

# Appendix **1**

## **China Country Review: Environmental Policy in China: Gaps, Innovations and Future Direction**

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# **Appendix 1**

## **China Country Review**

## A.1 Environmental Policy in China: Gaps, Innovations and Future Direction

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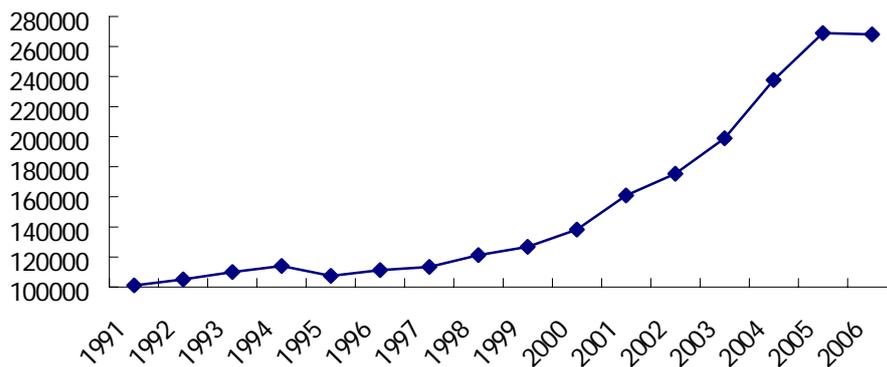
### 1. Serious problems from economic growth

From 1978 to 2006, China's economy saw some extraordinary growth, with GDP growing at around 10% a year. This economic growth, however, comes with significant environmental cost (Hu Y. 2005). Due to past economic growth certain environmental improvements have been attained (increased resource efficiency per unit of output, reduced solid waste generation per capita), while others – the majority of the environmental problems – have worsened, and continues to worsen unless substantial efforts are made to curb or prevent them.

Air pollution: Over the past three decades, air pollution has increased with economic growth. Industrial air pollution had experienced a 1.5 fold increase from 1991 to 2006.

Figure 1. Industrial Air Pollution in China, 1991-2006

Unit: 100 million m<sup>3</sup>



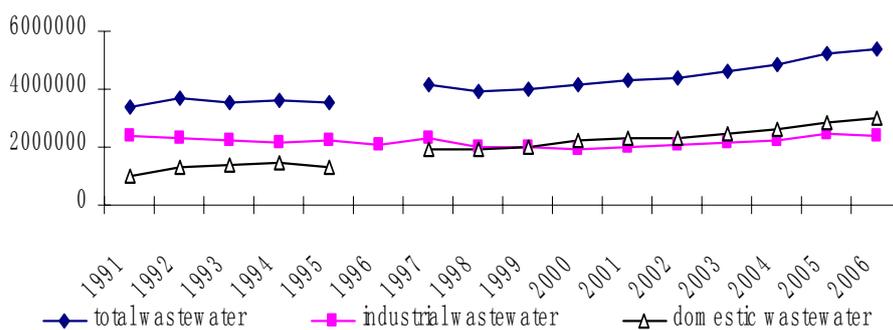
Source: China Environmental Statistical Yearbook, 1992-2007

It is important to note that SO<sub>2</sub> emissions remain a key area of concern for environmental protection. These SO<sub>2</sub> emissions mainly come from combustion of fuels (mainly coal) with high sulfur content. Power generation is the major process generating SO<sub>2</sub> emissions. High concentrations of SO<sub>2</sub> in the air impair human health and reduce industrial and agricultural

productivity due to acid rain. Total SO<sub>2</sub> emissions have increased by 60% between 1991 and 2006. (Liu and Chen, 2007). Industrial emissions show a similar increase, whereas SO<sub>2</sub> emissions from households account for a small and declining proportion of the total. During 1991 and 2006, emissions of soot in China reached a peak of 18.7 million tons in 1997, and declined thereafter. Industrial soot emission was the major component of total soot emission, whereas domestic soot emission accounted for a small proportion. The damage to human health caused by industrial dust is getting more attention in recent years due to its negative impact on human health (Yang 1997).

Water pollution: Water pollution is a major environmental issue in China. The wastewater emissions have continued to grow between 1991 and 2006. The amount of wastewater was 33.6 billion tons in 1991, and rose to 53.7 billion tons in 2006, a 60% increase in 15 years. It should be noted that during this period domestic wastewater emission has surpassed industry and become the bigger source of water pollution. Since 1999, domestic wastewater emissions increased in all provinces, except Tibet. Curbing Chemical Oxygen Demand (COD) has been the main target of water pollution control in China during the past three decades. The data indicates a decline in China's total COD emissions, with a slight increase in *domestic* COD emissions. In 1999, the domestic COD emission surpassed industrial COD emissions and became the major – and increasing - source of COD emissions. This indicates that domestic water pollution became the major new challenge facing China's COD control policies.

Figure 2. Wastewater Emission in China, 1991-2006 (Unit: 10,000 tons)

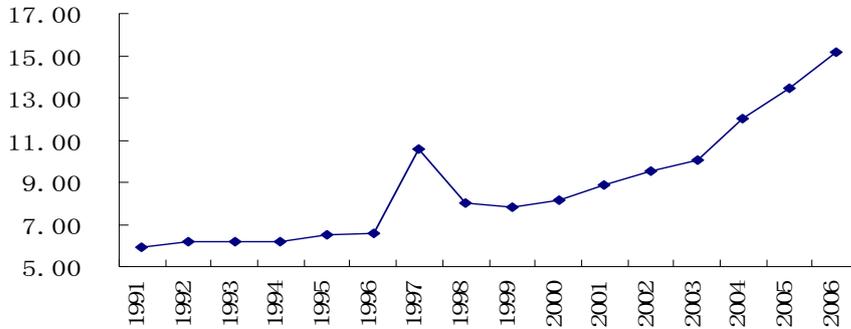


Source: China Environmental Statistical Yearbook, 1992-2007

Industrial Solid Waste: Dumping of industrial solid waste occupies land, contaminates soil, damages human health and causes serious water pollution when dumped into water. Dumping of industrial solid waste is also one of the major environmental problems facing China. China's

industrial solid waste has increased from 0.59 billion tons to 1.52 billion tons during 1991-2006.

