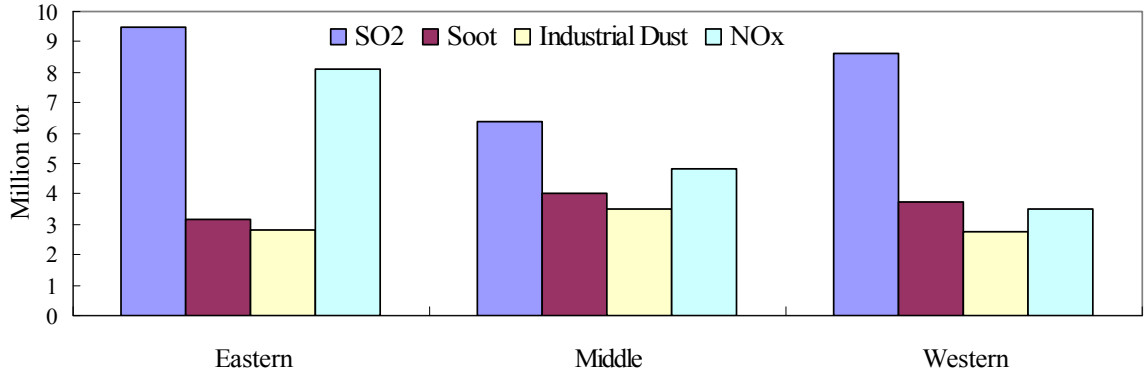

Figure 3-9 Air pollutant emissions form eastern, middle, and western regions

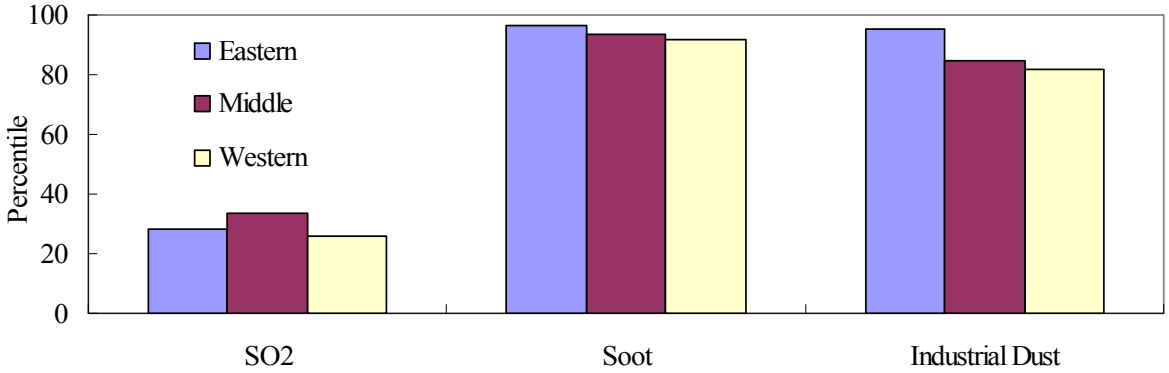

Figure 3-10 Treatment rates of air pollutants in the three regions

(3) Solid waste

For solid wastes, it was found, 1.19 billion tons of industrial solid wastes were generated in 2004, among which 652 million tons were reused and 264 million tons were properly disposed. Therefore, the integrated disposal and utilization rate is 78.8%. It was also found that the top five industries with large solid waste generation were power industry, ferrous metallurgy, coal mining, ferrous and non-ferrous metal mining industry. The eastern region is generating more solid wastes than that from other two regions.

Some of the results in physical accounting are listed in Table 3-2.

Table 3-2 Physical accounting of pollution in 2004

Element	Pollution source	Indicators	Quantity	Unit	% of the total
Water Pollution	Industrial sectors	Total generated amount	12.11	billion m^3	36.4
		Discharged amount meeting standard	17.38		78.6
		Discharged amount violating standards	4.73		21.4
	Municipal sewage and others	Total generated amount	38.60		63.6
		- meeting standards	7.06		18.2
		- violating standards	31.54		81.8
	Industrial sectors	COD	7.45	Million tons	35.3
		NH_3-N	0.51		23.2
	Agricultural sectors	COD	5.35		25.4
		NH_3-N	0.81		36.1
	Others	COD	8.29		39.3
		NH_3-N	0.91		40.7
Air pollutants Emitted	Industrial sectors	SO_2 generated	30.87		89.4
		Soot generated	189.93		97.9
		Dust generated	94.33		100.0
		NOx generated	13.18		79.8
		SO_2 emitted	21.86		89.2
		Soot emitted	8.96		81.8
		Dust emitted	9.05		10.0
		NOx emitted	13.18		80.0
	Others (agricultural sectors, tertiary industries and municipal households)	SO_2 generated	3.65		10.6
		Soot generated	2.74		2.1
		Dust generated	---		0.0
		NOx generated	3.32		20.2
		SO_2 emitted	3.65		10.8
		Soot emitted	2.00		18.2
		Dust emitted	---		0.0
		NOx emitted	3.29		20.0

Table 3-2 Physical accounting of pollution in 2004 (continued)

Solid waste	Industrial sectors	Total generated amount	1189.7		100.0
		Comprehensive use amount	673.9		56.6
		Disposal amount	263.6		22.1
		Deposited amount	256.7		21.6
		Discharged amount	17.6		1.5
	- Power industry	Generated amount	254.8		21.4
		Comprehensive use amount	169.0		25.0
		Disposal amount	33.5		12.7
		Deposited amount	57.6		22.4
		Discharged amount	0.6		3.4
	- Black metallurgy	Generated amount	208.1		17.5
		Comprehensive use amount	152.8		22.7
		Disposal amount	20.2		7.6
		Deposited amount	28.9		11.2
		Discharged amount	2.3		13.1
	Municipal and other sectors	Total generated amount	191.9		100.0
		Landfill amount	68.9		35.9
		Composting	7.3		3.8
		Incineration	4.5		2.3
		Random discard	44.6		23.2
		Piled up in order	29.8		15.5
		Random piled	36.8		19.2
	Hazardous wastes	Total generated amount	9.9		100.0
		Comprehensive use amount	4.0		4.0
		Disposal amount	2.6		26.0
		Deposited amount	3.3		33.0
		Discharged amount	0.01		≤0.1

3.3.2 Monetary accounting: pollutant treatment cost approach

In 2004, GDP by production approach of China was reported as 15987 billion RMB.

According to the surveying data of 2004, the actual and imputed costs for wastewater treatment were found 34.44 and 180.87 billion RMB, accounted for 0.215% and 1.13% of the GDP respectively. The actual treatment cost for waste gas was 47.82 billion RMB, accounted for 0.29% of the 2004 GDP, while the imputed treatment cost for waste gas was 92.23 billion RMB, accounted for 0.55% of the 2004 GDP. The actual treatment cost for solid wastes across the country was 18.28 billion RMB, accounted for 0.11% of the GDP of all the industries. The imputed treatment cost for solid waste was 14.35 billion RMB, accounted for 0.09% of the GDP. Figure 3-11 illustrates the calculated treatment costs for eastern, middle and western regions.

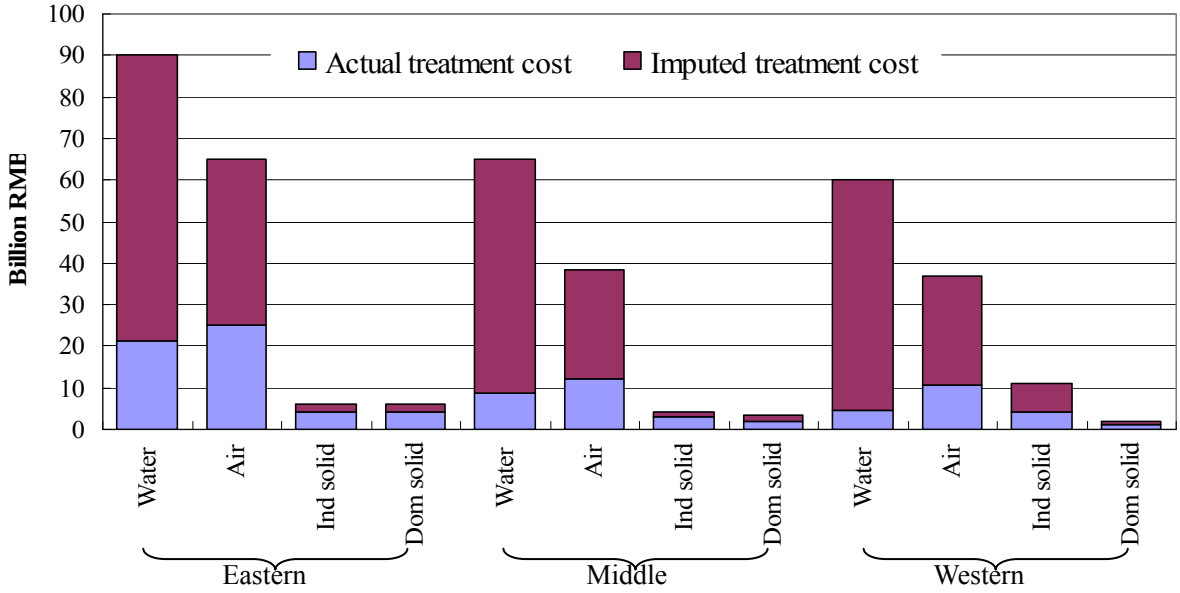

Figure 3-11 The actual and imputed treatment costs for eastern, middle and western regions

According to the accounting results, the total environmental treatment cost was found as 387.98 billion RMB, with 55.59%, 36.1% and 8.4% for wastewater, waste gas and solid wastes respectively. Within the total treatment cost, the actual was about 26% only, which illustrates that the environmental input was far from necessary.

In 2004, the actual treatment cost for pollutant attained emissions reached 100.53 billion RMB, among which actual treatment costs for water pollution, air pollution and solid wastes pollution were 34.44, 47.82, and 18.27 billion RMB respectively; while the imputed treatment cost for environmental pollution totaled up to 287.44 billion RMB, among which the imputed treatment costs for water pollution, air pollution and solid wastes pollution were 180.87, 92.23, and 14.35 billion RMB respectively. It is also noted, shown in Figure 3-12, that the imputed treatment cost for water pollution accounted for 84.0% of the total treatment cost for water pollution, 5.3 times as that of its actual treatment cost, so that the greatest input gap exists in water pollution control comparing with other pollutant treatments.

The actual and imputed treatment costs for industrial wastewater accounted for 74.2% and 55.5% of the total treatment costs. Among 39 industria1 sectors, ferrous metallurgy, chemical, paper-making, petrifaction and textile industries were listed in the first five places of actual treatment cost, while paper-making; food processing, chemical, textile and pharmacy industries were listed in the first five places of imputed treatment cost.

The total treatment cost for air pollution control from industrial sources reached 88.29 billion RMB, among which the treatment cost for waste gas from power industry was 55.14 billion RMB accounted for

62.5% of the total treatment cost. It is clear that power industry is the core of industrial air pollution control.

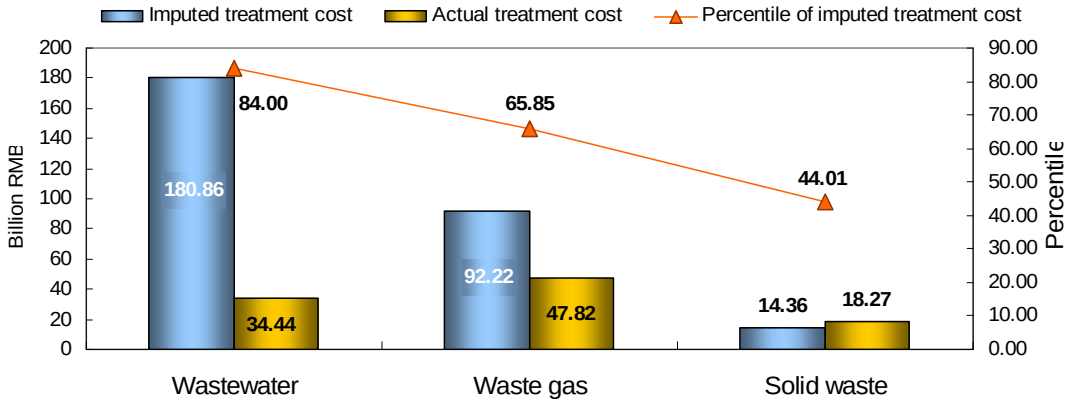

Figure 3-12 Imputed and actual treatment costs for wastewater, waste gas and solid waste

The actual and imputed treatment costs for industrial wastewater accounted for 74.2% and 55.5% of the total treatment costs. Among 39 industria1 sectors, ferrous metallurgy, chemical, paper-making, petrifaction and textile industries were listed in the first five places of actual treatment cost, while paper-making; food processing, chemical, textile and pharmacy industries were listed in the first five places of imputed treatment cost.

The total treatment cost for air pollution control from industrial sources reached 88.29 billion RMB, among which the treatment cost for waste gas from power industry was 55.14 billion RMB accounted for 62.5% of the total treatment cost. It is clear that power industry is the core of industrial air pollution control.

The actual and imputed treatment cost for industrial solid wastes were 11.13 and 9.99 billion RMB in 2004, 52.7% and 47.3% of the total treatment cost for solid wastes. The actual and imputed treatment costs for urban domestic wastes were 7.15 and 4.36 billion RMB, accounted for 62.1% and 37.9% of the total respectively.

The calculation results show that the imputed treatment cost of secondary industry in 2004 was 179.03 billion RMB, among which the input of 100.37 billion RMB was required for industrial wastewater pollution control, accounted for 56.1% of the total imputed treatment cost for the second industry, while the respective figure for the industrial air pollution control was about 38.4%, lower than that for wastewater. It was also found that the treatment for urban domestic wastewater was left behind. At the time, the actual treatment cost for urban household wastewater was 4.76 billion RMB accounted for 47.1% of the actual treatment cost for waste gas. Therefore, more environmental input for urban household wastewater pollution control has to be improved urgently.

In 2004, power industry was of the highest treatment cost of 59.35 billion RMB among the 39 industrial sectors, which also ranked first in the actual treatment cost list and imputed treatment cost list of industries. Paper-making, chemical, iron and steel, and food processing industries ranked from the second to the fifth place in the list of total treatment cost. The ranking of the above-mentioned four industries in the list of imputed treatment cost are basically same with that of total treatment cost, which shows that pollution control level of those four industries is relatively lower and they require greater environmental input for pollution control.

The eastern region of China is of densely population, high industrialization level and rapid economic growth, so its environmental pollution is also more severe. In 2004, the actual treatment cost for the eastern region is 54.51 billion RMB, accounted for 54.2% of the total actual treatment cost across the country. While the imputed treatment cost for eastern region amounts to 112.55 billion RMB, 2 times that its actual treatment cost. It shows that the input for the pollution control in the eastern region should still

be increased. The situation of the middle and western regions is much worse. The imputed treatment costs in the middle and western regions account for 77.0% and 81.4% of their respective total treatment costs. The actual treatment costs and imputed treatment costs in the eastern, middle and western regions are as shown in Figure 3-13.

