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China Environment and Climate Change Policy Brief

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This Environment and Climate Change Policy Brief was carried out as a desk study during June-August 2008.[1] In line with the Swedish development cooperation goal the document aims to summarise the key issues pertaining to environment and climate change facing China, related to poverty reduction and economic development. The Policy Brief will inform the Selective Cooperation Strategy process for China.

Contents

Executive Summary

This paper reviews environmental and climate change related issues in China. Covering these issues for such a vast country, and given all its complexities, implies substantial delimitations and simplifications subject-matter wise as well as analytically. Further analysis is warranted. Nevertheless, Chinas challenges regarding attaining environmentally sustainable development are daunting. Due to past economic growth certain environmental improvements have been attained (increase 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. This applies certainly to reducing greenhouse gas emissions, but also to mitigating local pollution of soils, water and air from industries, total energy resource use (coal, oil

[1] This Environment and Climate Change Policy Brief was written as a request by Sida (att: Gunilla Eitrem) by Ben Smith, SEI Oxford (climate), Jintao Xu and Haipeng Zhang, the Environmental Economics Program in China, College of Environmental Sciences and Engineering, Peking University (other environmental issues) and Anders Ekbom and Emelie Dahlberg (coordinators and editors) at the Sida Helpdesk for Environmental Economics, University of Gothenburg as part of Sida-EEU's institutional collaboration on environmental economics and strategic environmental assessment. Comments (on climate change) by Ping Höjding, Naturvårdsverket, are greatly appreciated. The views expressed in this policy brief are those of the authors and do not necessarily represent the views of Sida. Comments are welcome and can be sent to anders.ekbom@economics.gu.se.

and natural gas), agriculture including land degradation and soil erosion, deforestation and urban expansion.

A summary of the environmental situation shows that air and water pollution continues to grow in general. While soot and industrial dust basically has stayed constant, SO_2 emissions continue to grow. Regarding water pollution, domestic emissions of COD (chemical oxygen demand) has surpassed that of industry. Future effort to control COD emission has to place higher emphasis on domestic emissions. China's marine pollution has been reasonably controlled. However, the shift of heavily polluted area from East Sea to South Sea should be noticed and addressed to avoid further damage. Land degradation, especially soil erosion, has aggravated during the last couple of decades in China. The areas of low and medium level erosion have expanded. Although the intense and extremely intense erosion areas are relatively small, the speed of expansion is alarming. Wind erosion has been the largest cause of soil loss.

In recent years, China's area of forest resources has increased due to continued afforestation efforts. Specifically, the volume of standing forests has increased, while biological diversity in forests and other geographical areas have decreased. Moreover, China's grasslands are subject to depletion and degradation. How to halt these processes remains a topic of hot debate. China is one of the countries in the world with the largest natural disasters, in terms of area coverage, social disruption, economic loss and ecological damage. Floods and droughts are the most common natural disasters, while earthquakes, pests in rural land use, and cyclones are other key natural disasters affecting China. Historically, droughts affect the largest area of all natural disasters, while floods cause most calamities in terms economic and social impact.

Rural pollution has been increasingly serious. The rural environment is being deteriorated due in part by extensive and increased use of fertilizers, pesticides and plastic films in agriculture. With the increase and geographical expansion of rural industries, China's rural pollution situation is worsening and getting more complicated due to compound effects, uncertainty on responsibilities, choice and implementation of cost-effective policy instruments.

Both energy production and energy consumption have increased significantly in China across time. Domestic coal is still the dominant source of energy in production and consumption. While the share of coal production and consumption has remained fairly stable over the years, the scale or size of production and consumption has increased dramatically with the economic growth. The quest for energy has driven China to substantially increase its share of energy demand at the international energy markets, especially crude oil due to low domestic reserves and increased domestic demand.

China is very diverse, geographically, ecologically, socially as well as economically. This has implications on the characteristics, priorities and scope of the key environmental problems. For some pollution and resource issues, the regional disparities are large with very location specific environmental impacts. Hence, location specific policy instruments are necessary. Nevertheless, many environmental problems occur locally but share similar features across the country. Hence, *strong yet flexible environmental management is necessary to promote sustainable economic development*. Adjusting (taking into account local/province variation) and enforcing nation-wide environmental legislation is a true challenge ahead. Implementing a uniform national environmental policy system is particularly difficult in a country of China's size and large degree of variation across provinces and ecological regions.