Figure 3 Production quantity of industrial solid waste Unit: 100 million tons



Source: China Environmental Statistical Yearbook, 1992-2007

Marine resource degradation: In year 2000, an assessment of sea water quality indicated that more than 15% of the sea area was “less clean” or “slightly polluted”. Around 4% were “moderately polluted” or “seriously polluted”. Seven years later, in 2007, sea water quality has improved slightly. However, the seriously polluted area remains the same (2.9%). The largest (moderately or seriously) polluted sea area includes China’s East Sea. However, the largest pollution increase is found in Bohai, Yellow Sea and South Sea.

Table 1. Environmental Quality of China’s Sea Water (2000-2007) Unit: 10,000 square kilometers

Year	Total Area	Less clean	Slightly polluted	Moderately polluted	Seriously polluted
2000	20.6	10.2	5.4	2.1	2.9
2003	14.2	8.0	2.2	1.5	2.5
2007	14.5	5.1	4.8	1.7	2.9

Source: *China’s Marine Environmental Quality Bulletin 2000~2007*, State Oceanic Administration

Biodiversity: China’s rich and diverse geography and climate make it one of the world’s richest countries in terms of biological diversity. According to statistics, China’s biodiversity ranks eighth in the world and first in the Northern Hemisphere (Barntz, 1992). However, China is also one of the countries with the most severe bio-diversity degradation. Using endangered species as an indicator, 74 of 250 known seed-bearing plants are endangered. And 23% of the mammal

species are endangered. These figures illustrate serious problems in China's efforts to conserve biodiversity. The main causes behind the biodiversity loss are degradation and destruction of forest resources, grasslands, wetlands, rivers and lakes, respectively, and invasion of alien species.

Table 2. Endangered Species in China

Category	Number known	Number of endangered species	Ratio of endangered species (%)
Mammals	581	134	23.1
Birds	1244	182	14.6
Reptiles	376	17	4.5
Amphibians	284	7	2.5
Fish	2804	92	3.3
Insects	3400	100	2.9
Seed-bearing plants	250	75	30.0
Ferns	2400	80	3.3
Moss	2200	98	4.5

Sources: Chen (1999); Wang (2004); Wen (2004)

Soil erosion: Soil erosion is often considered the biggest environmental issue in China. Based on remote sensing data of soil erosion, the area of water and soil erosion was around 3.7 million square km<sup>2</sup> in the mid-1980s. This represents more than one third of China's territory. Of the eroded area, water erosion took up 1.8 million km<sup>2</sup>, while the wind erosion area was 1.9 million km<sup>2</sup>. In mid-1990s, the soil erosion area was 3.6 million km<sup>2</sup>, reduced by some 0.11 million km<sup>2</sup>. Comparisons of soil erosion data between 1985 and 2000 indicate only minor improvements at the total level. However, the area of severe soil erosion has actually increased. Major factors behind the increase include construction and mining activities (Fang et al. 2008).

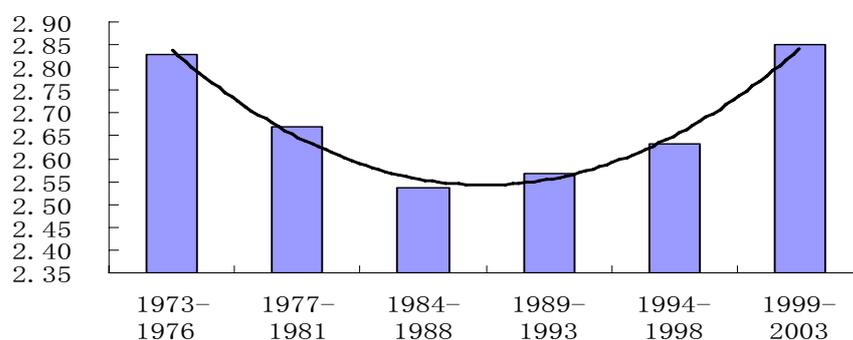
Table 3. Soil Erosion Area (unit: 1 000 000 km<sup>2</sup>) in China, 1985-2000

Erosion Types	Year	Total Area	Low	Moderate	High	Severe
Wind, water erosion	1985	3.67	1.86	0.78	0.48	0.30
	1995	3.56	1.62	0.81	0.43	0.37
	2000	3.57	1.64	0.81	0.42	0.38

Data Source: Li et al. (2008)

**Deforestation:** Before the reform and opening up in late 1970s, China's forest resources had suffered unprecedented destruction with at least 25% of the forests felled (Li et al 2000). According to the data from the second forest resources inventory, up until 1981, China's forest coverage rate had been only 12%, historically the lowest. Since the reform began, serious effort in afforestation was made which have led to forest area growth. Meanwhile, the volume of standing forests has increased as well. Although government programmes have increased the area, forests cover only 18% of China's land area, compared with 30% on world average. China is one of the world's most forest-deficient countries, with only 0.1 ha of forest per person, compared with a world average of 0.6 ha. Meanwhile, the quality of China's forest is taking a decreasing trend on the whole. What's more, the structure of China's forest resources is unreasonable: ordinary trees occupy a larger proportion than valuable trees, in addition to which, the proportion of valuable trees is decreasing and primitive forest is changing into second-growth forest in a fast pace; The ratio in coverage areas among young trees, medium-aged trees and mature trees are 1.2 : 3.3 : 5.5, which means young trees and medium-aged trees are having substantial weight (Dong et al. 2002).

Figure 4. Change of China's Forest Area Unit:100million ha.