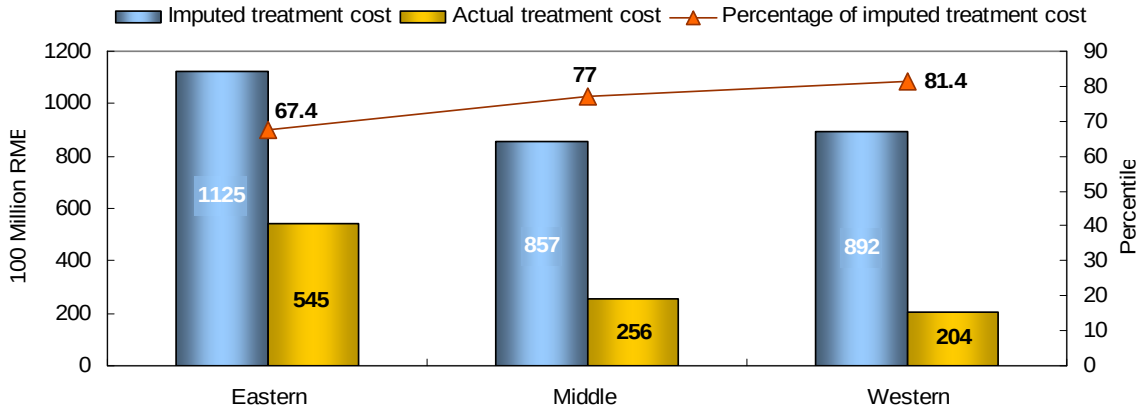

Figure 3-13 The imputed and actual treatment costs for eastern, middle and western regions

3.3.3 Monetary accounting: environmental degradation cost approach

While pollutant treatment cost approach can be regarded as pollution source – oriented, the environmental degradation cost method may be considered as receptor – oriented. In the 2004 projects, the cost by environmental degradation was also accounted. Relative to their importance, there can be over 20 items for such an accounting. However, due to limited conditions, only ten items, such as the health issues, impact on industrial and agricultural production and water shortage by water pollution etc., were calculated. The costs by soil contamination, groundwater pollution and other important parts were not included. The main results are summarized in the following.

(1) Water environmental degradation cost

Water environment degradation cost accounting included the costs due to water pollution: water shortage, health impact, agriculture loss, additional cost for industrial water supply, and additional cost fro urban domestic water supply.

In 2004, the environmental degradation cost caused by water pollution was calculated 286.28 billion RMB, accounted for 55.9% of the total environmental degradation cost and 1.71% of the 2004 GDP, among which the damage cost of human health in rural areas by water pollution reached 17.86 billion RMB, economic loss of water shortage caused by water contamination was 147.83 billion RMB, and the additional treatment cost for industrial water use was 46.26 billion RMB. Economic loss of agricultural yield by water pollution was 46.84 billion RMB, and additional treatment and prevention cost for urban domestic water was 27.49 billion RMB.

In 2004, water environmental degradation cost in the eastern region of China amounted to 151.77 billion RMB, which was the highest among the three regions and accounted for 53.0% of the total environmental additional cost by water pollution and 1.5% of the eastern region GDP. The water environmental degradation costs in the middle and western regions were 77.75 billion RMB and 56.75 billion RMB, accounted for 27.2% and 19.8% of the total water degradation cost respectively, but their percentages in the local GDPs were near 2.0%, higher than that in the eastern region.

(2) Atmospheric environmental degradation cost

For air pollution, it was considered the impacts on human health, agriculture yield depletion, and

material loss. However, due to limited conditions and pollution impact understanding, the following impacts were not included: human health by indoor air pollution, health effect by photochemical smog and odor, forest degradation by air pollution such as acid rain etc. In addition, the additional service cost due to air pollution was not included because that the surveying was not completed.

The environmental degradation cost caused by air pollution was 219.8 billion RMB in 2004, accounted for 42.9% of the total environmental degradation cost and 1.31% of the 2004 GDP, among which the damage cost of human health in urban areas by air pollution reached 152.74 billion RMB, economic loss of agricultural yield caused by air pollution was 53.78 billion RMB, and material loss by air pollution was 13.28 billion RMB.

In 2004, the environmental degradation cost by air pollution in the eastern region was the highest, which reached 131.16 billion RMB and accounted for 60.0% of the total atmospheric environmental degradation cost while that in the middle and western regions amounted to 54.16 billion RMB and 34.47 billion RMB, accounted for 24.6% and 15.7% of the total atmospheric environmental degradation cost. The percentages of air environmental degradation cost in local GDPs were 1.4%. 1.3% and 1.2% respectively in the middle, eastern and western regions.

(3) Environmental degradation cost caused by solid waste pollution

The environmental impact by solid waste includes land use occupation, soil and ground water pollution due to leakage, etc. However, in the 2004 projects, only land use loss was considered.

In 2004, the deposit amount of industrial solid wastes amounted to 17.62 million tons across the country, approximately occupying the land of 6.177 million m^2, resulting in the opportunity cost for land loss of 91 million RMB. At the same time, the deposit amount of urban domestic solid wastes amounted to 66.615 million tons while that of rural domestic solid wastes to 64.58 million tons across the country in 2004, both of which occupied the land of 35.769 million m^2, leading to the opportunity cost for land loss of 556 million RMB. To total up, the environmenta1 degradation cost caused by solid waste pollution amounted to 650 million RMB across the country in 2004, accounted for 0.1% of the total environmental degradation cost and 0.004% of the 2004 GDP.

In 2004, the eastern region was of the highest environmental degradation cost by solid wastes, which amounted to 248 million RMB; the next is the middle region with 213 million RMB of degradation cost by solid wastes; the western region is of the lowest, which reached 186 million RMB. The environmental degradation costs caused by solid wastes in the eastern, middle and western regions accounted for 38.39%, 33.0% and 28.8% of the total degradation cost by solid wastes respectively.

(4) Environmental degradation cost caused by pollution accidents

There were totally 1441 environmental pollution accidents taken place in China in 2004 with direct economic losses over 333 million RMB. In accordance with “the Report on the State of the Fishery Eco-Environment China”, 1020 fishery pollution accidents occurred in China in 2004 causing direct economic losses of 1.08 billion RMB while economic losses of natural fishery resources by environmental pollution amounted to 3.65 billion RMB. Therefore, the environmental degradation cost caused by pollution accidents totaled up to 5.09 billion RMB accounted for 1.1% of the total environmental degradation cost and 0.037 of the 2004 GDP.

(5) Integrated analysis on environmental degradation cost

The total environmental degradation cost in 2004 calculated by environmental degradation cost approach was 511.82 billion RMB, accounted for 3.05% of the 2004 GDP (the adjusted figure), among which the environmental degradation cost caused by air pollution, water pollution, depositing solid waste and pollution accidents were 219.8, 286.28, 650 million RMB, and 5.09 billion RMB, accounting for 42.9%, 55.9%, 0.1% and 1.1% of the total degradation cost respectively.

The environmental degradation costs in the eastern, middle and western regions reached 283.1, 132.2,

and 91.8 billion RMB respectively, accounted for 55.8%, 26.1% and 18.1% of the total environmental degradation cost across the country. The environmental degradation costs of the three regions and their percentiles in local GDP are shown in Figure 3-14.

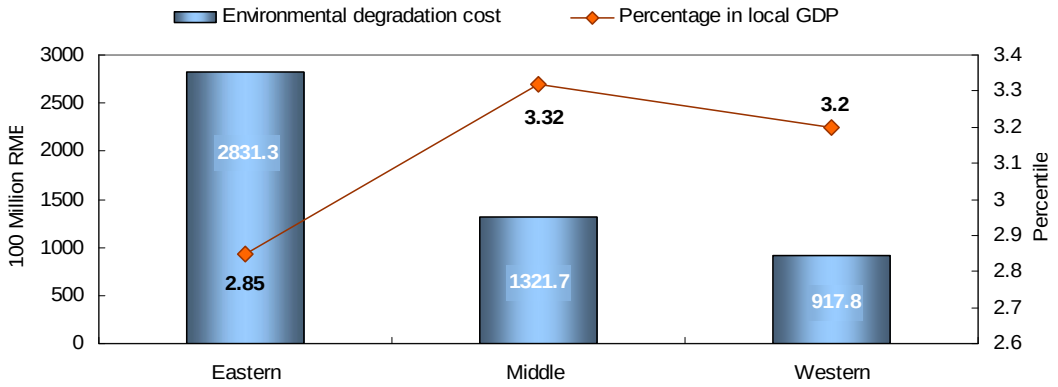

Figure 3-14 Environmental degradation costs in the eastern, middle and western regions

3.3.4 Environmentally Adjusted GDP (EDP)

According to the CEEA framework, the environmentally adjusted GDP, or EDP, refers to the value that the original GDP minus the imputed pollutant treatment cost. The Gross Domestic Product of all the industries calculated by production approach was 15987 billion RMB in 2004 in China while the imputed treatment cost was calculated 287.4 billion RMB. Therefore, the index of environmentally adjusted domestic production (I_{EDP}^{a}) was approximately 1.80%, which refers to the portion of the GDP of 2004 would have been spent if the pollutants were also treated.

It was accounted that the indices of environmental adjusted domestic production were l.13%, 2.17%, and 3.12%, respective to the eastern, middle and western regions. Therefore, it is shown that economic level and pollution control level of the western region are both lower. It was also found that, there were 21 provinces or municipalities with I_{EDP} 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 in Figure 3-15

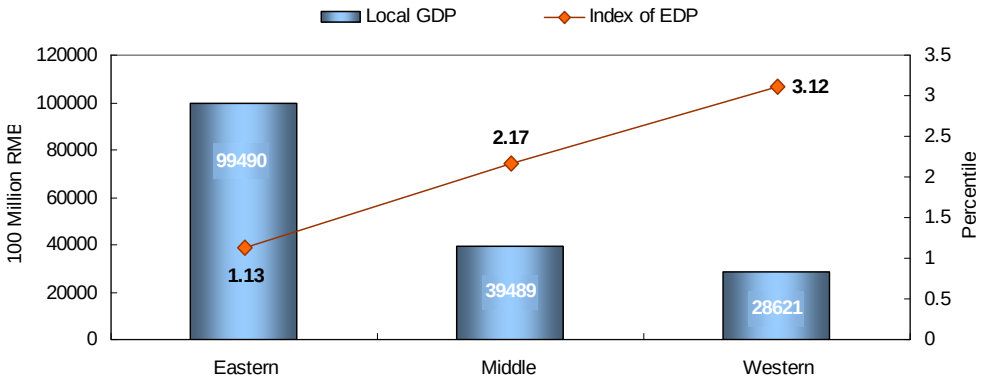

Figure 3-15 GDP and Index of Environmentally Adjusted Domestic Production (I_{EDP}^{a}) in Different Regions

The environmental adjusted values of industrial sectors were described by two indicators: the environmentally adjusted incremental values (EAIV) and the index of environmentally adjusted values (IEAV or I_{EDP}^{b}). The IEAV is expressed as Formula (3-5). I_{EDP}^{b} is equivalent to the portion that the imputed treatment cost be respective to the corresponding part of GDP.

$$I_{EDP}^{b} = \text{EAIV} / (\text{Incremental Value without adjustment}) \quad (3\text{-}5)$$

According to the results of environmentally adjusted GDP, the imputed treatment costs of the agriculture, secondary industry and tertiary industry were 33.07, 179.03 and 75.34 billion RMB respectively. The indices of environmentally adjusted GDP of these three parts were 1.58%, 2.42% and 1.16% respectively. The imputed treatment cost of these three parts and their proportions in the added values are shown as Figure 3-16,

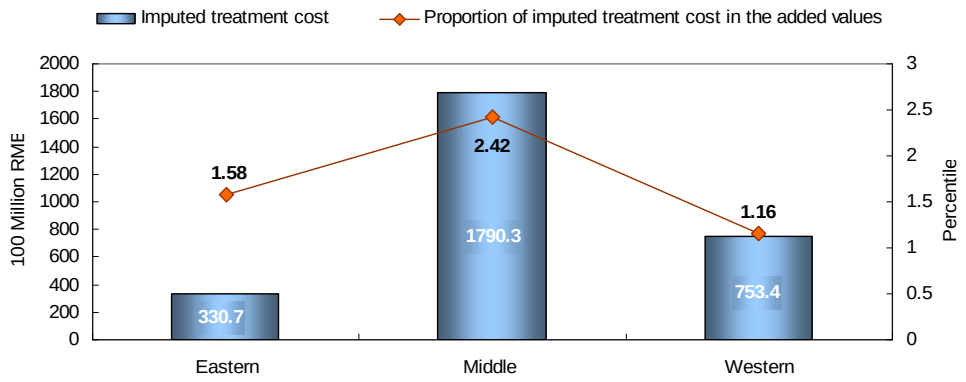

Figure 3-16 Imputed costs and proportion of imputed cost in added values at the three regions

Within different industrial sectors, in 2004, the water supply industry was of the lowest I_{EDP}^{b}, 0.04%. The follow ups are tobacco industry and furniture manufacturing with both I_{EDP}^{b} of 0.05%. The I_{EDP}^{b} of printing industry, communication industry, electrical and mechanical industry, stationery and other industries were not exceeding 0.1%, which showed that those industries were with less pollutant discharge and caused less pollution impact. However, The I_{EDP}^{b} of paper-making and non-ferrous metal mining industries were the highest, reaching 30.13% and 11.63% respectively, which illustrated that the ratio between economic benefits and environmental costs of those two industries were the lowest and had caused grave pollution. I_{EDP}^{a} of 39 industrial sectors is as shown in Figure 3-17.