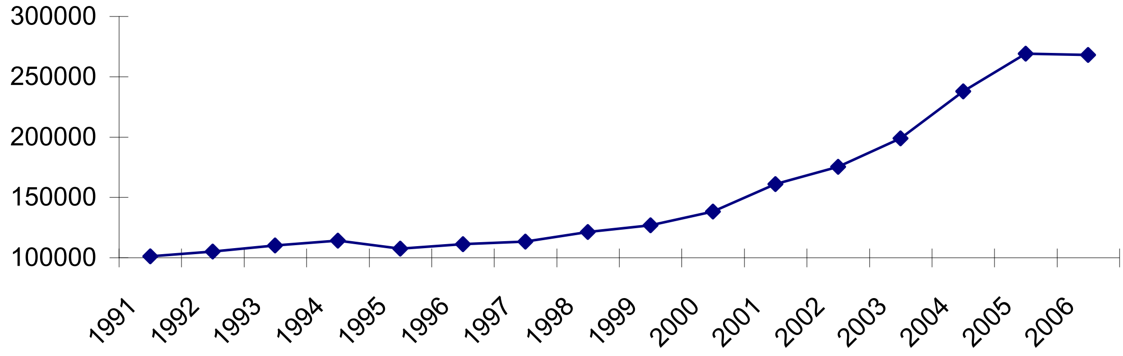
Regarding climate change is China currently the world's largest emitter of greenhouse gasses (GHGs). Emissions of carbon dioxide (CO_2) reached 1.6Gt in 2006. However, with CO_2 emissions of 5.1 tons/capita, China remains significantly below the EU average (8.6 tons) and US average (19.4 tons). With primary energy needs set to double by 2030, and increases in emissions by 2015 expected to far outweigh reductions from the Kyoto Protocol, China is a vital part of any future agreement on emissions reductions. China's official position is to support *common but differentiated responsibilities* and addressing climate change *in the context of sustainable development*.

Besides being a large GHG emitter, China will also be a victim of climate change. Until now, climatic hazards, including floods, droughts, tropical cyclones and storm surges, account for around 90% of economic losses from disasters in China from 1980-2003. 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 destabilised. Warming is expected to increase demand for irrigation thus putting more pressure on water resources and wetland areas, and will favour 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.

1. Key Environmental Problems and Opportunities[2]

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. The growth rate in pollution has been lower than the economic growth, and far lower than the industrial growth rate. In brief, sulfur dioxide (SO_2) emissions increased, emission of suspended particulates (especially soot) declined, while emission of nitrogen oxide (NOx) - which accounted for a small proportion of the total industrial emissions - was on a downward trend as well. This implies that SO_2 emissions remain a key area of concern for environmental protection.

Figure 1. Industrial Air Pollution in China, 1991-2006 Unit: 100 million m^3

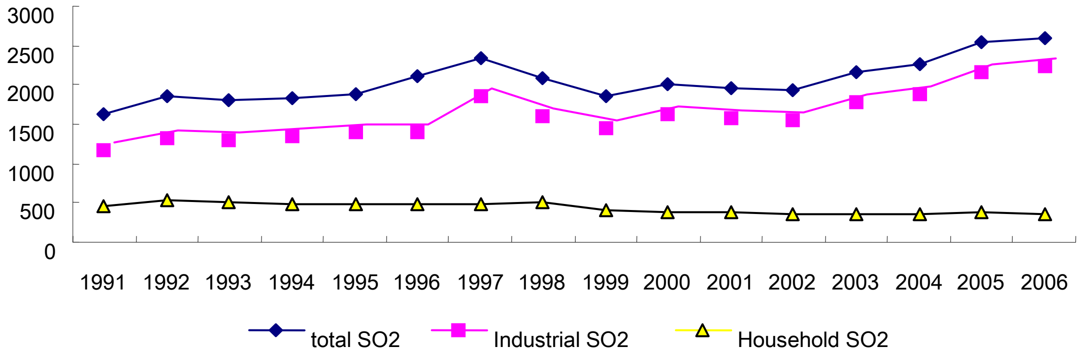


Sulfur dioxide (SO_2) emissions: China's SO_2 emissions mainly come from combustion of fuels (mainly coal) with high sulfur content. Power generation is the major process generating SO_2 emissions. High concentrations of SO_2 in the air impair human health and reduce industrial and agricultural productivity due to acid rain. As shown in Figure 2, SO_2 emissions have increased with 60% between 1991-2006. (Liu and Chen, 2007). Industrial emissions show a similar increase, whereas SO_2 emissions from households account for a small and declining proportion of the total SO_2 emissions. From a policy perspective, reducing SO_2 emissions is absolutely essential to prevent

[2] Due to their complexities and the regional variation in social, environmental and economic impact, the environmental issues are not listed in order of priority.

negative effects on health, the environment and economic production, among industries as well as households.