Source: China Environmental Statistical Yearbook, 1992-2007

**Grassland degradation:** China's grasslands are seriously degraded. The grassland degradation reduces livestock production and degrades the local environment generally. According to a survey by the Ministry of Agriculture, by the end of 2001, China's severely degraded grassland areas had reached 175.409 million hectares, accounting for 44.7 % of the total natural grassland area. Some studies (Xie 2005) reported nearly half of the grassland had been in moderate degradation. At the provincial level, the provinces (autonomous regions) with the largest areas of serious grasslands degradation were Inner Mongolia, Xinjiang, Gansu, Tibet and Qinghai; the provinces (autonomous regions) with the highest proportion of severely degraded grassland area to total natural grassland area were Ningxia, Gansu, Shanxi, Henan and Xinjiang. Among them, Gansu and Xinjiang, were the two provinces with both largest degraded area and highest

proportion. These two provinces should be given particularly high attention when dealing with grassland degradation in the future. Furthermore, combined with the grassland degradation situation in nine provinces of northern China from 1987 to 2001, we can find that China's grassland degradation represented a rapidly worsening trend. It can be predicted that the expansion of grassland degradation is still difficult to mitigate for a long time to come.

Table 4. China's Grassland Degradation Unit: 10,000 ha.

Region	Natural grassland area	Seriously degraded area		
		1987	1998	2001
Tibet	8205.2	133	221.9	1400
Inner Mogolia	7880.4	435.8	1074.9	4673.1
Qinghai	3637	0	1018.6	1351.4
Heilongjiang	753.2	59.8	7.2	210
Gansu	1790.4	222.7	433.4	1508
Shaanxi	520.6	7.3	107.6	140
Jilin	584.2	13.2	50.1	107.3
Hebei	471.2	37.9	99.5	216.7
Liaoning	338.9	0	52.4	81.4
Total	24181.1	909.7	3065.6	9687.9

Source: Xie (2005)

Natural Disasters: China is one of the countries in the world which are most affected by natural disasters. Floods and droughts are the most common types of disasters with the largest impact in terms of area coverage in China. Other natural disasters include earth quakes, pests and cyclones. Since 1950, the area subject to natural disasters has basically remained the same. In terms of area coverage drought is the largest factor. However, floods and earthquakes may be more limited in area coverage but cause much larger economic and social damage. People can cope with drought using irrigation system to sustain crop production, but have limited capability and capacity to mitigate flood damage.

Rural environmental pollution: With China's economic development, rural pollution has become more serious. In some case, rural pollution originates from urban pollution. The emissions of wastewater and solid waste from urban industry and household are transferred to rural areas, causing pollution in rural air, water and soil. However, more commonly large-scale use of chemical fertilizers, pesticides and farm plastic films in agricultural production are direct

sources of rural environment pollution and degradation. The booming rural industry has also increased the severity and complexity of China's rural pollution. Application of pesticides in China's agriculture has increased substantially since 1991. In 1991, pesticide use was only 760,000 tons, but by 2005, this figure had reached 1.46 million tons. Regarding agricultural fertilizer, the use continues to grow. Between 1978 and 2005, the fertilizer application volume increased 439% (16% annual growth). Undoubtedly the increase in agricultural fertilizer use has increased agricultural production, but it has also contributed to negative downstream water resources impacts (e.g eutrophication of water reservoirs). Another significant and growing environmental issue is the use of plastic film in agriculture. Plastic film is a successful technology to increase agricultural output. However, the plastic film is difficult to degrade in natural conditions and may pollute the soil for at least 200 years unless it is removed. The opportunities for recycling and reuse are limited. To illustrate the magnitude of the problem China has doubled its use of plastic film since 1995, and in 2005 1,762,325 tons were used in agricultural production. In addition, 960,000 tons of mulching film was used, which is somewhat less environmentally polluting.

Figure 5 Pesticides Use 1991-2005

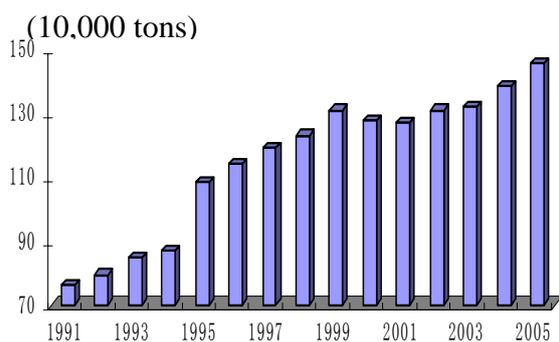
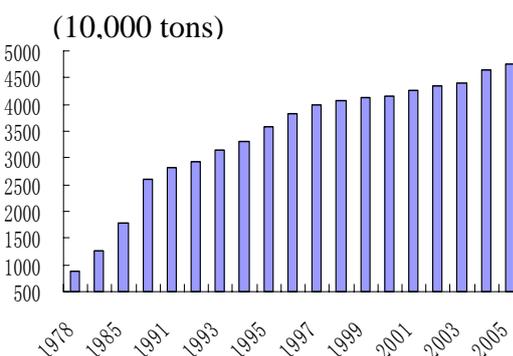


Figure6 Fertilizer Use 1978-2005



Source: *China Statistical Yearbook 2007*

**Energy production and consumption:** Both energy production and consumption have increased significantly over the past 28 years (1978-2006). Energy *production* increased by more than 2.5 times; energy *consumption* increased by 3.3 times. Starting in 1992, imported energy surpassed

domestic supply and became the major source of energy supply. China's quest for energy continues to affect global energy production and energy prices (Yang et. al 2005). China's per capita energy consumption is still low. If per capita energy consumption in China reaches the level of OECD countries, total energy consumption in China will rise dramatically in the future due to the large population size (Hang 2007; Research Group of China's Energy Demand and Supply 2007). Regarding energy production structure coal remains the dominant energy type in production as well as consumption. The share of coal production in total energy has remained stable over the years (around 75% since 1990) while that of hydro-power has more than doubled. Crude oil is the second major type of energy production, but its share of production has decreased (12% in 2006). China's crude oil production is low due mainly to its limited oil reserves and large coal reserves (Zhou 2004). The gap between domestic crude oil supply and demand is estimated to continuously widen in the future. The estimated proportion of the gap in total domestic demand will be 46.0 % in 2010 and 53.4 % in 2015, respectively (Zhou 2004).