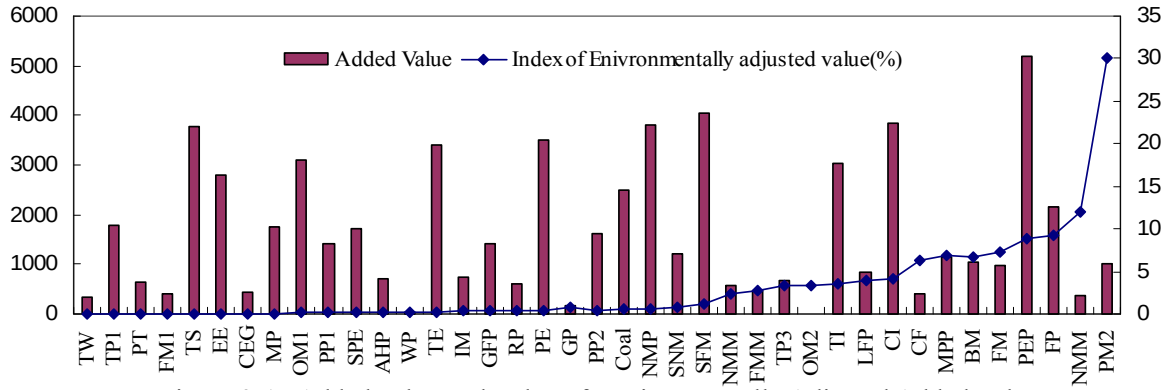

Figure 3-17 Added value and Index of Environmentally Adjusted Added Value of 39 different industrial sectors

TW	Tap Water	TE	Transport Equipment	TP2	Timber Processing
TP1	Tobacco Processing	IM	Instrument Machinery	OM2	Other Mining
PT	Printing	GFP	Garments and Fiber Products	TI	Textile Industry
FM1	Furniture Manufacturing	RP	Rubber Products	LFP	Leather, Furs Products
TS	Telecommunication Services	PE	Petroleum Extraction	CI	Chemical Industry
EE	Electric Equipment	GP	Production of Gas	CF	Chemical Fiber
CEG	Cultural and Educational Goods	PP2	Petroleum Processing	MPP	Medical and Pharmaceutical Products
MP	Metal Products	Coal	Coal	BM	Beverage Manufacturing
OM1	Ordinary Machinery	NMP	Nonmetal Products	FM2	Food Manufacturing
PP1	Plastic Products	SNM	Smelting of Nonferrous Metals	PEP	Production of Electric Power
SPE	Special Purpose Equipment	SFM	Smelting of Ferrous Metals	FP	Food Processing
AHP	Arts and Handicraft Products	NMM	Nonmetal Minerals Mining	NFM	Nonferrous Metal Mining
WP	Waste Processing	FMM	Ferrous Metal Mining	PM	Paper Making

3.3.5 Interpretation of the 2004 green GDP accounting results

(1) Environmental expenditure and environmental input

"China Green National Accounting Study Report 2004" shows that, in 2004, by the environmental degradation cost approach, the environmental loss was calculated 511.8 billion RMB, accounted for 3.05 percent of GDP that year, but by pollutant (imputed) treatment cost approach, the loss was calculated 287.4 billion RMB, accounted for 1.80% of GDP that year. These two figures "3.05%" and "1.80%" are the core resulted from the 2004 China Green National Accounting Study project. The meaning of these two numbers can be interpreted as follows:

3.05% --- Environmental expenditure in the process of China's economic development

A complete Green National Accounting should include at least five kinds of the cost of natural resource depletion (cultivated land resource, mineral resource, forest resource, water resource, and fishery resource) and two kinds of environmental degradation costs (environmental pollution and ecological disturbance). Due to the limitations of available data and technical level, the costs of natural resource depletion and ecological disturbance of environmental degradation were not included in the green national accounting in 2004. Only the cost by environmental degradation was calculated. However, even for environmental degradation, there should be more than twenty items to calculate. But in the two 2004 Projects, only ten items were calculated. The costs by soil contamination, groundwater pollution and other important parts were not included. Nevertheless, it already accounted for 3.05 percent of GDP, which is cost of China's economic development due to the environmental damage. If the uncounted parts: other environmental degradation items, ecological damage, and natural resource depletion, had also been accounted, the resultant figure would have been expected much greater than the present 3.05%, an alert to the development mode of China!

1.80% --- Input for environmental pollution control was seriously insufficient

The imputed treatment cost for environmental pollution amounted to 287.44 billion RMB in 2004 in China, among which imputed treatment costs for water pollution, air pollution and solid wastes were 180.87 billion RMB, 92.23 billion RMB, 14.35 billion RMB respectively, accounted for 62.9%, 32.1% and 5% of the total imputed treatment cost. In 2004, the GDP (by production approach) amounted to 15987.8 billion RMB in China while the environmentally adjusted GDP was 15700.4 billion RMB, which means that proportion of imputed treatment cost in the total GDP, namely as I_{EDP}^{a}, was only 1.8%.

In order to have all pollutants treated for attained emission or discharge, we need to pay for the cost of 1.80% of total GDP. It is noted that the pollutant treatment cost approach targets to attained emission or discharge, which means the pollutant concentrations in the effluents are lower than the required standards, so that there are still pollutants released to the environment. Furthermore, in the 2004 Projects, only limited pollutants in wastewater, waste gas, solid waste were considered. Therefore, the value 1.80% should be far from accurate. It is expected the actual figure might be a few times larger.

In view of different regions, it was found that the situation of Inner Mongolia was the worst. The environmental degradation loss was found 7.42% of the local GDP. On the other hand, Hainan was the best, the figure was only 1.25%.

(2) Pollution control for industrial sectors is arduous and environmental input for urban wastewater pollution control bas to be improved urgently

The calculation result shows that the imputed treatment cost for pollution of secondary industry is 179.03 billion RMB, 2.9 times that the actual treatment cost, among which the input of 100.37 billion RMB is required for industrial wastewater pollution control, accounting for 56.1% of the total imputed treatment 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 treatment cost, but its absolute amount is quite much reaching up to 68.61billion RMB, comparing with urban air pollution control, the disposal capacity for urban household

wastewater in China still lags, behind. At present, the actual treatment cost for urban household wastewater is 4.76 billion RMB accounting for 47.1% of the actual treatment cost for waste gas. Therefore, more environmental input for urban household wastewater pollution control has to be improved urgently.

(3) Emphases of industrial pollution control vary in different sectors and a large gap exists in environmental input for industrial pollution control.

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

(4) The inputs for pollution control in the middle and western regions are severely insufficient and input for the eastern region should still be increased.

The eastern region of China is of densely population, high industrialization level and rapid economic growth, so its environmental pollution is also more severe. In 2004, the actual treatment cost for the eastern region is 54.51 billion RMB, accounting for 54.2% of the total actual treatment cost across the' country. While the inputted treatment cost for the eastern region amounts to 112.55 billion RMB, 2 times that its actual treatment cost. It shows that the input for the pollution control in the eastern region should still be increased. The situation of the middle and western regions are much worse. The imputed treatment costs in the middle and western regions account for 77.0% and 81.4% of their respective total treatment costs. The actual treatment costs and imputed treatment costs in the eastern, middle and western regions are as shown in Figure 3-l8.

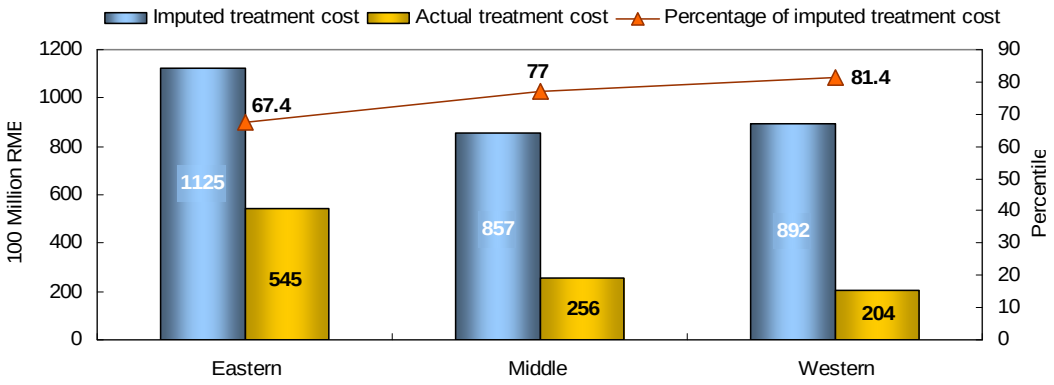

Figure 3-18 Actual treatment costs and imputed treatment costs in different regions

3.4 Green Wealth Accounting for Shennongjia Forest District in 2004

As green wealth accounting is a necessary component of the national GGDPA system, the task force of the project "Establishment of China Green National Accounting System" has also valuation of tourist resources and biodiversity and green wealth accounting in Shennongjia Forest District.

3.4.1 Background and methods

The Shengnongjia District is located in north-west part of Hubei Province, where is also famous for primary forest in China covering an forest area of 3575 km^2. The accounting scope of green wealth covered the values of natural capital and eco-service. The natural capital included forest, forest products, forest land, hydro-energy and mineral resources, and the functional values of eco-service included the values of oxygen production, carbon fixation, storing water, tourism and recreation and biodiversity. The methods for different value accounting are summarized in Table 3-3. The results are shown in Table 3-4.

Table 3-3 Methodology for green wealth accounting

Resource	Objects	Principle or Method	Formula or method of accounting
Forest	Value	Market price	$V_m=P_m \cdot V_{om}$; $V_{T1}=\sum V_m$; V_{T1}-Value of total forest V_{om}-accumulation volume; P_m-average price of tree of kind m
Forest products	Value for foods, textile, and medicine	Market price	The price and output were based on surveying result
Forest land resource	Annual profits of the land in the future	Present value of earning	$V_{T_2}=\sum_{m=1}^{k} A_m \cdot (\mathrm{i, n, V_m/A_m})$ (i, n, V_m/A_m) is the coefficient of present value of annuity, which should be 1/i if the land is without time limit. m – kinds of forest land; k – kinds number of forest; n – serviceable life of forest land; i – land discount rate (~8%); A_m – annual profits of the land m;
Hydroenergy	Value theory on hydroenergy resource	Marginal expense for substitute or saving of unit hydroenergy resource	$V_{T_3}=\alpha \cdot Q_e \cdot P_e$; $P_e=j \cdot \frac{i(1+i)^n}{(1+i)^n-1}+u$ j – marginal investment for substitute or saving of unit hydroenergy resource; i – discount rate of the land (~8%); n – economic life of substitute measure; Pe – unit price of hydroenergy resource; Q_e – annual electric power generation; α – conversion coefficient between power production and water consumption for electricity
Minerals	Value of various minerals	Present value of earning in market price	$V_{mk}=\sum_{k=1}^{m}(P_k-C_k-T_k)\cdot Q_k(1+i)^n$; $V_{T4}=\sum V_{mk}$ V_{mk}-gross value of kind m minerals; P_k-unit market price of mineral resource m; C_m-unit cost of exploitation of mineral m; T_m-unit tax; Qm-verified exploitable mineral m resource; i-discount rate(~8%)

Table 3-3 Methodology for green wealth accounting (continued)

Oxygen production and carbon fixation	Market value		– Fixation of CO_2: 0.11t/m^3(forest)·a, and production of O_2:0.082 t/m^3(forest)·a; – The benefit of fixation M1=Qc·150×8.0, Qc=V×0.11×0.27 Where V-accumulated volume of the forest, 150-Price for 1t of carbon in USD 8.0-exchange rate – The benefit of oxygen production, M_2=V·0.082×400 – Total benefits M=M_1+M_2
Storing water	Shadow price	Shadow engineering approach	Water storage capacity: 3.0 bil.m^3 reservoir Investment indicator for reservoir: 1.28 RMB/m^3 Net water storage benefit of forest: 2..44 bil.m^3
Tourism and recreation	Willingness to pay	Travel cost method	– Based on survey of travel cost, consumer surplus, travel time and other costs
Biodiversity	Non-use value	Contingent valuation method(CVM)	– Questionnaire and email survey; – Identification of sample groups for exact feedback; – Statistical analysis of the survey; – Accounting for values
Material Wealth	Non-financial assets and balance between the financial assets and negative assets		– Because of the data limitation only non-financial assets in 2004 was temporarily calculated

Table 3-4 The results of green wealth accounting in Shengnongjia District in 2004

Unit	Natural Capital Value					Functional value of eco-service				Total
	Forest	Forest Product	Forest land	Hydro energy	Mineral resources	Oxygen & Carbon	Water Storage	Tourism & recreation	Bio-diversity	
Total/billion RMB	2.02	0.013	2.49	0.06	0.114	1.38	1.86	2.44	13.25	23.61
Percentage %	8.55	0.06	10.52	0.25	0.48	5.83	7.86	10.33	56.11	100
Subtotal /billion RMB	4.69					18.92				23.61
Percentage %	19.86					80.14				100

3.5 Recommendations and Follow-up

3.5.1 Recommendations

In order to establish the formal GGDPA system in China, a series of fundamental work will have to be done in near future and as a long term task. The recommendations of further work were presented by the task forces as follows:

(1) Continuous improvement on the framework and methodology of China's GGDPA system

Both green GDP accounting and green wealth accounting of 2004 are the first overall accounting practice in China. Because of the complexity of the accounting there are still heavy work remained to be solved by near future studies and practices.

- Further improvement of the framework of "Framework of Green National Accounting System in China"
- Strengthen and broaden the technical approaches for physical accounting of ecological disturbance, natural resources, environmental degradation, etc.
- Study the practical methods of monetary valuation for accounting of environmental pollution, ecological damage, natural resource wealth, etc.
- Building a relative complete monitoring and survey system to accumulate information on environmental pollution and degradation, for GGDPA, and meanwhile improving current national and local statistical system.

(2) Strengthen the coordination and communication among sectors, provinces and localities

These were the weak links in 2004 GGDPA. However strengthening the coordination and communication contains systematic tasks from policy making, management of task forces, public participation, education, mass media, and training programs, etc.

(3) Accelerate setting up related systems on GGDPA

This is an important task to practice the GGDPA including:

- Formulating environmental and economic policies, such as environmental revenue and compensation, and the examination system to evaluate official's administrative performance;

- Building specific standard and regulation systems, supervision and management systems, data exchange and sharing, and reward and penalty institution, etc.

(4) Improve the statistics of natural resources and expand pilot green wealth accounting

It was shown by the accounting of Shengnongjia Forest District that the statistical indicators and data in routing monitoring and survey on natural resources and eco-services can not satisfy the implementation of the GGDPA and also green wealth accounting. So that more pilot projects on natural resource and green wealth accounting are necessary in the country.

(4) Fully take advantages of international cooperation platform and enhance international cooperation.

The Environmental and Economic Accounting Committee and its working groups under the UNEP and UN statistical commission has facilitated GGDPA in developing countries. The World Bank (WB), the European commission, the Organization for Economic Cooperation and Development, the Asia Development Bank (ADB), and Norwegian and Canadian Governments have rendered funds and/or positive appraisal for the GGDPA projects in China. The project of 2004 GGDPA in China has been with strong support form the WB. Therefore, to fully take advantages of these international cooperation platforms and further enhance international cooperation were and will be essential for continuous promoting GGDPA and increasing its quality and completeness.

3.5.2 Follow-up of the 2004 China GGDPA

Following the 2004 GGDPA in China, the "China National Green Accounting Study Report 2005" has been prepared by the task force in 2006, but indefinitely postponed to release.

The issue was directed by consensus from local officials who were sensitive to the drops of GDP after green adjustment, and in addition some experts considered that the data of eaGDP may be not complete and enough to carry conviction, and the methods were not accurate mature.

Some specific comments of the issue are shown and discussed in the next section.

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4. ESTABLISHING AN SEEA SYSTEM IN CHINA AND THE POTENTIAL OF POLICY APPLICATION

The National Bureau of Statistics (NBS) and the State Environmental Protection Administration (SEPA), with the support of the World Bank-Italian Trust Fund, launched the research project - Integrated Environmental and Economic Accounting (Green GDP Accounting (GGDPA) Study) in 2004, and completed the task by 2006. Along with the project going, the issue of GGDPA attracted attentions from officials, professionals and general public, and became a common topic discussed in the administrative sectors and academic circles. Especially the results of Green GDP accounting for 2004, a part of the research project and released in 2006, sparked off a nationwide debate on the necessity and possibility of setting up a green accounting system in China. There have been more than a thousand pieces of opinions, comments and articles concerning the issues of GGDPA expressed on websites and in publications since 2004. It seemed that the mainstream advocated the establishment of SEEA[1] in China and supported a normal promulgation of annual accounting results. However, different voices were heard. While it was reported in late 2006 that the establishment of SEEA system at various administrative levels met difficulties, NBS officially claimed in July 2007 that the release of GGDPA results for 2005 data will be postponed indefinitely. Even in March 2008, during the Chinese People's Political Consultative Conference (CPPCC), in response to a news reporter, a scholar who was an enthusiastic GGDPA supporter last year said, it would be better to put in force GGDPA later and slowly rather than being found not thoughtful right after the release of accounting results. It showed that the opposite side won the first dispute that there is a strong resistance to the new economic accounting approach. The questions ranged from data reliance and collection difficulty, method scientific background, to whether there is another country does the similar accounting etc.