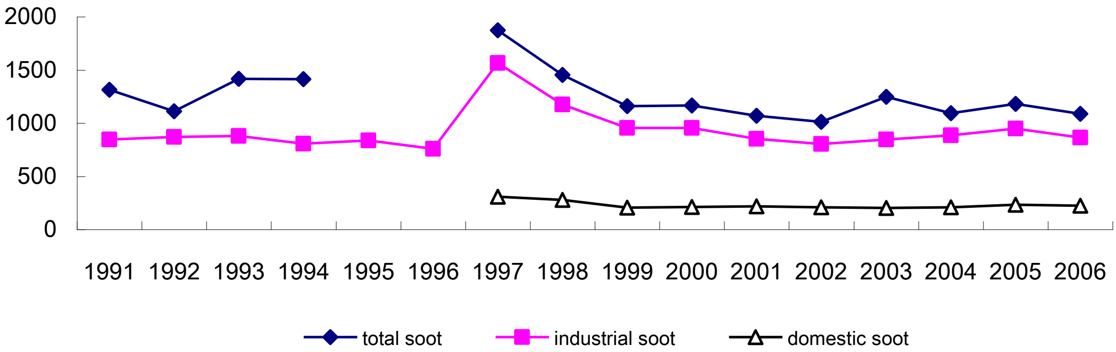
Figure 2. SO_2 Emissions in China,1991-2008 Unit: 100 million m^3



At the provincial level, SO_2 emissions increased in all of China's provinces, except Beijing, during 1991-2006. The top five provinces (which show the highest SO_2 emissions growth rate) include Qinghai (+505%), Fujian (+305%), Henan (+257%), Inner Mongolia (+215%) and Ningxia (+192%). Specific attention needs to be paid in these provinces in order to reduce China's industrial SO_2 emissions.

<u>Soot and Industrial Dust Emissions:</u> As indicated in figure 3, during 1991 to 2006, emissions of soot[3] in China reached a peak of 18.7 million tons in 1997, and declined thereafter. Industrial emission had a similar trend. This trend indicates that policies on soot control have been somehow effective. Industrial soot emission was the major component of total soot emission, whereas domestic soot emission accounted for a small proportion.

Figure 3. Soot Emissions in China, 1991-2006 (Unit: 10,000 tons)

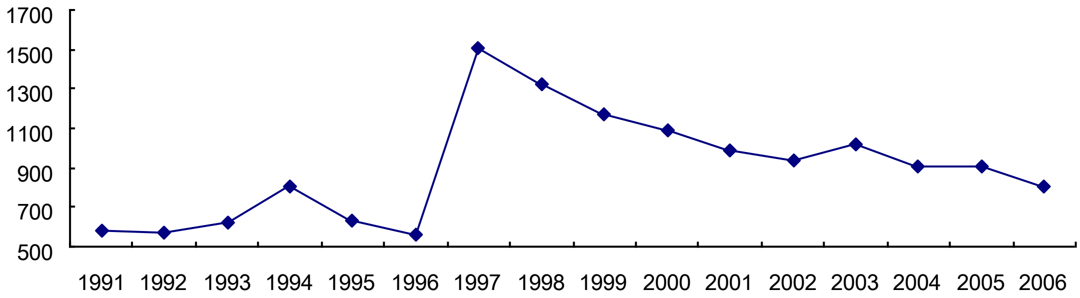


Provincial level data shows large variation. Provinces with the largest reduction between 1991-2006 were Beijing (-85%), Shanghai (-69%), Jiangsu (-39%), Liaoning (-35%) and Heilongjiang (-34%). Provinces with the largest increase were Shanxi (+101%), Guangxi (+94%), Henan (+73%), Xinjiang (+45%) and Hunan (+39%). The need for differential attention across provinces is key to optimise pollution control measures vis-a'-vis soot.

[3] Soot refers to solid particulate which comes from coal combustion and industrial production. It constitutes a hazard to human health as well as a pollutant in several ecosystems. The main components of soot are silica oxide, alumina, iron oxide, calcium oxide and carbon particles before burning.

The damage to human health caused by industrial dust[4] is getting more attention in recent years due to its negative impact on human health (Yang 1997). As indicated in Figure 4, industrial dust emission in China peaked in 1997. Industrial dust control has improved markedly since then, despite rapid economic growth.