Table 5. Energy Production and Structure 1978-2006

Year	Total Production (millions tce)	Share (%)			
		Coal	Crude Oil	Natural Gas	Hydro-Power
1978	62 770	70.3	23.7	2.9	3.1
1990	103 922	74.2	19.0	2.0	4.8
1996	132 616	75.2	17.0	2.0	5.8
2002	143 809	72.2	16.6	3.0	8.1
2006	221 056	76.7	11.9	3.5	7.9

Source: China Statistical Yearbook 2007

Climate Change: The average temperature over China increased by 0.79°C over the period of 1905-2001, slightly above the global average, with greatest warming experienced in Northern China and in winter. There has been no clear national trend in precipitation, although at the regional level some trends are apparent, such as drying in the Yellow River basin and North China Plain (Yin et al 2007, NDRC 2007). Effects of increased temperatures since 1950 have included a 21% reduction in glacier extent, a reduction of 5m in the thickness of permafrost on the Qinghai-Tibet plateau, a 2-4 day advance in the first budding of plants, severe drought in the North and North-East of China, a 7-fold increase in the number of reported floods and a decrease in sea-ice in the Yellow Sea and Gulf of Bohai. (NDRC 2007, Zeng et al 2008, Lin et al 2007). Climatic hazards, including floods, droughts, tropical cyclones and storm surges, account for 89.1% of economic losses from disasters in China from 1980-2003 (Shi et al 2008). National-level projections of climate change for China show that average national temperatures are likely to increase faster than the global average, by 2.3-3.3C by 2050 and 3.9-6C by 2100, subject to large regional differences. Average precipitation is expected to increase by 10-12% by 2100, with large variation across regions. Most likely there will be more extreme rainfall events and the intensity of tropical cyclones is expected to increase. Without adaptation the overall effects on Chinese agriculture are likely to be negative, as grain yields could decline by 5-10% by 2030 and cropping systems destabilized. Warming is expected to increase demand for irrigation thus putting more pressure on water resources and wetland areas, and will favor the spread of agricultural pests. In light of the ensuing social, economic and environmental effects, the needs for accelerated *mitigation* as well as *adaptation* are evident. Although some initial efforts are being made, more needs to be done.

Cost of Environmental Problems: Based on a report published by SEPA (2004), the direct economic cost of environmental pollution (except health effects) was estimated at 512 billion

Yuan per year, corresponding to 3.1% of GDP that year. Calculating the economic impacts of environmental pollution and natural resource depletion of this kind is associated with large uncertainties. Compared to other calculations of similar kind (compiled in table 7 below) implies that this figure is a relatively conservative estimate of the environmental costs; it gives an indication of the magnitude of the problem, and point at the potential benefit of cost-effective environmental abatement. (to be developed)

Table 6. Economic Cost of Environmental Pollution

Year of Analysis	Cost/year (bill. Yuan)	Share of GDP	Source
1980	44.4	9.3%	“China Environmental Forecast and Macro Environmental Analysis toward 2000”, 1983.
1981-1985	38.2	6.8%	“China Environmental Forecast and Measures toward 2000”, Research team, 1984
1988	95.0	6.8%	CCICED, 1992
1992	40.0	3.0%	Smil, 1992
1992	129.7	4.9%	Lei, 1995
1993	102.9	3.2%	CASS, 1996
1995	187.5	3.3%	Zheng et al, 1999
1997	54.0(US\$)	8.0%	World Bank 1997, “Clean Water, Blue Sky”
2004	511.8	3.1%	SEPA, 2005

Source: Qi(2005)

## 2. Identification of priority issues in order to promote sustainable development

The general consensus is that China’s environmental situation has improved in some respects, but deteriorated in general. Based on analyses of environmental authorities (Xie 2005, Zhou 2008), the pattern of the high economic growth and industrial structure are mainly to be blamed for the problems. The irrational mode of development is manifested in many aspects, the most important of which include a widening income gap, an imbalanced industrial structure and low

energy efficiency.

Income disparity : It is the same in China. During the process of China's economic development, the gap in per capita income among different groups of people is widening. According to *Yearly Report on China's Per capita income of 2006*, the gap includes four aspects: the first is concerned with the gap between urban and rural per capita income. In 2005, the former is 3.2 of the latter. Secondly, gap exists among the urban residents. In 2005, the per capita income of the 10% highest-income group is 9.2 times that of the 10% lowest-income group. Thirdly, gap exists among the rural residents. In 2005, the per capita income of the high-income rural households is 7.3 times that of the low-income rural households. Fourthly, gap exists between regions. At present, urban per capita disposable income in eastern part of China is 1.5(Zhao,2008) that of western part of China. It is the same case with rural capita net income. The aforementioned difference in income put China in a difficult position to choose between economic development and environmental protection. For the low-income group, economic welfare is the priority, whereas for those who have stepped out of poverty, environmental quality become significant in their welfare. Since the formation of policies is collective action, the government are inevitably put into a dilemma that focus should be put on the economic welfare of low-income people or demand in environmental service of high-income group.

For example, developing the western regions is a challenge that China faces. With both low per capita income and rich natural resources, the local governments in the western part of China have strong wishes to develop their economy. However, the environment in western China is fragile and worsening. If more economic construction is carried out, the environmental situation would become worse. At the same time, western regions are the origins of many major rivers of China where there is large area of grass land as well, and therefore play critical role in preserving water and soil. As a result the developed provinces down the rivers hope the central government would spend more efforts in ecological construction. Consequently, the contradiction is marked.