In this chapter, various views and opinions on implementing GGDPA are summarized and discussed. The debate of various views may promote public understanding on the necessity and possibility of establishing and implementing GGDPA or SEEA in the country. The scientific development notion (SDN) is a Chinese mode of sustainable development. Practicing SDN needs the underpinning of GGDPA system that is discussed in the chapter. The values of GGDPA system for effective making and executing resource – environmental policies and bring other useful functions into play will be demonstrated in the practice.

4.1 Debating and Impediments

4.1.1 Necessity and possibility of green GDP accounting in China.

There has long been the debating on the necessity and possibility of green GDP accounting in China from the early 1980s. The early debate pros and cons concentrated in the adequacies of methodology and validity of data. The interested groups were mainly within the academic circle and environmental sector, while the launch of the 2004 green accounting projects aroused the public interests and provided wide publicity to the knowledge of GGDPA. Especially, the release of the 2004 accounting results sparked off a nationwide debate upon the necessity and the possibility of GGDPA in China. More than one thousand pieces of arguments, discussions and papers showed up since early 2004. After the announcing of the

2004 accounting results, the same research group continued their work for the 2005 data, and completed the accounting in 2006. However, the debate on green GDP accounting led to an indefinitely delay for the proclamation of the 2005 accounting results. The main arguments are on the necessity and possibility in implementing GGDPA in China.

4.1.1.1 Views of dissenters

The disagreement on establishing GGDPA systems at provincial and city levels and on releasing the 2005 accounting results might be attributed to the following reasons.

(1) Awareness of sustainable development

Governmental officials and general public, due to the lack of knowledge on sustainable development, often hold such views as:

– "The higher GDP regions, the more input for environmental protection and the higher environmental quality." Therefore, it makes less sense to carry out GGDPA in economically backward areas;

– The Environmental Kutznets Curve is a law of truth, China is still at the rising branch of the curve, so that it is not yet the time for China to use expensive tools as GGDPA;

– To promote GGDPA, environmental investment should be increased, but it would reduce household income and influence economic growth;

– Local and common benefits often conflict with each other. There are officers and people who know the meaning and importance of sustainable development, but are not willing to implement the theory and practice of pollution control or resource saving in respect to local benefits.

(2) Theoretical difficulties

– GDP is believed by some of the economists and officers as the best economic indicator applied by the international society. And the SNA provides GDP a feasible, reliable and objective standard to evaluate the administrative performance.

– GDP is defined as the market value of all final goods and services of a certain region and in a given period of time. But environmental degradation often involve broader spatial area and wider time span. For example, the degradation of the environment of a region may be caused by the pollutants transported from outside of the region, or accumulated from the time much earlier of the accounting. On the other hand, the environmental impact of the pollutants emitted in the accounting region may generate effects to the outside and be influential much longer than the accounting time period.

– GDP is well defined that it is calculated by market values. But monetary valuing for environmental degradation or resource depletion is very difficult. For example, acid deposition has been known from the late 1960s that it generates damages to surface water, soil ecology, trees or plants, as well as

materials. However, due to the complexity of differentiating the influence of acid deposition from other impacts, there is still no adequate method to estimate losses by acid deposition.

- One of the methods to perform monetary accounting for environmental degradation is by treatment cost both actual and imputed. However, the term "treatment" is not carefully defined. Commonly a pollutant is released after "treatment" means that the effluent (either wastewater or waste gas) is discharged within the emission criterion, often defined by effluent concentrations. However, attained discharge still means that there are pollutants discharged into water body or the atmosphere, and in different countries the threshold values can be different. Then what is the fate of the released pollutants? Do they produce impacts onto the environment or human health?

Therefore, it seems that a practical approach to evaluate environmental degradation is by the treatment cost method by which, the cost, or afterwards the green part of GDP, is of the same category as that of GDP. However, from environmental point of view, treatment cost can only be an initial step of green accounting. The impacts of pollution would last and expand. More rigorous green accounting should be based on the losses in environmental, ecological, and social aspects.

(3) Technical limits

- The accounting by means of treatment cost method is easier than pollution loss method. The later involves multiple sectors, disciplines, and with high uncertainties.

- The knowledge on estimating economic losses of environmental degradation is still very limited. To valuate environmental changes depends on the development of scientific knowledge about the mechanisms of change, dose-response relationship of harmful substances and physical activities and practical experiences. All of these conditions are weak and deficient in China.

- Owing to technical barriers, there are rarely even developed countries having yet developed the full set of accounts, SEEA. Therefore, it is necessary and understandable for China only to do some pilot and tentative work to prepare establishing the SEEA system.

- Over the years, there have been various technical limits that differentiate judgment and available conditions to launch formal accounting in China. It should be practical to implement gradually the SEEA system when the relevant technical barriers are broken continually with efforts.

- Surveying is a necessary condition for resource depletion accounting. It is heard that comprehensive inventories on some resources are still on the way, for instance forestry resource. On the other hand, although water has been shown a long time precious in many areas, but an inventory respective to water resource has not been completed.

(4) Institutional impediments

- GDP oriented institution of evaluating official administrative performance has been implemented for many years, which drives local government officials towards their decision-making according to the

rule that GDP first, social issues second, and environment third so that they often behave reluctantly to implement GGDPA.

- Institutionally the data collected by various administrative sectors are stored in the respective sectors at central and local levels, e.g., production data are stored at industrial departments and environmental data are stored at SEPA and local EPBs. Although there are laws and regulations to let NBS and local bureaus of statistics collect these data, but the collecting routes might not be smoothly through enough.

- The establishment of GGDPA requires building a comprehensive and qualified data system to provide available data for reliable accounting.

- As a developing country the resources and environmental monitoring and surveying are weak links. The available data are usually far not sufficient to support the work of the SEEA. The government should input a great deal budgets to tailor the gap for long time.

(5) Other problems

- Despite the environmental degradation cost approach was tentatively used in China 2004, accounting the flaws in valuation and the narrow scope covered in the accounting made the results less persuading.

- The valuing on environmental degradation and resource depletion involve comprehensive knowledge in multiple disciplines. The working team is not ready for GGDPA.

- To carry out a GGDPA, much more data are needed for statistical analysis. However, such an accounting has not been listed in the routine governmental work, so that a financial shortage is also a question.

4.1.1.2 Views of supporters

On the contrary, GGDPA supporters cognize its necessity and possibility, and believe that the attainment of the goal is an evolutional process that need years of enthusiastic efforts. They insist that GGDPA is needed for practicing sustainable development or SDN (scientific development notion) and promoting circular economy; and that the institutional impediments might be stridden over and technical difficulties will be surmounted along with the practice of GGDPA.

(1) The necessity of GGDPA

- It is known that GDP has a number of limitations, e.g. [2]. When the world is facing challenges of population growth, climate change and resource shortage etc., it becomes crucial that GDP does not measure the sustainability of growth. A country may achieve a temporarily high GDP by over-exploiting natural resources or by misallocating investment. Economic growth at the expense of environmental degradation can end up costing dearly to clean up; GDP does not account for this.

- Learn the historical experience of the smooth transition from the Material Product Accounting (MPA)

to the National Economic Accounting (NEA) System (i.e. SNA).

The MPA system drawn from the experience of the former Soviet Union had been implemented since early 1950s in China for about 30 years. In 1981, the input-output table was introduced into MPA system. The MPA system and the SNA had been mixed use from 1985 to 1992. In 1992, the Chinese National Economic Accounting System (trial implementation) was promulgated. The NEA (i.e. SNA) system has been formally implemented since 1993. With the process of try and error, the NEA system has become modified and substantiated in contents, improved in structure and statistical accounting[3,4]. Using the NEA, the State Statistical Bureau has regularly issued National and Provincial GDP annually since then. Despite the results and methodology are still sometimes questioned by international experts, the process has been smoothly promoting and played benign role in the national economic development. The history of GGDPA or SEEA study is much shorter than that of the NEA, so that time is needed for GGDPA practitioners to solve the problems. But once the institution and framework are established the SEEA will generate a tremendous power to back sustainable policy making.

– The opinion that denies current necessity for GGDPA in China stems from the old mode of thought that resource depletion and environmental degradation are coupled with economic growth and following the law of EKC.

Many scholars and officials in China still believe in that EKC (environmental Kutznets curve) is a law reflecting the change of pollution loads and resource deletion vs. per capita GDP in a country. The pitfall of their view is the ignorant in historical advancement of global technology, management and

Table 4-1 Evolution of environmental management and technology

Time →	Before 1970	1970 →	1985 →	1990 →	21 century →
Management and technology					
	Resistance to change		Innovation-Directed		
Phase	1	2	3	4	5	6
	• End of pipe treatment • Pollution control to meet standards •Government regulators prescribed ways for companies to clean up pollution	•Acceptance without initiatives •Less innovation in pollution control •High price in pollution defense prices	•Total environmental quality management •Pollution prevention technologies •Intensive resource productivity	•Life cycle assessment •Cleaner production or pollution prevention • Product stewardship and selling service • Circular economy and market oriented policies	•Design for environment •Green technologies and consumption •Green process design & plan management	•Holistic economic, social and environmental management • Implementing SEEA •Eco-industrial webs •Environmentally sustainable economics and society
	•Debate in severity of environmental laws and policies and passively follow up the standards		•Partnership of government, company and general public environmental management •Innovation-directed resource-for sustainable development			

- The current institution of examining officials' administrative performance in China is GDP oriented. Only from last year, a few indicators that are of environmental and resource including as reduction in COD discharge and SO^2 emission, and energy consumption per unit GDP, are now taken into account. However, these are of secondary importance in officer's evaluation. GGDPA is to take into consideration on monetary basis natural resource depletion and environmental degradation, so that it will lead local governments to pay the attention not only to present social-economic benefits but also essentially to prolonged term benefits. Therefore an SEEA system should be able to provide a comprehensive index system and be involved in the official's examination institution. Despite the difficulties in building the institution the resolution of the central government should be essential to push the enforcement of an SEEA system.

- The development of a GGDPA system is a trans-disciplinary and trans-sectoral task. When the task is in line, NBS should be the authority to lead and coordinate the whole business. Under the framework, a comprehensive and qualified data system will be built to underpin the reliable accounting.

- Over the years, the resource-environmental survey and monitoring have still been weak links in resource conservation and environmental protection. The shortage of financial and material input to support survey and monitoring must be improved even for law enforcement. The establishment and implementation of GGDPA system will certainly increase financial input and gradually strengthen the capability of resource survey and environmental monitoring, thus also contribute to routine resource and environmental management.

- It is a well known fact that the technique used in GGDPA 2004 was with considerable defects. It is natural because this is only at the beginning of developing undertaking. Even for the international SEEA 2003, it at large represents the progress of a such framework. The development of SEEA continues in a number of areas and needs revising again in the not too distant future.[1] Very few countries have developed a broad range of accounts for the SEEA, but no country has ever developed the full set of SEEA accounts[1]. However, the technological barriers should not be the reason to stop the work going. On contrary, the efforts of establishing SEEA systems should be promoted for further development.

(2) The possibility of establishing the SEEA institution in China

- The two projects, the national and the World Bank, were completed by 2006. Although with deficiencies, the results of the projects have confirmed by themselves the possibility and successfulness of establishing a fundamental SEEA institution in China. The results already raised attention from the entire country as well as the abroad. Although a serious debate was initiated and the release of new GGDPA results has to be postponed indefinitely, it actually reveals the necessity of establishing such an accounting system.

- There will be a distance between possibility and practicable reality or from the trial accounting of 2004 to regular issue of annual results of GGDPA, but the goal will be achieved within several years, according to the plan.

4.1.2 Challenges to establish a SEEA system in China

In China, the National Bureau of Statistics (NBS) is the authority of national level economic statistics and accounting as well as the institution in responsible to general design and coordination of establishing GGDPA system. NBS will lead such tasks as designing the overall accounting framework, establishing regulations and standards, coordinating sectoral accounting and the reform of accounting and statistical system. However NBS will face a series of challenges or impediments from three aspects.

4.1.2.1 Institutional challenges

(1) Reform of the existing official's examination system

Current GDP oriented officials' examination system is an impediment to implement GGDPA. The main reform of this examination system should highlight the results of GGDPA. Because the present imperfect resource-environmental statistics has not been sufficient for the needs of GGDPA, and moreover it will take time to found the institution on standardization of accounting methodology, data audit and management system, the progress of the main reform will be an evolutionary process. The first step may bring such available indicators as energy consumption, per thousand RMB GDP, water consumption per thousand-RMB GDP, pollutant discharge per thousand Yuan GDP, thousand Yuan output per hectare land, water and air quality parameters, and ratio of environmental outlay with total GDP, etc.

(2) Organize and coordinate task forces from various sectors and locales.

GGDPA needs organizing many tran-sectoral groups to work together for the accounting on the resources as land, water, mineral resources, forest, coastal wetland, etc., and different damage of environmental degradation. It has not been accumulated sufficient experiences and possessed sufficient technical personnel to undertake the task in China. Many ministries, state bureaus, especially the SEPA, and commissions shall join the task. The organization and coordination of the task forces will be great challenges. The leadership group of GGDPA under the State Council will be the key in directing the organization and coordination.

(3) Strengthen the institutional capability

The institutional capability to sustain GGDPA in terms of technique and management includes three essential parts.

- The first is strengthening the capability of national and local resource survey and environmental monitoring, data handling and statistics at various sectors in central and local government.

- Standardization of GGDPA methodology is a systematic mission to certificate the correct and commensurable results for public understanding and governmental decision making.

- GGDPA either the national or local level is the business of immediate concern to government and general public. The quality management of the accounting process and results needs to build an

institution in charge of whole process inspection and management, the reliable annual issue of GGDPA, and an unimpeded information exchange system for government and general public.

(4) Unite the international SEEA with Chinese practice

SEEA provides a common framework for economic and environmental information, permitting a consistent analysis of the contribution of the environment. SEEA covers complex and diverse topics but some of which are still subject to debate[1].

The problems of resource depletion and environmental degradation and impacts on social-economic systems have their regional characteristics and follow localized specific management objectives. Although the basic principles of environmental-economic accounting are similar, the selection of methods and available data differ greatly so that there may generate inconsistent results.

(5) Considerable financial input for building the infrastructure to bear the task of GGDPA.

The existing infrastructure of data collection, handling, management and retrieval system and that for environmental monitoring, resource survey and natural ecosystem investigation by far can bear only the normal NEA system. Basically the economic statistical system including its infrastructure has been relatively perfected over the years for the NEA of China, but it failed in representing the relationship between economic growth and environmental degradation as well as resource depletion. One of the reasons of the failure is the shortage of available data. However it needs to input considerable fund from the government to improve environmental monitoring, resource survey and natural ecosystem investigation. Over the years the inputed funds are much less than what should be needed. For example, the number of employees working in the central and local environmental monitoring and management inspecting was 47,000 which accounted for one third of that working in the whole environmental protection system in China in 2004. Based on the statistics of the Tenth Five Year Plan of China, the financial input from SEPA into environmental monitoring was only 600 million RMB[15][16]. Plus 1.3 billion RMB of local input, the total was only 1.9 billion RMB. The average per staff input was only 8.1 thousand RMB, which could only afford staff's wages, not adequate to meet the expenditure of routine monitoring. The hydrological data collection exhibits similar shortage, e.g. in Yellow River Basin the density of hydrological examination stations was one within 2330 km^2. However, it was much less than 1326 km^2 in EU countries[16].

4.1.2.2 Theoretical and technical challenges

Some debates are on the monetary accounting of GGDPA. The main challenges can be described as follows.

(1) How to set the price of environmental pollution

The traditional GDP accounting or NEA is based on market price, to describe and explain the performances of economic activities. In GGDPA 2004 accounting, the work team used imputed costs of pollution control, which was consistent to the environmental expenditure from the data of environmental protection industry in NEA. This is because the pollution control costs can be calculated by means of

market price.

Since short of market pricing system, the costs of environmental degradation and eco-disruption are difficult to be calculated objectively in market price. The accounting of monetary flows has to use methods with combined mode of market pricing and non-market pricing, such as opportunity costs, man-power capital, shadow price etc. There were ten items considered in the 2004 GGDPA: human health, material corrosion, crop production, and cleanse cost affected by air pollution, human health, crop production, pretreatment of industrial water and cleanse cost affected by water pollution, solid waste disposal and land occupation.

(2) Build a capable database to support GGEPA

GGDPA needs a capable and multiple disciplinary data base containing huge amount of statistical data derived through numerous investigation monitoring and surveying by multiple governmental sectors and research institutes. Historically these governmental sectors and research institutes have accumulated a great quantity of data and information. While these data and information are still far from sufficient for regular green accounting, unfortunately these databases are mostly segregated in different individual sectors or institutions and not open and easy to access. It is another difficulty to make use of the data at different and separate institutions. The financial input for environmental monitoring, natural ecosystem investigation resource survey has been too less to support necessary data collection and building a long term data base to support the green accounting.

The information system on dose-response relationships is an essential task to support hybrid accounting, that is discusses elsewhere before.

4.1.3 Resolution in establishing a GGDPA system

4.1.3.1 Administrative resolution

(1) President of China, Mr. Jintao Hu once addressed that: “We shall study the way of the Green GDP accounting, probe the assessment system bringing resource depletion, and environmental damage and benefits into the accounting of economic development level in 2004.”[6] This indicates the awareness of the top leaders of China on the severity of environmental degradation and resource depletion.

(2) Based on the achievements contributed by the task force of GGDPA study, it is recognized that the NBS should officially take the lead to direct and organize the sectors including resource management and environmental protection to accelerate the establishment of GGDPA framework and institution, to conduct pilot projects on methodology of monetary accounting, and breakthrough several key impediments in theoretical, institutional and technological fields. It is heard that NBS has yet worked with the State Forestry Bureau (SFB), Water Conservation Ministry (WCM), Land Resource Ministry (LRM), etc. in cooperation with many developed countries on the research projects concerning water, energy, forest, mineral and other resource accounting.

(3) Currently, energy-saving and pollutant (SO_2 and COD)emission reduction began officially included in

the evaluation of government performance. This is a kind of physical accounting for environmental degradation and resource depletion. With the experience on such accountings, more items would added to the evaluation process towards a GGDPA.

4.1.3.2 Strategy of organizing the national and sectoral tasks

To organize national and sectoral tasks for GGDPA, several actions should be taken.

(1) Popularizing the knowledge on sustainable development and GGDPA

Following the eco-awareness from the 1970s, developed countries have been changing the growth orbit towards green national accounting system and successively improving the feasibility and reliability of the system. China as a developing country, a considerable part of population is still struggling with poverty and there is still a long way for development. The important point is to gather the lessons from developed world that before the situation get worse, education and training should be enhanced to popularize the knowledge on sustainable development and GGDPA.

(2) Complementing legislative vacancies respective to GGDPA.

Laws and regulations should be developed to provide a legal basis of implementing a GGDPA System.

The first step of the actions is to work out practicable rules for GGDPA and formulate technical guidelines.

The second is to standardize the statistics of GGDPA data which are compiled through monitoring, verification, analysis and validation.

The third is to establish an award-penalty institution to encourage the contributors and check the negative actors, e.g. individual, officials and/or social-economic units.

(3) Promotion in cumulative and step by step ways

With the “Framework of Green National Accounting System in China” and SEEA 2003, environmental and resource accounting either single factor or multiple factors at sectoral or local level is beneficial to accumulate experiences and strengthen the infrastructure of GGDPA system.

Over the years many pilot or demonstrative studies as that described in Chapter 2, and later China forestry accounting study, GGDPA in Jiangsu and Anhui provinces, Shenzhen and Beijing City, Mountain Tai and Shennongjia Areas have provided a pant of vital experiences for establishing the complete GGDPA system or SEEA in China.

(4) Building the institution of cooperation and creation

The task needs close cooperation of experts from various disciplines, business agencies and academic institutes. Because it is a creative and multidisciplinary work, it needs the integrated knowledge of natural resource and environmental economics, accounting expertise and special knowledge fields on environmental, forest, water, land and other science and engineering.

4.1.3.3 Technical aspects

(1) The standardization of classification, methodology, rules and operational techniques

The standardization of classification, methodology, rules and operational techniques will be the task and put into the agenda of further work.

In SEEA2003 the technical terms and classification of assets, flows of natural resources and ecosystem inputs, physical products of residuals, environmental activities and expenditure, environmental industries, etc. are rather clearly defined. In China, the definitions of terms only partly are defined, and most terms have not been defined yet. The classification of assets and other items has yet been done outlinedly. For example, the term “Man-made assets” in forestry sector, does the asset of “forest land” include the land occupied before for other uses, i.e. farmland, construction land, barren hill, etc. but now for forestry; does the asset of timber include timber forest or timber in natural eco-forest?

The conventional classifications of assets, industries and products are often ambiguous so that these are necessary to be redefined and modified.

– Standardization of asset evaluation system

Because all products and services provided by various natural resources and environmental assets are the objects of market pricing, defining the scope of each kind of asset, product or service is prerequisite to the accounting. Otherwise repeated calculation, careless omission and non-commensurable results will occur. For instance, in forestry accounting, the functions of a forest ecosystem usually contain such services as timber supply, non-wood product supply, water containment, soil conservation, carbon fixation and oxygen production, biodiversity, air purification, agricultural protection, landscape and recreation, natural disaster prevention and reduction, cultural value, and many other services. Each of these services has had a versatile approach to classification and pricing system. If there is no unified classification and pricing system in the nation the results of accounting for the same item will be discrete without comparativeness.

– Standardizing the methodology of measuring quantity and value of physical flows, structure of the accounts and rules of the account records.

(2) The methodology of valuation

The resolution of methodology for the valuation of physical flows and measuring environmental degradation into practical use is one of rigorous challenges or impediment in China.

Two types of methods are in common use for GGDPA valuation, that are based on the test results of environmental damages.

(a) Valuation based on damage

– Dose-response approach

This approach sounds rational, and may numerically demonstrate the effects of environmental degradation. The response values estimated can be applied to quantify the impact of pollution on human health, crop production, deforest and other damages. The challenge is that owing to the deviation of does-response functions for specific environmental factor may vary remarkably. Thus this approach usually brings up to local tract. The technical impediment will be that dose-response function only gives the impact of environmental change on the receptors. Thus the monetary valuation of the impact has draw on the methodology from environmental economics. The fundamental works to define great number of dose-response functions have to be done to meet the needs of GGDPA. Although a part of functions can be cited from international reference or data.

– Changes in product approach

Resource depletion and environmental degradation reduce the output of productivity that causes the costs of economic system as shown in Equation (4-1)

$$C = \Delta O \cdot P \qquad (4\text{-}1)$$

Where

C--- Costs of environmental damage or resource depletion,

ΔO --- reduced output of product, and

P--- market price of the product.

This approach looks simple but practically the users have to stride over at least two impediments.

The variation of product output depends on complicated interactions among many factors. It is difficult to identify the impact of environmental factors from other social-economic factors. For instance, agricultural products depend not only on environmental change but also on climate, fertilizer, seeds, soil and even more, other social factors.

This approach implicates the assumption that the physical flows and market prices are alterable over time. When it is short of market competition and the existence of unfair subsidies and taxes, the problem will be how to adjust market prices properly.

– Applicability and challenge

Because of current restricted knowledge in valuation, it is bound to take time and to input funds to prepare the national and local dose-response data base for accounting.

The monetary cost is based on practical investigation or survey which had been worked out in past time, and thus it may be unrealistic to use past data to modify and adjust current GDP.

(b) Valuation based on costs

This type of valuation is based on the evaluation of necessary expenditure to defense the natural assets and or environmental quality to meet the legal standards and public expectations. A number of methods of environmental economics can be applied for the purpose:

- Defensive expenditure approach, e.g. expenditure for urban sewage quality；
- People's willingness to pay the costs for abatement and control of pollution；
- Shadow project approach；
- Hedonic pricing approach；
- Contingent valuation method, which is broadly used to evaluate an ecosystem services, health risk, etc； and
- Others.

The challenges or impediment of this approach are the following:

(a) Differentiation in judgment

Differentiation in judgment and evaluation on same function of a resource or environmental element may obtain different outcome among different experts, individuals and economic entities. Is it possible to build a standardized valuation system? That will be a great challenge.

(b) Technical limitations

The existing forms of environmental values are versatile and complicated. Because of the limits of knowledge, technique and capability, expert groups can not identify and measure the total good and service provided by an environmental asset, but only a part or main part of the total. In consequence, the results may not reflect true measurement of the inner value.

(c) Insufficient available conditions

Because the real prices of many environmental resources do not truly exist at the market, their inner value could not be exactly reflected. Furthermore there are many factors as market pricing, regulations, exchanging patterns, etc. may mislead the results being yielded from these methods.
Further improvement and development of the practicable valuation methodology for GGDPA is truly a challenge and impediment to the task forces.

4.2 Scientific Development Notion (SDN) and GGDPA

4.2.1 Connotation and practice of SDN

4.2.1.1 The guarding principle of Chinese government

The connotation of SDN was presented formally at the 16th Central Committee of CPC in October 2003 (at the 3rd Plenary Session). It is defined as the notion of view or philosophy on the long term development of China. It takes "people-oriented" as the basis and persists on an all-round, harmonic and sustainable development.

The strategy of "Five Plannings as a Whole" has been the practical notice in promoting SDN since 2004, that means: planning the urban and rural development as a whole; planning the regional development as a whole; planning the economy and society as a whole; planning harmonic development with nature as a whole; and planning the requirements of domestic development and openness to the world as a whole.

4.2.1.2 Connection among the concepts

Four concepts are embedded in SDN: "People-oriented", "All-around development", "Harmonic development" and "Sustainable development". A diagram can be used to show the connection of these four concepts, Figure 4-1.

"People-oriented" is the basis of SDN and the target of Sustainable Development; "Sustainable development" to meet the needs of the present without compromising the ability of future generation to meet their own needs. It is, when pursuing economic development, prosperous life and civilization, present generation shall enhance the harmony of human and nature, and realize the targets of population control, resource conservation and environmental protection, to preserve the development potential for future generation with equity.

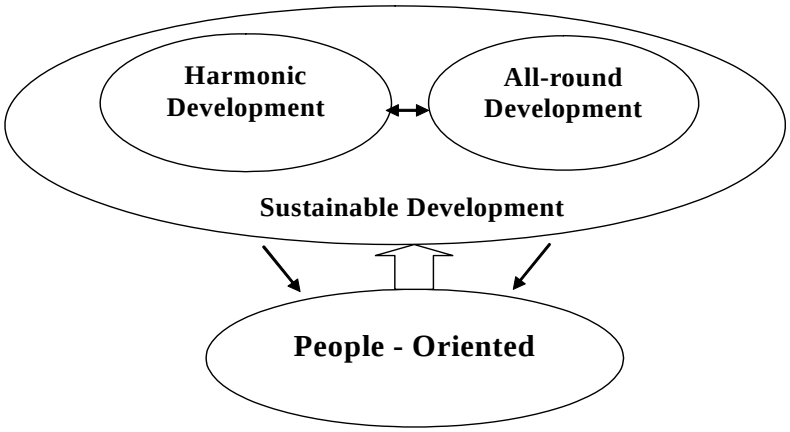

Figure 4-1 Connection of four concepts of SDN

The social-economic mechanism of promoting sustainable development is carrying out the "All-around development" and "Harmonic development". All-around Development means taking economic development as the center to build further higher levels of economy, political affairs and culture, and realize all-around social-economic development. Harmonic development emphasizes the relationship of economic development and other dimensions, social, environment, resource, and culture etc.

4.2.1.3 Challenges of practicing SDN

(1) Six severe challenges the development of China

The social-economic development has been extraordinary fast since 1990s, and soon got confronting severe challenges in six aspects:

- Total population, population aging and employed population are all reaching their peaks and putting higher pressure on the economic-social and environmental systems.
- Extraordinary extraction, consumption and utilization of energy and material resources.
- Implementing sustainable urbanization strategy is meeting great pressure.
- The trends if accelerated environmental pollution and degradation of natural ecosystem.
- Reducing the disparity among different areas and solving the problems of rural areas, farmers and agriculture,
- Promoting the capability of national sustainable development and international competition.

(2) The strategy to meet the challenges

Seven subjects are being designed to meet the challenge by the government.

- Consistently maintaining rational growth of document to meet people's rational needs.
- Exert high strength to enhance the quality of economic growth and improve the structure of wealth growth, accompanying less energy and resource consumption ,minimum environmental pollution, and higher knowledge content and dematerialization.
- Satisfy the requirements of subsistence to conform the principle of 'Human Factor Comes First'.
- Regulate the quantity of population and promote the quality of population with the coordination of people's physical ability, technical ability and intelligent ability with the education and training.
- Conserve, extend and protect the basis of natural resources.
- Focus a breakthrough at bottleneck of development through scientific and technical progress that means giving strong coordination within the great development system of science-technique, society-economy and management institutions for the purpose of a breakthrough at its bottleneck.
- Regulate and control the environmental impact within tolerance all along the development process.

(3) Priority actions

The priority actions to practice SDN are planned in three domains.

- Changing the connotation of development which sacrifices the environmental quality as the costs, seeks honor and benefits through fraud and deception, and wastes resources to show local leaders' great images and political performance.
- Altering the economic growth mode that means: take promotion of the quality and benefits as the centre; regard resource saving, environmental protection as the target to extend the strength of implementing sustainable development strategy; the mechanism of developing circular economy,

and take scientific-technical progress as the pillar.