Industrial Structure: In China, since the initiation of reform and opening-up, the industrial development, especially the development of heavy industry, strongly promoted the development of the whole economy. China's heavy industry took on speed in development from the late 1980s, and since then has occupied larger and larger share in China's industrial system (Li 1998). During the years from 2002 to 2006, the percentages of China's heavy industry are 60.5%, 60.9%, 64.3%, 67.6% and 68.5% respectively (Yang 2008). Heavy industries include those producing machinery, energy, and chemicals, etc, all of which are require substantial

energy consumption and pollution prone. In other words, China's industrial structure featured by heavy industry playing a key role is the major factor of pollution. With large number of rural migrant workers pushing for jobs it is becoming a daunting task to balance pollution control and industrial growth.

Energy Efficiency: China is facing two difficulties in the energy use. On the one hand, China is the second-largest energy consumer, after the United States, and the demand of energy increases rapidly; on the other hand, there is a large gap in the energy use efficiency between China and other countries. China is still following the mode of "high energy consumption, low output" (World Bank 2001). So far from 1978, China's energy use efficiency has experienced two stages. From 1978 to 2000, China's energy use efficiency had improved steadily; from 2000 till now, China's energy use efficiency starts to decline. (Shi 2002). In all, China's energy use stays in a relatively low level. As most researches find, China's energy use intensity is 8 to 9 times of Japan's and 2 to 3 times of the world average. Even take into the consideration of exchange rate adjustment, China's energy use intensity is still 4 to 5 times of Japan's. If we use the energy physical efficiency as an indicator, China's energy efficiency is about the early 1990s level of Europe's and the middle 1970s of Japan's (Wang 2005). Apart from the backward production technology, the change of industrial structure is one of the important reasons which result in the low efficiency of energy use. The proportion of heavy industry increases rapidly while light industry decreases rapidly. The rapid development of high energy consumption industries such as iron, steel, chemical and construction materials results in a sharp increase of energy demand.

Central-Local Divide in Environmental Protection: In China, the central government plays a major role in environmental protection. China's environmental protection system which follows the traditional political system is vertical management. The most distinctive feature of this system is that the central government will give some indicators to the local government and conduct regular assessment on those indicators. With this top-down approach, the environmental policies are uniform, with no regard of the differences in local environmental conditions, economic development, and corporate pollution reduction costs. The consequences of this approach are low efficiency and social injustice. Command and control plays a dominant role in environmental management, while the role of economic incentives is quite limited. As statistics indicate, there are as many as 100 types of fines in the national and local laws and regulations. This kind of environmental management mechanism makes corporate and individual passive recipients of environmental policy. There are few channels for the public to participate in the environmental protection. In the meantime, there are no incentives for the local government to undertake environmental management innovation. What's most important, market cannot play a

significant role in environmental protection as it should be.

### **3. Existing national policy or law**

From 1992, the Chinese government has established and promulgated a series of laws and regulations to promote sustainable development in China. More than 100 environmental policies, laws and regulations have been passed. These laws and regulations involved every aspects of the sustainable development and initially formed the law and regulation system for the sustainable development of China. The key laws and regulations to promote the sustainable development are listed in table 7:

Table 7: The key laws and regulations to promote the sustainable development

Item	Name	Ratification Organ and Date	Main Contents
1	Ten Primary Measures for Environment and Development	CPC and the State Council of China, 1992	a programmatic document for the environment and development of China
2	China's Environmental Protection Strategy	The National Environmental Protection Agency, the National Planned Economy Committee, 1992	Policy files on environment protection
3	China's national scheme on gradually eliminating the damaging substances to the ozone layer	The State Council of China, 1993	The concrete scheme to comply with the Montreal Protocol
4	China Environmental Protection Action Plan (1991-2000)	The State Council of China, 1993	The country's ten-year environmental protection action plan by fields
5	China's 21st Century Agenda	The State Council of China, 1994	The White Paper for the people, environment, and development of China, the national <i>21st Century Agenda</i>
6	China's Action Program of Biological Diversity Conservation	The State Council of China, 1994	National action plan for performing the <i>Convention</i>
7	China's 21st Century Agenda: Environmental Protection	The National Environmental Protection Agency, 1994	The department level <i>21st Century Agenda</i>
8	China's 21st Century Agenda: Forestry Industry	The Ministry of Forestry, 1995	The department level <i>21st Century Agenda</i>

9	China's 21st Century Agenda: Ocean Industry	The State Oceanic Administration, 1996	The department level <i>21st Century Agenda</i>
10	Resolutions to Some Environmental Protection Problems from the State Council of China	The State Council of China, 1996	The regulation files of the State Council of China
11	The Ninth Five-Year Plan for National Environmental Protection and the Prospective and Target in 2010 of China	The State Council of China, 1996	Action outlines to the environment protection in the next five to fifteen years
12	China Trans-Century Green Program (The first issue)	The State Council of China, 1996	Concrete program of the Ninth Five-Year Plan for National Environmental
13	The Country's Main Waste Emission Volume Control Plan	The State Council of China, 1996	Mandatory national plan for decreasing waste emission during the Ninth Five-Year
14	Notification on further strengthening the land management and protecting the arable land	CPC and the State Council of China, 1997	
15	Division Scheme on the Acid Rain Control Area and the CO2 Pollution Control Area	The State Council of China, 1998	In the "Two areas", the CO2 emission needs to meet the standard, and the total volume of CO2 emission is under strict control
16	Notification on stopping producing, selling and using the vehicle gasoline that contains lead before required date	The State Council of China, 1998	Make a deadline through the country to stop producing, selling and using the vehicle gasoline that contains lead

17	Notification on protecting forest resources and restraining deforesting, reclamation and occupying the forestland in random	The State Council of China, 1998	Resolutely protect the virgin forest and protect the forestland
18	The National Plan for Ecological Environment Construction	The State Council of China, 1998	Ecological construction plan in the fields of agriculture, forestry and water conservancy
19	National Eco-environment Protection Outlines	The National Environmental Protection Agency, 2000	Prospective, tasks and measures for eco-environment protection
20	China's Sustainable Development Action Compendium for the early 21 <sup>st</sup> Century	The State Council of China, 2003	Pointing out the prospective, key areas and safeguard measures for sustainable development
21	Notification of key works to construct the economizing society	The State Council of China, 2005	Quickening to construct the economizing society in production, construction, circulation and consumption
22	The advises to develop the cycler economy	The State Council of China, 2005	Policy files on cyclic economy
23	Guidelines on Collective Forest Tenure Reform	CPC and the State Council	Provisions to promote and guide tenure reform in rural China

Source:Chen et al.(2007)

Specifically, China's environmental Sustainable development has included 9 dimensions, all of which covered by a series of policies (table 8).