- Transforming the economic institution through systematic measures, includes: deepening the reform of financial and tax institutions; resolving the similarity of regional industrial structure, ad extensive but lower level growth; diminishing the segregation of urban and rural areas; deepening the reform in social dimension snd scientific-educational-cultural-sanitary institutions; promoting the institutional reform in social employment and allocation; improving social security system; and transforming officials'(cadres') work style.
- From the connotation it is obvious that SDN is a comprehensive formulation encircling all-around economic, social and environmental systems, but the priority domains are closely related to resource conservation and environmental protection which are the infrastructure of SDN.

4.2.2 Restriction and breakthrough of implementing SDN

Implementation of SDN involves all sectors and fields of the country. An overall discussion on the restriction of implementing SDN is too sophisticated. In the following, we concentrate the discussion on economic and resource-environmental dimensions.

4.2.2.1 Main perplexed questions

The implementation of SDN is facing many problems and difficulties. Among them, the following six are perplexed questions.

- An overall system of laws, regulations and policies underpinning SDN has not yet been formed in China, although many special laws relevant to SDN have been officially promulgated over the years. For example at least thirty laws and many administrative regulations directly concerning resource conservation and environmental protection have been promulgated by the legislative bodies and the central government, and also many more laws and regulations about economic social and political dimensions have been promulgated over the years, but there has not been a complete legal framework to embody effective implementation of SDN available yet in China.

- A sound and logical pricing system of natural resources and environmental capacity has yet been lack in China. Consequently, the prices of primary resources are too low or even free of charge in market causing severe abuse of resources and pollution of the environment. The coordination of economic growth and environmental protection often displays impotent in policy making and practical operation, e.g. practicing 3R (reduce, reuse and recycle) of circular economy in companies is often uncompetitive cost-wise.

- A sound and logical pricing system for environmental protection has yet been lack in China. Because of market failure, the externality of environmental pollution and degradation must be internalized through legislation and policy instruments based on market mechanism. Therefore the establishment of legal framework and governmental intervention through policy instruments to induce market function in the direction of environmental protection must be required for practicing SDN.

- Although the central government has persistently realized the strategic significant role of SDN and expressed the resolution to practice, the financial support has yet not been sufficient and/or substantial. For example, the development of "circular economy" projects is often marginalized and not included into the consideration of economic policies for specific implementation. SEPA and local EPBs have often complained these conditions over the years. Furthermore there has had no effective investment and financial mechanism formed to promote specific objectives of SDN. The surveying of resource conservation, environmental monitoring and inspection and law enforcement in many areas, even some big cities, are often short of funds, so that the databases are far insufficient to support a sound implementation of actions under SDN.

- SEPA and local EPBs are authorities for the management and supervision of environmental protection, and the state commission for development and reform, Ministry of Geology and Mineral Resources, Ministry of Coal Industry, Ministry of Water Resources, Ministry of Forestry, etc, are authorities for the management and supervision of resource conservation and economization. However local governments mostly focus on enhancing economic growth and employment opportunities, and adopt a tolerant or favorable attitude towards behaviors that violate the laws on environmental protection and resource conservation. Because local EPBs are directed by local senior officials when making decisions even against environmental laws, the EPBs can not carry out their legal responsibility to correct the mistakes. Among governmental departments, SEPA is relatively small and weak. However, from March 2008, SEPA (State Environmental Protection Administration) has been promoted to Ministry of Environmental Protection (MoEP). This is an important signal that the position of environmental protection department is now raised to the same as those "big" departments. More influences can be expected from MoEP on economic and social developments.

- There has not yet been developed a consistent statistical system and transparent information systems for the all-around management of implementing SDN, including an adequate resource and environmental supervision, management and statistics system, and also information access for public participation.

4.2.2.2 Build resource-efficient and environment-friendly society as a strategic option.

To build a resource-efficient and environment-friendly (REEF) society is the substantial and strategic option for implementing SDN. A REEF society provides an across-the-board support to the economy, society and environment – the three dimensions of sustainable development. It is the demand and manifestation of SDN[5].

It is noted that, to build a REEF society never means confining development, but development more comprehensive, more coordinative and more sustainable. The strategy is focusing on six actions.

(1) Improve management institutions and form virtuous administrative structure

The first is transforming government's function from universal administration to service oriented

institution bringing the role of market into full play. The second is simplifying administrative structure and enhancing the efficiency. The third is based on the principles of *ip so jure*, equity, openness and timeliness, strengthening the management capacity and social control on resources, environment, health, public security and public services.

(2) Formulate strategic plan and promote orderly priority development

The construction of REEF society needs long-medium development plan which will determine the strategic focus and targets with a series of policy instruments and an indicator system for evaluation of the performance.

(3) Improve incentive mechanism to promote integrated energy saving and environmental protection.

Establishment of sound environmental-economic policy system is the effective instrument to give impetus to promote integrated energy saving and environmental protection. Current defective financial-tax institution and investment system has encouraged the resource squander, trend of similarity in local industrial structure, extended manner of growth, and repeated industrial construction at low technological level, etc. The economic leverage is an effective tool to regulate market behavior.

- Strengthen the dynamics of reform on resource pricing mechanism and internalizing the environmental externalities. Over the years Chinese government has adopted a strategy of gradual adjustment approach to resource pricing for fearing of the disorder in the market. The consequences are wasteful use of energy, mineral, land and water resources. Therefore, raising resource prices and/or taxes is an urgent, necessary condition of REEF society..

- Build environmental property right system and internalize environmental costs. It is necessary to adjust existing resource policies, to establish environmental property rights and empower local government the right of use, meantime to bring environmental externality into line with resources and their products' price. The environmental-economic institutions are needed to be built up in China, e.g. pollution permit or license, tradable pollution right, ecological compensation and other policies.

- Establish Green GDP Accounting system and bring the system into line with the reform of administrative performance examination system for local officials and government.

- Take REEF as the design basis of public policies

- These policies are concerning public financial and tax policies, e.g. consumption taxes, import-export taxes, etc.

(4) Strengthen the institutional building and long term guarantee

Building of the REEF society is dependent on the guarantee of a series of legislative, economic, administrative and integrated institutions.

- Build a legal system to restrict malfeasance and excessive consumption. Many existing laws and regulations concerning resource and environment have remained to be modified and amended, e.g. Energy Saving Law, Mineral Resource Law, Water Law, Promoting Clean Production Law, etc.

- Modify and improve standard system concerning resource and environmental

- Strengthen the power of law enforcement, and improve the infrastructure of monitoring, survey, statistics and supervision institutions.

- Re-mound thrifty culture through education, mass media and policy guidance

Hard work and thrifty life are of traditional virtue in China. This moral tradition do coincide with the principle of building REEF society and pursuing sustainable development. However, there are people who got sudden wealth are pursuing an extravagant-wasteful life style, some business sectors seek higher profits to meet excessive demands, and some mass media often direct people to non-moderated consumption etc. The building of the regulations and policies to re-mound thrifty culture, the strengthening the education of thrifty, and fostering a social mood of REEF are essential measures.

4.2.3 Policy system to translate SDN into mass actions.

The implementation of SDN needs to manage a broad portfolios of assets – not only human and capital, but also resources and environmental assets. These assets are not completely substitutable. The immediate gain from depleting and damaging them can be over weighted by costs in near future productivity and lost options of sound development. The solution of these contradictions is to use policy instruments that align individual and social incentives either through taxes, subsidies, and regulation or through the deliberate creation of new market mechanisms. Failure to adopt such policies—even when it seems to be 'win-win'—is most often the results of distributional problems and society's inability to make long term commitments.

Effective coordination of practicing SDN requires institutions (informal and formal rules and organizations) that undertake the functions: picking up signals (information, feedback, anticipation of future problems), balancing interests and executing agreed-on decisions (commitment and enforcement mechanisms) and form benign policy-institution-assets loop, as shown in Figure 4.2.

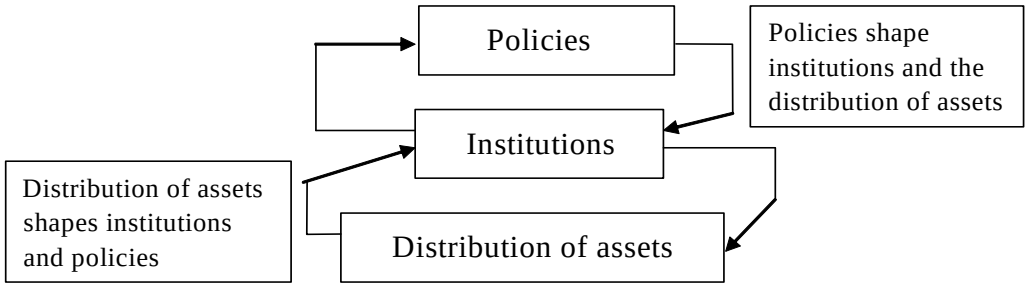

Figure 4-2 Policy—Institution—Assets loop

But such institutions are often lacking or flawed when the assets are uneven distributed and/or the information are unbalancing among different stakeholders, so that the results would lead to a vicious cycle in which the biased institutions implement relevant policies that result in an increase in unequal asset distributions, resource abuse and environmental degradation. On the other hand, any unreasonable distribution of resource and environmental assets would affect the effectiveness of institutions and policies, as shown in Figure 4-2.

To break this negative cycle, applications of certain mechanisms as promoting transparency, feedback, accountability, commitment, and negotiation of interests have been proved successful in solving environmental and social problems as land use, pollution abatement, etc.

4.2.3.1 Resource and environmental policy system for decision-making

The implementation of SDN needs a policy system composed with economic, social and resource-environmental dimensions. However, in this report we focus on resource – environmental policies, as shown in Figure 4-3.

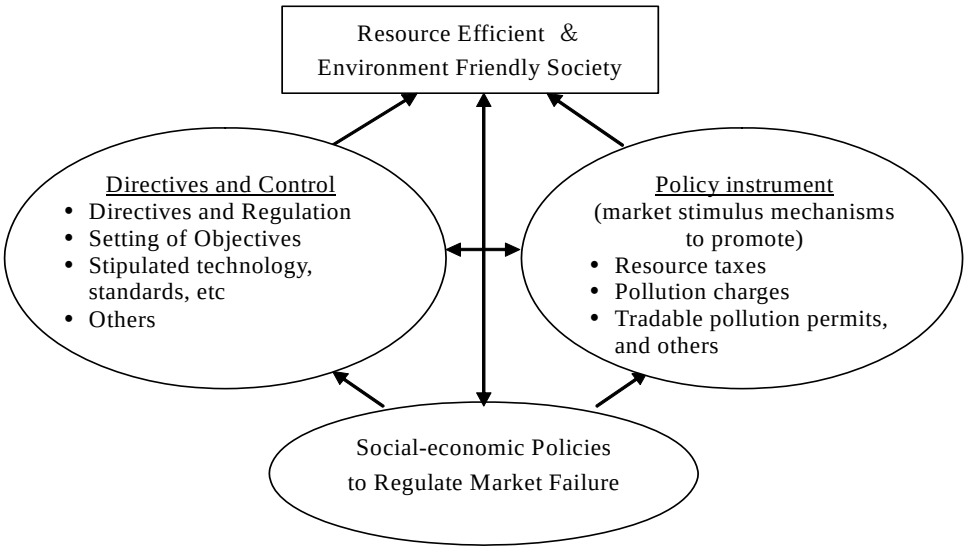

Figure 4-3 A simple description of the policy system

(1) Legal liability system

Legal liability system is the basis of executing other policies.

- Legal obligation of debt services;
- Levying charges of regulation breach;
- Common and special legal liability;
- Liability for natural resource damage;
- Insurance of liability;
- Stimulant mechanisms for law enforcement; and
- Others.

(2) Define the property rights of resources and environment

Ownership

- Land ownership or certificate of land ownership
- Ownership of water resource
- Ownership of mineral resources

Right of use

- Use under property right administration
- Permit

(3) Market establishment

- Tradable pollution permit(or trading permit)
- Tradable quotas of resource and energy use
- Tradable quotas of resource and environmental exploitation
- Tradable quotas of water resources
- Other tradable resource quotas

(4) Financial implement

- Effluent taxes
- Emission taxes
- Production input taxes
- Product taxes
- Export taxes(e.g. the compensatory payments for domestic resource depletion and environmental degradation)
- Import tariff
- Discriminative taxes for different transaction

(5) Cost levying system

- Levy of various environmental pollution payments
- Levy of user’s fees
- Costs to pay the improvement of environmental and living conditions
- Environmental impact charges
- Road tolls
- Various administrative fees

(6) Financial instruments

- Financial subsidies for REEF products;
- Soft loans
- Environmental grant or awards
- Financial incentives for master layout or structure adjustment for sustainability in a region or city
- Sector funds for enhancing sustainable development
- Environmental insurance foundation, and
- Others

(7) Bonds and cash deposit-repay institutions

- Environmental performance bonds(e.g. forest management bond)
- Land reclamation bonds(e.g. mining land revival bond)
- Transport and refusal reuse bond
- Environmental accident contract and bond(e.g. oil-spill and industrial accidents, etc.)
- Goods deposit-repay institution(e.g. packages, electrical household appliances, etc.) and
- Others

Over the years the policies listed above, mostly have been formally or tentatively practiced in China.

4.2.3.2 Limitations in policy making and implementation

The policy system listed above compiles a variety of specific policies which have been used for addressing market failure and making correction measures, and have been proved effective in resource conservation and environmental protection either in developed countries or in some developing countries, but there are or will be many limitations to make adequate clauses, detailed rules and standards in attached documents when making a specific policy in China.

(1) Limitations in policy making

The conditions needed for a sound policy making but often found insufficient are discussed as follows.

- A database provides policy makers information for evaluating the static and dynamic efficiency of specific policy instrument. The static and dynamic efficiencies mean achieving the policy goal at a minimum cost to the society, and providing innovation and search for alternatives effectively to meet the objectives – while minimizing the costs of implementation i.e. monitoring and enforcement costs.
- Many environmental assets do not have been well defined with property rights, but to introduce them into market, their property rights are needed. In GGDPA, it is needed to evaluate environmental degradation and resource depletion in market values. Therefore, it is needed to design a mechanism to assign individual property rights and accumulate information to the change of environmental assets.

- Some property rights, e.g. pollutant trading permits, are possible to define and to allocate in market place based on available regulations and institutions. However, it would be a challenge for finding the right balance between giving free to market forces, and for monitoring and enforcement. The national and local statistical and accounting systems should provide the conditions to create operable policies and measures.

- Public participation and monitoring can also make policies more effective. The condition is public engaging the policy process and sharing information, and/or information disclosure and transparency.

- A mechanism to find and address policy failure is important when a policy is being made. Many resource and environmental stresses today are not the result of ignorance about what polices to adopt, but the mechanism to find what social interest groups blocking the necessary reforms and how to stride over the barriers. Certainly any policies are necessary to be modified with changed conditions or the lapse of time. Hence the system of integrated economic and resource—environmental accounting

system built at national and local levels with sufficient information disclosure and transparency should be the condition for policy making.