Table 8 Sustainable development dimensions and policy issues of concern

	Sustainable development dimensions	Sustainable development policy issues of concern
1	Industrial sustainable development	controlling industrial pollution of air, water and solid waste; the resource utilization efficiency; environmental protection industry
2	Construction and protection of the eco-environment	national garden cities; eco-agricultural demonstration counties and places; desertification; soil erosion; basic farmland reserves; nature reserves
3	Development and utilization of energy	saving the energy; energy structure; clean energy; renewable energy and the new energy
4	Protection, development and utilization of water resources	water resources shortage; water pollution
5	Management and protection of forest resources	maintain and expand forest resource; mountain area forestry's comprehensive development
6	Management and protection of grassland resource	grassland protection system
7	Management and protection of marine resources	pollution control; ecological protection; and resources management
8	Air protection	sulfur dioxide emission; acid rain; vehicle waste emission;
9	Disaster prevention and decreasing	comprehensive projects construction to decrease disasters; national disaster monitoring and warning system; disaster insurance

Source: Zhang (2004)

Industrial sustainable development: Firstly, to adjust the industrial structure, the Chinese government has shut down a batch of mills which are lag in technology, causing serious pollution and consuming more energy and materials in production. MEP (and earlier, SEPA) has mainly focused on controlling industrial pollution of air and water. The key policy instruments used by MEP and local agencies include pollution standards and a levy system, initiated in early 1980s. In late 1990s, more command and control measures have been adopted in order to enhance effectiveness of pollution control. Most dramatic actions include the Midnight Actions on New Year's Eve (January 1) of 1997, on Huai Riverbasin, when all mills failing to meet pollution standard would be closed by force. Another most influential measure was the closure

of all under-sized mills in 15 sectors recognized as most pollution intensive. During the 9<sup>th</sup> 5-year plan, the Chinese government has closed 85,000 under-sized mills such as steelmaking mills, small cement mills, small glass mills and so on. Secondly, the Chinese government is actively regulating the strategy of the industrial pollution prevention and control and energetically promoting the clean production in order to improve the resource use efficiency and alleviate environmental pressure. Meanwhile, Chinese government also emphasizes the enforcement of the industrial environmental protection law. The mills must meet the emission standard within the required time, and the production equipment which are outdated and may cause serious pollution will be forced to phase out. Till the end of 2000, about 90 percent of the pollution-causing mills reached the waste emission standard, which resulted in one third decrease of emissions from 1995 level. Thirdly, Chinese government is doing technical transfer in order to decrease the consumption and control the pollution. From 1994, the Chinese government has invested 30 billion Yuans on 232 technical transfer projects for environmental protection. Finally, China actively supports the environmental protection industry and defines it as the priority development area. Up to the year of 2000, the total value of the environment protection industry has reached 108 billion Yuan, and there are more than 18,000 enterprises and institutions with more than 1.8 million people partially or fully employed in environmental protection industry. The income of the environment protection related industry in GDP was about 1.9% and about 1.6 times the government total investment to environmental pollution for the same time (Li 2002).

Since 1997, Chinese government has promulgated a series of regulations and rules to control solid waste and set up the solid waste declaration and registration system and the hazardous waste transferring registration system. The government has also begun to try out the management licensing system for hazardous waste in the comparatively developed coastal cities and provinces. Meanwhile, the comprehensive utilization of industrial solid waste in China has achieved great improvement. In 1996, the government put into place the tax break policy for the comprehensive utilization of industrial solid waste, in particular for fly ash and coal gangue. China's industrial solid waste has increased from 0.59 billion tons to 1.52 billion tons between 1991 and 2006. In the year 2007, the comprehensive utilization rate of industrial solid waste reached 62.8%. Since 1998, municipal solid waste landfills, incineration plants, and chemical fertilizer plants with advanced treatment technologies were installed in many cities financed through national debts.

Hazardous waste management is also highly regarded. Up to now, the government has built up two radioactive waste treatment plants. And 23 temporal storehouses for radioactive waste by

the nuclear technology use has been put into effect. The radioactive waste is under effective control. The government also seriously executes the *Basel Convention*. And China has established the Asia Pacific Hazardous Waste Management Training and Technology Transfer Centre under the support of the Secretariat of the *Basel Convention* to provide trained technical personnel of hazardous waste management to the Asia-Pacific countries.

Protection of ecology and environment: Firstly, the Chinese government has established *the national ecological construction planning* and *the national eco-environment protection compendium*, and gradually brought these policies into the national economy and society development plan for implementation. Secondly, the whole country has established 20 national garden cities, 120 eco-agricultural demonstration counties and more than 2000 eco-agricultural demonstration sites. At the same time, in order to prevent and control the desertification on a large scale throughout the country, the government has established 20 key counties, 9 test areas and 22 test demonstration bases. Thirdly, soil erosion control has made significantly progress by expediting the soil erosion control in typical areas and actively promoting the comprehensive control experience in small watershed. Up to 2005, the accumulated new soil erosion control area of the whole country is 920,000 square kilometers. Chinese government has made about 83% arable land of the country under effective protection by demarcating basic farmland reserves. Meanwhile, the government has build up a compensation system of farmland occupancy. From 1998 to 2005, the arable land of the country had increased by 2,130, 000 hectare by developing, cultivating, and reclaiming, which exceeded the area of arable land converted for construction in the same period, and resulted in a balance of land occupancy and compensation. In order to protect and ameliorate the farmland quality, the government has implemented a farmland environmental quality detection system and fully promoted the pollution prevention and control technologies for agricultural chemicals. Finally, the scale and quality of nature reserves are greatly improved. Most typical eco-system and endangered species obtain effective protection. Up to 2007, China has built up 2,531 nature reserves with total areas reaching 15.188 million hectare.

Development and utilization of energy: The Chinese government pays great attention to energy saving and has established a series of regulations and technical or economy policies on energy saving. The government also promotes the clean coal and the technology of the coal cleaning and comprehensive utilization. The renewable energy and new energy have also been brought into national agenda recently.

Protection, development and utilization of water resources: The government has primarily

established the law and regulation system and made a series of policies for the sustainable usage of water resources. Up to 2002, the Chinese government has revised, promulgated and implemented four laws: the *Water Law of the People's Republic of China*, the *Flood Control Law of the People's Republic of China*, the *Soil and Water Conservation Law of the People's Republic of China*, and the *Law of the People's Republic of China on Prevention and Control of Water Pollution*; 18 water administrative regulations, such as the *Implementation Methods of the License System for Water Utilization*; about 88 water conservancy rules, such as the *Guideline to the Long-term Water Supply and Demand Plan*; other policies like the *Water Resources Industry Policy* and technical standards on the comprehensive management of water resources. The local governments have established many relevant local policies and regulations based on their local situations. In order to alleviate water shortage, the government has invested in water-saving irrigation and water-saving agriculture. For these reason, water consumption in China has been being kept on a relatively low level with the fast growth of economy. From 1980 to 2007, China's water consumption per capita and water consumption per ten thousand yuan of GDP were still decreasing. The government also worked on the water pollution control in many key watersheds, such as Huaihe river basin, Haihe river basin, Liaohe river basin, Taihu Lake, Dianchi Lake, and Chaohu Lake; speeded up the construction of the sewage treatment plant in cities in order to make the trend of the water environment deterioration under control.

Table 9: The water resources consumption of China, 1980-2003

	Total water consumption (billion m <sup>3</sup> )	Water consumption per capita (m <sup>3</sup> )	water consumption per ten thousand yuan of GDP (m <sup>3</sup> )
1980	4436	452	9820
1990	5411	473	2911
2000	5498	430	615
2007	5760	437	251

Source: Wang et al .(2005)

Protection of forest resources and grassland resources: To maintain and expand forest resource base in China, a set of policies were developed over time. Components of the policy set include a logging quota system, relatively centralized tenure system, ecological compensation fund and a series of national afforestation programs implemented over the past three decades. The government has carried out some important forestry eco-system construction programs, such as the Natural Forest Protection Program (NFPP), Sloping Land Conversion Program (SLCP), Beijing-Tianjin Sandstorm Source Control Program, the Three-North Shelterbelt Program, etc. In particular, the central government issued policy of tenure reform on collectively owned forests in July 2008. The policy allows farmers to have user rights for up to 70 years and enjoy comprehensive property rights (transferability, inheritance, and collateral). This is a major effort on the central and local government parts to improve farmer livelihood in the natural resource rich areas and to attract private sector investment to forest resource development. Subsequently, other key forest policies are subject to revision. The implementation of logging quota policy has already been altered in the reform regions and revision of the policy is pending upon revision of the forest law.

China has established three laws on the grassland protection like the *Grassland Protection Law* to strengthen the protection and management of grassland resources. Regulations like the *Construction Plan for National Grassland Ecological Protection* were developed. During 2000 and 2001, about 97 natural grassland recovery and construction projects had been completed throughout the country, which greatly improved the ecological integrity of the grassland. Up to 2007, the grassland enclosure area of the country reached 55 million hectare.

Management and protection of marine resources: China has established regulations and laws to protect marine resources. Up to the end of 2006, 90 marine nature reserves had been established. The marine environmental detection network and marine environmental information and forecasting system have also been strengthened.

Air quality control: Firstly, the government has defined the sulfur dioxide and the acid rain control areas, and carried out the control of sulfur dioxide emission within the areas. Attempts have been made to promote clean coal, clean combustion, flue gas desulfurization and dedusting technology and to increase the use of natural gas and centralized heat-supply system. Several major municipalities have had policies to regulate urban vehicle uses in order to reduce the increasingly serious emissions from automobile use. In general priority is given to developing public transportation and controlling emission of vehicles. The government is also seriously performing the *Montreal Protocol on substances that causing damage to the ozone layer*, controlling and eliminating these substances.

Disaster prevention and decreasing: The government launched some comprehensive projects to decrease disasters, such as flood control and drought resistance, and disaster mitigation, geological and biological hazard prevention and control, and so on. Meanwhile, the government established the national disaster monitoring and warning system. The loss caused by natural disasters has been reduced significantly.

International cooperation: In order to improve the work in protecting natural resources and environment, China is strengthening law making at home and cooperation with other countries by signing international conventions, such as Basel Convention. In addition to these multilateral treaties, China has also signed 25 bilateral treaties. Through implementation of these treaties and conventions, tremendous learning has been achieved and performance enhanced.

China has also done a lot in the areas of multilateral and bilateral cooperations, such as the cooperation with the European Union (EU). In 1985, China signed with EU *Treaty on Developing Partnership and Cooperative Relationship between China and European Countries*, which laid foundation for their cooperation in resources and environment. In the following years, a mechanism on carrying out dialogue between China and EU has been built up. Since 1994, in every 2 or 3 years, China and EU would sponsor an international conference on energy in turn. By 2006, 6 conferences have been held. In April of 2004, China and EU have together initiated a 5-year project concerning resources and environment, which is worth 42.9 million Euros. The goal of this project is to realize sustainable use of natural resources. In June of 2007, EU started in China a program on realizing clean development which is worth 2.8 million Euros.

Actually, there are still some cases of using market tools to protect environment in addition to the government, and it ignites hopes in protecting China's environment.