(2) Limitations in policy implementing

Policy can be designed to improve the management of environmental assets. In practice many worthwhile policies are not implemented, therefore the breakthrough of such limits as the institutional atmosphere in promoting implementation of policy, weak in picking up signals about needs and problems, balance interests or alternatives from different governmental sectors and social groups, and executing policy decisions credibly following through on agreement will be the prerequisite for policy implementing.

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– Picking up signals

Signals of social needs and environmental degradation can be based on either scientific data, e.g. air quality, or voice and feedback, but their effectiveness is dependant on the component part for information and action. The ability to pick up signals is closely associated with the ability to balance interests. Creating and receiving signals range from the feasibility of detecting a phenomenon in a meaningful way to the process of aggregating the signals and getting the attention of decision depends on social and political relations, and also the availability of systematic data or information which are true and open.

– Balancing interests and alternatives

An environmental protection policy, e.g. air quality protection policy, operates within an authorized framework that balances interests. It may impose emission standards and taxes, and strengthen enforcement. This will strengthen benefits to air quality and meantime rights of others. The balancing of interests may take place at many levels: in administrative agencies at control and local levels, in market places, in individual norms, in corporate boardrooms and branches, and in the seen or unseen social—economic processes.

Information provision can catalyze shifts in political balances and helps implementing a specific policy. The experiences from developed and some developing countries have shown that transparency in policy implementing do help better governance.

– Executing policy decisions

As an environmental administration executes policy decisions through charges, taxes, regulations and enforcement, people and firms change their pollution behaviors. However execution of policy is an extension of balancing, and good procedures and broad participation can help in the execution of policy decision. Good procedure requires broad participation and that can help in the execution of policy. Routing environmental impact assessment of the policy enforced with good quality information and public participation can predict consequences before policy execution. Thus the information basis, especially time series provided by the integrated economic and environmental accounting system functions as a device.

4.3 Application and policy uses of GGDPA (SEEA) in China

At the 2004 Central Forum on Population, Resources and Environment President Hu Jingtao pointed out that: the Scientific Development Notion means: Economic development shall fully take natural carrying capacity and enduring capability into consideration, firmly prohibit the way of plundering nature and destructing nature as over grazing, pillaged mining and devastating deforestation. Study the way of green GDP accounting and probe the assessment system bringing resource depletion and environmental damage and benefits into the accounting of economic development level in 2004. That means the Chinese leaders have recognized the role of GGDPA in practicing SDN. In fact from the contents discussed in above sections of this report, it can clearly be seen the important roles of the SEEA.

Unfortunately many officials, mass media, general public, even some experts have held the views that the Green GDP accounting system or the SEEA only plays the role of providing annual data to show the costs from national and local resource depletion and environmental degradation for people to learn. These views have led people to question: is it worth inputting a great deal of funds to establish GGDPA system (or SEEA). And are there any alternative approaches to yield similar results?

Following part of the report discusses the value of GGDPA system for effective making and executing resource – environmental policies and other useful functions.

4.3.1 Common weakness of making resource – environmental policy

(1) Historical problems with policy making

China has formulated and promulgated a setting of resource—environmental policies concerning environmental management, pollution prevention and control, natural ecosystem protection and resource conservation since early 1970s. The early policies mostly are based on administrative compulsory measures and command. Along with the practice of nationwide reform and openness, the policies based on market mechanisms has been gradually introduced and applied in policy making. Six principles have been claimed to be insisted in Chinese policy making since 1970s:

- Coordination of economic construction with environmental protection;
- Integrated measures for prevention and control of environmental pollution and resource conservation.
- Any unit or individual who is authorized to exploited natural resources has borne the obligation to conserve and protect them;
- Any unit of individual who does pollute the environment is borne the obligation of remedy or treatment;
- Environmental protection shall rely on the mass action; and
- Combination of reward and penalty.

These principles are good and rational under planned economy but often cannot be carried out through specific market-based or regulation in the down-to-earth manner and become empty slogan. This problem has had imputed to ignore the externality of environmental and resource issues. The policy makers are

failed to fully take the role of environmental economic principles into consideration.

Connecting to Chinese historical condition we may put forward some main explicit problems as follows..

– The economic implement

Such implement as pollution charges or resource taxes has been practiced since early 1980s but determining the rates of charge and tax mainly were based on the negotiation among governmental ministries. Because of weak in sustenance of series data the feasibility studies and alternative policies were often sketchy. It is often short of sufficient budgets to support the implement of policies. For example the budgets to pay personnel training, pollution monitoring, the costs agencies to collect charges, etc were often much lower than what was needed.

– Obstruction at local level

Over the years local government have been prone to economic growth first and underrated the significance of environmental protection. The diversity of investment bodies has rapidly increased the amount of firms particularly the number of small and medium firms using lower grade technology, but the number of personnel working for environmental supervision and monitoring has not increased proportionally since 1990s. That has caused the obstruction of policy implementing and law enforcement as a popular phenomenon at local level.

– Inadequate in setting of charges and taxes and coverage of pollutants

Because there has often been short of benefit—cost analysis in policy making, the rate of pollution charges and resource taxes has not been adequate set as impetus of firms for pollution abatement and resource conservation. For example, the emission charge of sulfur dioxide is only 10% of the treatment cost in 1990s and about 50% of the treatment cost for COD (Chemical Oxygen Demand).

Another problem has been only small number of pollutants covered in the pollution charge standards and a part of resources listed in the scope of tax payment.

The eco-compensation taxes (or fees) have been conducted at many selected provinces, cities, mines, etc but the tax rates are often too low..

– Other restrictive factors

The actual technical strength, management horizon, experiences in environmental policy making and national economic conditions have been gradually raising along with the reform and openness of China since 1970s. Hopefully the historical problems with the policy making have been overcoming smoothly over the years.

(2) The weakness in policy making

Comparing to most developed countries main weakness in Chinese policy making is rest with the deficient of an underpinning of economic—environmental statistical and accounting system. Over the years restricted by limited data and information available for policy studies, the process of policy making has mainly been dependent on the political guiding principles, experiences from leaders and experts, and less of

feasibility and alternative studies as the basis of decision making. It is particularly true at local level in the process of policy making. The cause of following enumerated points of weakness may reflect the necessity of establishing the SEEA in China.

- Lack of cost—benefit analysis.
  Lack of cost—benefit analysis in policy making and formulating standards often decrease the feasibility of policy or standard in executing process.
- Lack of alternative studies in policy making.
- Oversimplifying the objective reality may decrease the effectiveness of a policy.
- Information concerning the facts and reasons in policy making were not sufficiently available for consumers and producers.
- Historically integrated economic—environmental data analysis is often insufficient; and
- Others

(3) Values of GGDPA (SEEA) for policy use

The purposes of GGDPA are not only providing a set of data on environmentally adjusted GDP, NDP (net domestic product), GNI (gross national income) and NGS (national genuine saving), but more importantly seeing up a dynamically integrated environmental and economic information system for measuring sustainability and designing harmonic policies. The latter point has been often overlooked by officials and general publics.

Broadly speaking there are three sorts of values of applications: valuable for implementing SDN, promoting sustainable development and monitoring the sustainability of an industrial sector and local development.

- The applications of time series--statistical data concerning the development of the setting indicators are valuable either for statistical sector or other' sectors studying on the different subject areas covered in the SEEA.
- The second sort of uses shows how specific policy analysis or making can be based on the data and techniques covered in GGDPA system or SEEA. and
- Monitoring and measuring the press exerted by economy on resources and environment, and to explore how these might be decoupled.

4.3.2 Application of a GGDPA system

4.3.2.1 Application of physical flow accounts to track the causes of environmental degradation and energy efficiency

To combat climate change and environmental degradation, Chinese government has taken the indicators of energy saving and pollutant emission reduction as significant policy oriented objectives in formulating plans and examining administrative performance. The physical flow accounts can be applied to provide information and indicators the purpose.

(1) Tracking the structural causes of low efficiency of energy and national uses

In order to design effective environmental policies, the designers must understand the structural deficiencies in low efficiency of energy and material uses. The statistical system in SEEA can be used for this purpose and for differencing between the roles played by an industry's technology and management, as well as the role played by the level of output. A stepwise process based on the model of "Driving forces →Stress→Response→Countermeasures" may be useful for the purpose. Figure 4-4 describes the process.

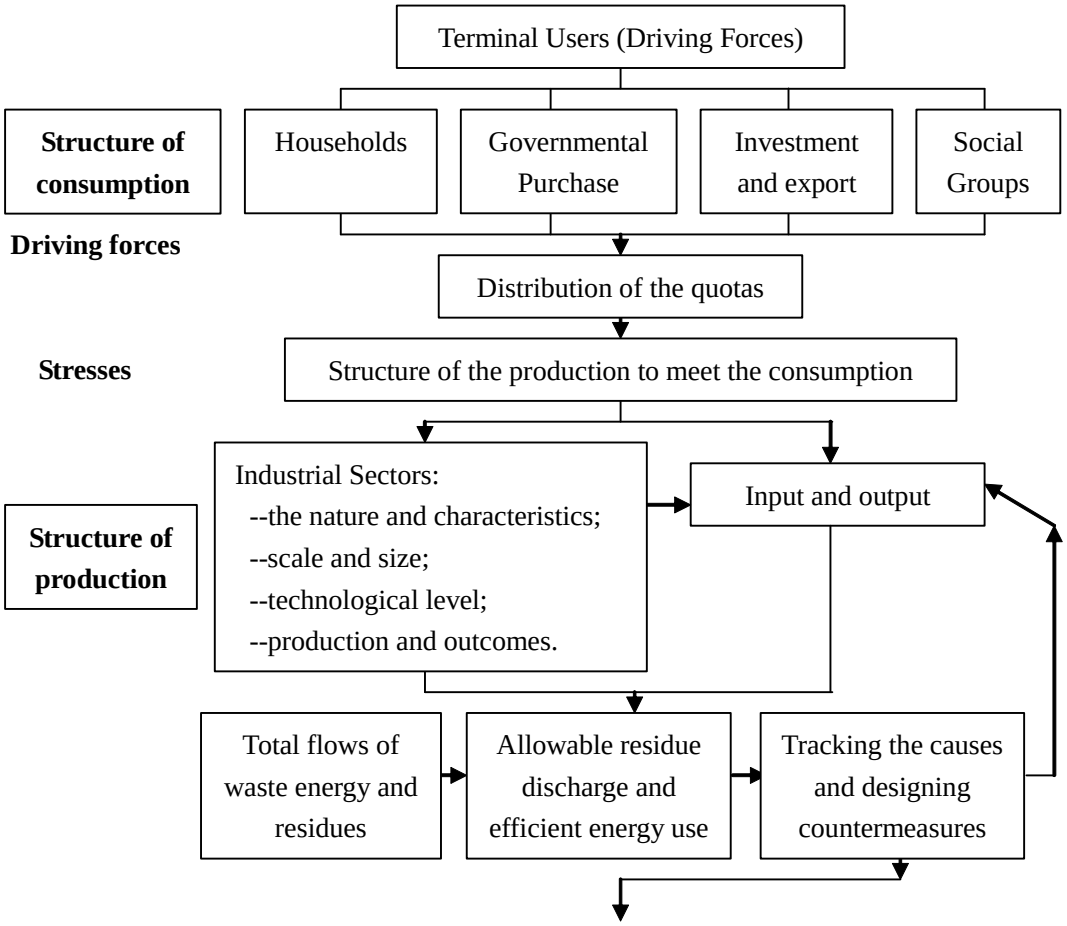

Figure 4-4 Stepwise process to track the causes of environmental degradation and energy efficiency

For Figure 4-4, the following points are noted.

(a) Use hybrid input – output table to measure

- the total impact (direct and indirect) of each important consumers (users), and
- reallocation of sector emission or discharge from different industries driven by different final consumers.

(b) Structure decomposition of total amount of a specific pollutant to different industrial sectors. The impact of a pollutant will sometimes show that the total effect is much bigger than direct effects or the

indirect effect is bigger than direct effect.

(c) Based on quantitative analysis the government can design more effective strategy to reduce energy and material uses and to manage the reuse and recycle of residues and the energy consumption.

(2) Understanding long-term environmental changes

Structural decomposition analysis is also a technique developed to distinguish the different sources of change in the economy over time by decomposing differences in the direct and indirect requirement matrices derived from the input—output tables and hybrid account in the SEEA. Further, we may analyze the change of long-term driving forces, and account for the energy consumption level and emission or discharge level. Then we may predict the effects of changes in economic policies, environmental policies and regulations, and further look at future decisions on development alternatives of technology and the structure of final demand levels in production.

4.3.2.2 Application of environmental expenditure and tax accounting

(1) Integration of environmental expenditure with “circular economy”

To promote “circular economy” in China is a powerful measure to realize SDN and to decouple economic growth with environmental degradation. A crucial prerequisite for implementing circular economy is the creation of a social – economic policy system compatible with market economy as discussed in section 4.2.3.1. Because there are limitations either in the functions of SNA or in that of SEEA, the integration of the two systems greatly help the implementation of circular economy.

(a) SNA may provide the information to identify current and past costs incurred for preventing and controlling environmental degradation and resource depletion. We can use these information to postulate the approaches to prevent and control the growth of energy squander and pollution raise through:

- Using the accounts of environmental expenditure and resource management; and
- Adopting policy instruments, e.g. eco—taxes, emission permits, etc.

Because the scope of information or data provided by the SNA are confined in physical flows, the quantitative cost—benefit evaluation of specific policies is often not feasible.

(b) On contrary the SEEA may provide the information of data to demonstrate:

- How much environmental expenditure in past and present economic functioning? and which economic—environmental policies had been adopted over the years?
- What is the connection of environmental expenditures and specific production activities and existent environmental problems?
- Who commit the environmental expenditures, public or private sectors, industries or households?
- What are suitable rates for the emission charges, environmental or resource taxes?
- What roles do environmental protection play in promoting economic growth?

- Is it really possible?
- How to make the environmental expenditure and energy saving measures as the driving forces to encourage cleaner production, eco—industry and circular economy? And what are their results of cost—benefit analysis.

The integration of environmental expenditure with the "circular economy" will be the opportunity of transformation form traditional view of environmental expenditure, as "economic burden" to impetus of healthily economic development. Figure 4-5 may described the concept.

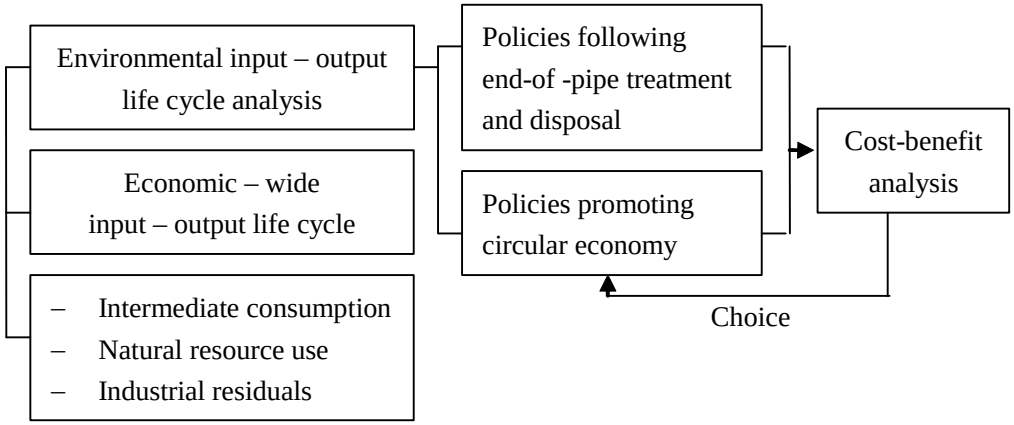

Figure 4-5 Policy making to promote "Circular economy"

(2) Application to policy analysis

Policy analysis is a broad area for application of GGDPA system.