Water trading:. In 2000, Dongyang and Yiwu, two cities in Zhejiang province, signed a contract about transferring parts of of Hengjin reservoir's water rights to Yiwu. Dongyang sold about 49.999 million cubic meters of permanent water rights to Yiwu at a price of RMB 0.2 billion. The water right trading between Dongyang and Yiwu is the first case in China and it is a mechanism innovation in water management. What's more, Zhangye, a city in Gansu, is also a successful example in water rights trading. In 2000, the State Council imposed a total quantity control in water diversion from Hei river by Zhangye city. As a result, Zhangye began to implement total quantity control and sell those tradable permits to farmers. Now, about 22 million cubic meters of water will be saved each year by Zhangye and the fees of watering each acre of land are reduced by 7 yuan. There are not only economic gains, but also great contributions to the ecosystem downstream. Another successful case is the water use compensation between Beijing and the neighboring Hebei province. To compensate the loss of Hebei province in supplying water to Beijing, Beijing gives the local farmers 450 yuan per acre of land for changing their plantations of rice to some dry crops in upper places of Miyun reservoir such as Zhangjiakou. It has successfully solved the problem of water use conflicts between Beijing and Hebei province.

Forestry carbon sequestration :As for forestry carbon, there are 8 projects in Inner Mongolian, Guangxi, Sichuan, Yunnan, Liaoning, Anhui, Hebei and Shanxi provinces so far, among which Guangxi and Inner Mongolian forestry carbon projects are CDM projects. The methodology of Guangxi project, which was approved by CDM board, is the first one on CDM reforestation approved in the world. There will be 77,300 tons of carbon dioxide credits generated during the counting period 2006 to 2035. The total cost of this project is 22.7 billion US\$. (Li , 2007) The total income is estimated at US\$ 21.1 million within crediting period, including: US\$ 15.6 million from employment; US\$ 3.5 million from sales of wood and non-wood products; US\$ 2.0 million from sales of CERs. It is estimated that 5,000 local households will benefit from this project.

Figure7. China's forestry carbon pilot projects



Source: <http://www.fcarbonsinks.gov.cn/thxm/index.aspx>

Environmental Trading Centers: At present, China have established several Environmental Trading Centers for trading in SO<sub>2</sub>, carbon sequestration, environmental technology and water rights and so on. China Beijing Environment Exchange(CBEE), Shanghai Environment Energy Exchange(SEEE) and Tianjin Climate Exchange(TCX) are very famous in China. CBEE and SEEE are international comprehensive market platform for the transactions in the fields of environment and energy. SEEE is mainly engaged in the transactions of technological property rights, equity and capital from pollutant discharge reduction, environmental protection, energy and energy- saving. TCX is focus in the transactions of SO<sub>2</sub> and COD at the initial stage.

Figure 8, SEEE and TCX



Source: Those pictures were downloaded from the website as follows;

SEEE : <http://www.cneex.com/ourservice/jienenghuanbao.html>

TCX : [http://www.chinatcx.com.cn/templet/default/index\\_cn.jsp](http://www.chinatcx.com.cn/templet/default/index_cn.jsp)

#### **4. The problem from implementation of existing policy or law**

The Chinese government has been attempting to establish a comprehensive system of laws concerning sustainable development; Numerous laws and regulations were drafted and released. However, the effects of these laws are in general low. As was admitted by Premier Wen Jiabao in the 2006 National Environmental Protection Conference, during 2000-2005, the eleventh five-year plan period, China had realized its goal of economic growth, but failed to achieve the goals of environmental protection.

In 1997, China put into practice *Laws on Saving Energy* and corresponding regulations as well. Besides, China has also set up in its 10<sup>th</sup> 5-year plan the goal of realizing 15%—17% reduction of energy consumption per unit of output from the year of 2001 to 2005. However, two institutional defects prevent these goals from being reached: firstly, there is no special structure in charge of coordinating the formulation and implementation of energy policies; secondly, energy enterprises enjoy important political and economic power in both central and local settings. And lastly, some energy-intensive enterprises such as steel and chemical enterprises are controlled by the state and are free of hard budget constraint, which make them suffer little influence caused by the rise in price of energy.

People generally point the cause of failure in complying with environmental regulations to lack of funding, industrial structure and lack of policy enforcement by local government. These are

probably all true. However, the root causes for all of the above are not sufficiently addressed. Existing regulations and policy have a heavy reliance on command and control measures. It seems that the central government is the only authority to implement environmental protection. Lack of funding and shortage of absolute power over local government were often cited as major causes for the underachievement. Less was noticed in policy design that local economic conditions vary so tremendously that it is impossible to achieve the same level of equilibrium via an uniformed policy. Without properly addressing the huge variation in costs and benefits of environmental protection across locations, current environmental regulations simply render social cost of pollution control too high to afford by most local jurisdictions. The necessity of establishing some kind of market mechanism seems to be extraordinary.

## **5. Summary**

Along the path of fast economic growth, environmental problems become increasingly severe which is not only causing damages to various dimensions of human life, but also damaging the prospect of sustainable development in the country. Some dramatic changes in policy and modes of development have to happen in order to mitigate the impacts caused by environmental degradation.

China seems to be at a turning point as awareness of environmental protection and conservation among government, academia and civil society has reached historical height. Ambitious goals and numerous strategies were made in recent years in the pursuit of improved environment. However, effective and efficient policy instruments have yet been found and used. Government efforts are still largely focused on command and control measures. Uses of market based instruments and private sector initiatives are still limited.

Taking stock of current knowledge, several changes are necessary. First, while efforts need to be strengthened in industrial pollution control, effective policy should be designed to curb the ever growing urban and rural non-point source pollution; secondly, on industrial pollution, policy should be transformed from focusing only on one pollutant (e.g. COD) to the control of multiple pollutants in order to reap the co-benefits of pollution reduction. Policy also needs to be in place to enhance effort in the adoption of clean production technology, instead of only focusing on end of pipe pollution control; Thirdly, market based solutions should be given higher attention. Successful example of this includes water trading between Beijing Municipality and upper reach farmers in Hebei Province. Tremendous cost saving has been

achieved through this trial. Fourthly, using economic instrument to reduce urban air pollution is an area with tremendous potential.

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