(a) Integrating environmental expenditure and tax accounts with economic models for policy analysis

Environmental expenditure and tax account can be used in policy analysis to find out:

- How large is the economic impact of environmental administration and control?
- How large is the economic impact of environmental taxes?
- A comparison and assessment of economic, social and environmental benefits from pollution reduction and residue administration and control costs; and
- What are economic effects of 3R (reduction, reuse and recycle) and/or circular economy?

Environmental expenditure and tax account can be used to simulate the impact of environmental protection measures under postulated visions on the direction of economic activities, economic growth and employment patterns. The accounts can also be applied to calculate the costs of pollution reduction.

Policy makers may understand the appropriate rate of environmental taxes through the comparison of the national tax structure which includes such taxes as nature resource tax, environmental property tax, emission tax, residue tax, etc. Further they may learn the proportion of specific kind of tax and how large of their economic impact? Then they can adopt proper measures to remain the equilibrium among the policies.

(b) Measuring the sustainability of the national assets and policy analysis

There have been many approaches developed yet to measuring sustainability of the national assets and policy use. One important use for us is to track whether the national stock of assets is being maintained over time or whether production and consumption processes diminishes the stocks without replacement. The SEEA can provide the information or data base for measurement. It is particularly making sense for practicing SDN in China.

- SDN needs monitoring national wealth change over a long period of time. While none-declining national wealth does not guarantee sustainable development, declining national wealth almost certainly indicate unsustainable development unless it is accompanied by technological interventions to enhance the growth rate of renewable resources or more efficient use of none—renewable resources, and new discovery of the national resource stocks[7]. More comprehensive accounts for national wealth can also improve the ability of policy—makers and researchers to make informed decisions[8].

- Physical asset accounts can provide varies indicators to judge the sustainability of ecosystem and detail information for resource management.

- When planning the patterns of resource exploitation the accounts may furnish the capacity and time period of national minerals to support the development, as well as the alternatives of adjusting the exploitation modes and quantity.

- When decomposing the quantity of biomass (e.g. fishery production in specific water basin, timber stocks in a forest, etc) based on regeneration ages the accounts can be used to determine sustainable products and helpful in marking harvest policies.

- The accounts can be useful in monitoring the change of stocks and flows of land resource assets.

- The accounts can also be used for the impact assessment of GHGs' stocks and flows on climate change; and further track the change of carbon stocks and flows, e.g. forestation, vegetation, energy saving, etc.

(c) Monetary stock of assets

- The monetary accounts of asset stocks in the SEEA can support the analysis of productive assets and natural assets in terms of monetary value. The accounts can be used to evaluate the diversity of wealth and the distribution of their property rights. The distribution of asset property rights between public and private sector, central and local government, different social group, and domestic and foreign firms implicit economic significance and affects the sustainable management of natural resources and environment.

- China is a country practicing socialism—market economy institution. The government owns the great part of resource property rights. The government uses the resource rent for investment in public sectors and resource conservation and environmental protection. The hybrid accounts in

the SEEA can provide the basis for policy analysis.

- When making policy analysis the government has to balance the economic efficiency, social—economic objectives and sustainability of natural resource consumption in accordance to the principle of equity.

- The depletion of none—renewable resources are unsustainable but the government can invest the resource rents in production of substitutive resource to maintain so called “weak sustainability”. The function of policy instruments is to control the consumption rate and set proper resource tax levels based on the statistical data and accounts in the SEEA.

- The policy instruments can be used not only to promote resource efficiencies, but also to draw resource rents from commercial business.

4.3.2.3 Valuation of environmental degradation and policy use

(1) How much are the costs of environmental degradation and resource depletion and how effectively apply the costs to the management and policy making? This problem does remain to be improved. It is well known that the environmental management and policy making are based on the possession of sufficient information on the physical flow accounts, hybrid flow accounts, and relevant sources of residues, economic effects of energy and material consumption, and production of goods. When making a specific policy the makers should know:

−Where is the most effective place to use limited financial resources?
−How many parts compose the costs of environmental degradation?
−What are the economic benefits taking from the costs of environmental degradation?
−What methods can be applied to evaluate the environmental degradation? and then?
−What specific policy may the government use to mitigate the pollution and squandering?

Therefore the applications of environmental valuation are significant for policy design and effect monitoring.

(3) When making policies concerning prevention and control of environmental degradation it is also necessary to estimate the costs to lay down and implement the policy. Because of the externality the bearers of costs are not certainly the beneficiaries. Therefore the policies should be designed to balance the costs and benefits of both sides, and meantime the policies must give the polluters and beneficiaries’ impetus and urge to reeducation of emission or discharge. The SEEA will play essential roles of providing:

−the physical flow data sets, which may provide the data to explain the degradation processes of resource—environmental assets for policy simulation; and
−the monetary flow data and hybrid flow data, which may provide a common platform and unit, and make possible of comparison and options for distinct policy alternatives.
−the SEEA will help to overcome the weak link of cost—benefit analysis in policy making in China,

because lack in sufficient data base has been the bottleneck over the years, that was in varying extent crippling the effectiveness of a specific policy.

(3) Pricing the non—market goods and environmental services

The prices of none—market goods and environmental services are often underrated in policy making. For example the "Green Wealth Accounting of Shennongjia Forest District in 2004" by the Project "Establishment of China Green National Accounting System—Final Report" [World Bank—Italian Trust Fund Project (No. TF054326)] presented that the total value of green wealth in Shennongjia Forest Distinct amounted to 23.61 billion RMB in 2004. This figure may be underrated. Because of the shortage of historical statistics on valuation for a forest district the opportunity value of forest land and other eco—services were not fully taken into account. Meanwhile the outlay of daily management for unique ecosystem protection like the Shennongjia Forest Distinct was not included.

4.3.3 Underpinning of strategic planning

China has had a tradition to lay down strategic plans for national long-term visions of development since 1978, e.g. 'The Vision and plan of 2000 China' in early 1978, 'The 21st Agenda' in 1994, 'The Development Strategy of China in 21st Century' in late 1990s, etc. These strategic plans play important roles in promoting sustainable development, directing policy making, and encouraging officials, entrepreneurs and citizens to endeavor for the goal. The challenges of these planning are weak in solid data supporting and scrutinized test or proof. Besides these strategic planning are basically in light of governmental leaders' preference and expert experiences, and also their experiences. For the purpose of practicing the scientific development notion(SDN) it is necessary to lay down the strategic plans with the objectives of economic efficiency and development, sustainability of resources and environment, as well as socio-economic objectives.

(1) Economic efficiency and sustainable development

When discussing the economic development in final analysis we shall recognize that the determinant is recovery of resource rent from commercial operations can be deployed to ensure a more equitable distribution of benefits from the use of resources(including environmental capacity) among current different groups and between current and future generations. Within current generation, the resource rent of income can be used to support economic development that betters the lives of all citizens, not only the minority who may own companies, political power and wealth, and be the riches. However, to ensure intergenerational equity the country needs to resist the pressure to consume all the rent or income in the current period. At least some portion of the rent must be re-invested to contribute increasing well-being for future generations[9].

The property rent or income payable to the government for the use of natural resources and environment can be compared with total resource rent darned in the production process. Three problems have to be solved to bring the comparison to the proof, which are whether:

- government is recovering the whole of resource rent;

- the appropriation by government at least covers the costs of managing the production industries; and
- current strategic plans and policies of management can maximize the amount of rent generated from the resources and could be higher than alternative plans or policies[10],

Developed countries, e.g. Norway can use the SNA and SEEA to assess the contribution of natural resource to the economy, and also to compare the share of resource rent in total government revenues and the share of resource management costs incurred by government. It will be greatly helpful in managing economic efficiency and sustainable use of resources and environment with the underpinning of the SEEA or GGDPA system.

(2) Sustainability of strategic plans

The issue of whether extractive industries are managed in a mode of sustainability is an important factor for all economic sectors. The first problem is whether the government reinvests the rent receiver from non-renewable resources to maintain the level of capital stock without reduction in accordance with the "principle of weak sustainability".

Government can institute the measures to monitor the use of resource rent based on the information provided by the SEEA. Sustainable resource management can be evaluated from the angle of economic efficiency to determine if alternative policies might increase the income and economic value of a resource. For renewable resources, e.g. forest, fishery, etc. another option is to maximize the sustainable yields.

(3) Socio-economic objectives

Two fundamental socio-economic objectives are the equity of distribution between the present groups in society and between the groups of present and future generation. In pursuit of the objectives government will often modify the approach of simply maximizing economic efficiency for other socio-economic objectives. For example, the government prefers to create more employment and generate income in some parts of the country but taking sacrifice of economic efficiency and greater income as the costs. In strategic planning monitoring these kinds of situation requires estimating the share of rent that accrues to government and to private sectors. Despite it is difficult to determine the allocation of benefits and costs.

When the government pursues the socio-economic objectives that conflict with economic efficiency a cost mat have to be paid. To know the cost through monitoring and statistical data will make the policy for balance of cost and benefit more effective. An initial, static analysis of trade-off might measure the gain and loss of resource rent based simply on data and information from local and/or industrial statistics under existing resource management regime, but for strategic planning it is needed to base on the formal and sound national and provincial SNA and SEEA and to use more sophisticated modeling of industries for determining long-term economic effects of alternative management strategies on the value of a resource.

The policy use and application of the SEEA are much broader than what discussed in this report.

As concluding remark, that the establishment of a sound and formal green GDP accounting system of

the SEEA with sound, compatible data collection and strategic planning in pursuit of sustainable development.

In a recent news of SEPA, the working team continued their accounting and completed the accounting for the year 2006. However, it would encounter the same situation as the one for the year 2005, indefinitely waiting for release.

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5 CONCLUDING REMARKS

China is brilliant in economic achievements in the current world, and also well known as a country of huge population, with restricted but in high depletion resources, and severe environmental deterioration. The situation has raised the question: "Will the future development of China be sustainable?" While GDP is used as the predominant index to measure economic growth, people have been arguing that the rapidness of GDP growth in China is at the cost of severe environmental degradation and over consumption of resources. One of the attempts to tackle this problem is to introduce and set up a national green accounting system, which follows the international SEEA 2003, respective to China's practice.

The necessity of developing a Green GDP Accounting system in China may be expressed from three major aspects: informing the government and public how much is the cost in environmental degradation and resource depletion for keeping high GDP growth rate; providing a solid database for measuring the sustainability of economic sectors and environment/natural resources; and tracking the causes of environmental degradation and energy efficiency, so as to support policy making and strategic planning.

Only limited items were manifested in environmental degradation accounting and resource depletion was not yet included. Nevertheless, the possibility of setting up a Green GDP Accounting (GGDPA) system in China has been confirmed by the completion in 2006 the green GDP accounting projects and by the report of 2004 accounting results released to the public.

A retrospect of the development of economic accounting and green accounting in China showed the great enthusiasm and potential of the people in marching forward, and the gradual awareness on the costs due to environmental degradation and resource depletion that are coupled with GDP growth. It led to the studies on damage calculation, since early 1980s, despite that all of these studies were classified into one-off exercises and played only the role of alarm-bell. The historical experiences also show that: the economic losses by pollution and eco-disruption are sufficiently persuading for governmental officials to lead off regular accounting and to integrate the monitoring on environmental consequences of economic activities. It is necessary to establish a national, provincial and local database system in China to support a routine loss calculation based on a system of integrated environmental and economic accounting.

There are still conceptual, theoretical, institutional, and technical barriers for the establishment of GGDPA. Considerable efforts are needed to set up and improve the approaches and methods to estimate the losses by environmental degradation and resource depletion. Also crucial is to differentiate and harmonize the two accountings: purely economic and green integrated. The strategy of organizing the national and sectoral tasks for building GGDPA system thus should take a systemic approach through: popularizing the knowledge on sustainable development and GGDPA; legislative actions to complement the regulation vacant and financial input concerning GGDPA; and. promoting the task in cumulative and step by step ways, and building the institution of cooperation and creation.

Implementing Scientific Development Notion (SDN) as a political manifesto declared by central government of China needs the underpinning of GGDPA. SDN, in fact is the Chinese expression of Sustainable Development and the guarding principle of Chinese government Six severe challenges of

practicing SDN are: in demographics trend; extraordinary extraction, consumption and utilization of energy and material resources; sustainable urbanization; environmental pollution and disturbance of natural ecosystem; disparity among different areas and solving the problems in rural areas; and promoting the capability of national sustainable development and international competition. The strategy to meet the challenges will be prior in three domains: changing the connotation of GDP oriented development; developing circular economy, and taking scientific-technical progress as the pillar; and transforming the economic institution through systematic measures.

To build a resource-efficient and environment-friendly (REEF) society is the substantially strategic option for implementing SDN. A REEF society provides the across-the-board support to the economy, society and environment--the three dimensions of sustainable development, which are the demand and manifestation of SDN. However building the REEF society should let government and people know clearly the resource-environmental costs of GDP growth, and formulate the institution and policies for decoupling the relations between economic growth and environmental degradation – resource depletion.

Translating SDN into mass actions needs to build compatible policy system concerning economic, social and resource-environmental dimensions, which include directives and regulation, setting of objectives, stipulated technology, standards, etc; market stimulus mechanisms to promote resource taxes, pollution charges, tradable pollution quotas; and social-economic policies to regulate market failure.

Limits in policy making and implementing in China have greatly confined the effectiveness of many existed policies. A data base like the SEEA provides the policy maker information for evaluating the static and dynamic efficiency of specific policy instrument, and public engaging the policy process and information disclosure /transparency are especially essential. The institutional atmosphere in promoting implementation of policy has been weak in picking up signals about needs and problems, balance interests or alternatives from different governmental sectors and social groups. Executing policy decisions credibly and follow through on agreement will be the prerequisite for policy implementing. Information provision can catalyze shifts in political balances and helps validly implementing a specific policy.

Comparing to most developed countries main weakness in Chinese policy making has mainly been dependent on the political guiding principles, experiences from leaders and experts, and less of feasibility and alternative studies. This issue has been rest with the deficient of an underpinning of integrated economic—environmental statistical and accounting system or GGDP system.

The purposes of GGDPA (SEEA) are not only providing a set of data on environmentally adjusted GDP to the officials and general public, but also a valuable instrument and underpinning in policy application. For examples: application of physical flow accounts to track the causes of environmental degradation and energy efficiency; the structural causes of low efficiency of energy and national use; understanding long-term environmental changes; particularly integrating environmental expenditure with the “Circular Economy”. When formulating various strategic plans the SEEA is also valuable in measuring economic efficiency and sustainable development and balancing sustainability of strategic plan with socio-economic objectives.