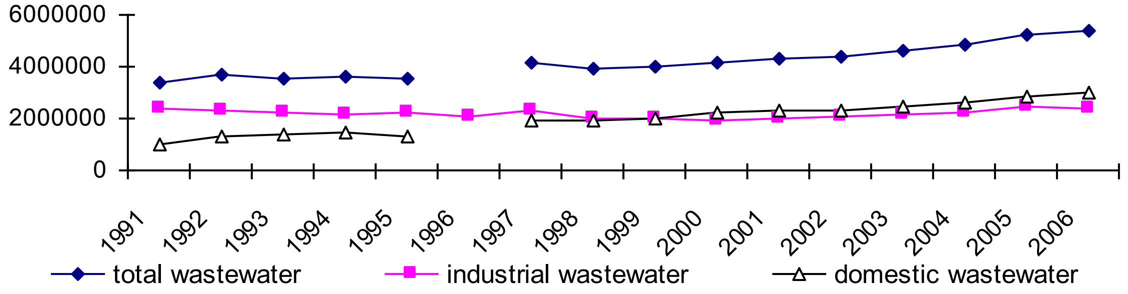
Figure 4. Industrial Dust Emission in China, 1991-2006 (Unit: 1,000 tons)



At the provincial level, the pattern of industrial dust emission varies substantially across time and regions. Only 9 provinces (incl. autonomous regions), including Tibet, Shanghai, Hainan, Tianjin, Beijing, Guangdong, Fujian, Shandong and Heilongjiang reduced industrial dust between 1991-2006. Among the 21 provinces experiencing increases, the top five were Qinghai, Hunan, Shanxi, Jiangxi and Jiangsu, where the growth rate exceeded 100 %.

Water pollution: Water pollution is a major environmental issue in China. The wastewater emissions have continued to grow between 1991-2006. 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 biggest source of water pollution.

Figure 5. Wastewater Emission in China, 1991-2006 (Unit: 10,000 tons)



Since 1999, domestic wastewater emissions increased in all provinces, except Tibet. 25 provinces exceeded the national average growth rate (28%). Ningxia, Fujian, Chongqing and Jiangsu rank highest with a 100% wastewater emission growth rate since 1999.

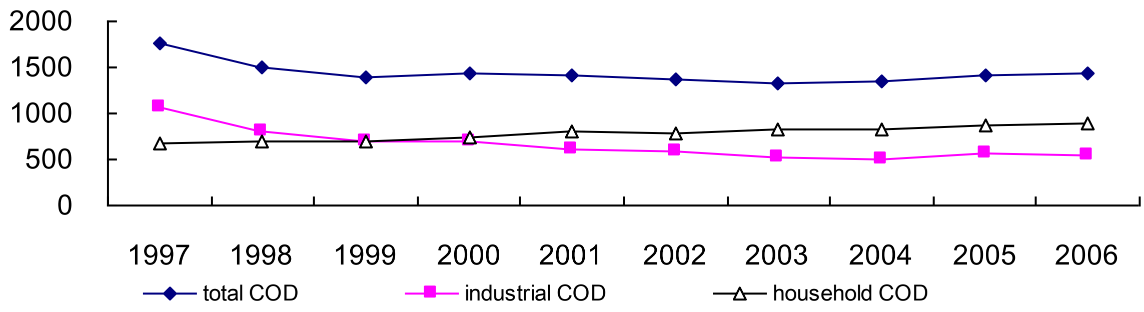
Some provinces decreased their industrial wastewater emissions during 1991-2006. Provinces with a decreasing rate include e.g. Beijing (with most reduction by 74%), followed by Shanghai (-64%), Gansu (-55%), Guizhou (-53%) and Heilongjiang (-44%).

Organic water pollutants: Curbing Chemical Oxygen Demand (COD) has been the main target of water pollution control in China during the last decade.

[4] Industrial dust refers to solid particle that comes from industrial process and can be suspended in the air for a certain amount of time.

Figure 6 indicates a decline in China's total COD emissions, with a slight increase in the *domestic* COD emissions. The decline since 1997 is partly caused by the implementation of a series of hard policies, such as "Midnight Action in New Year's Eve 1997", "Closure of Small Enterprises in 15 Key Polluting Industries". 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 is the major challenge regarding China's COD emissions.

Figure 6. COD Emission in China, 1997-2006 (Unit:10,000tons)



Again, there are large regional variations. At the provincial level, domestic COD emissions increased in most (24) provinces between 1997-2006, and declined in 7 provinces. Provinces with high COD growth rate (above 50%) were Hunan, Fujian, Guangxi, Sichuan, Jiangsu, Yunnan and Gansu. Provinces with declining COD growth rate include Tibet, Tianjin, Beijing, Shandong, Jilin, Ningxia and Shanghai.

Industrial Solid Waste: Dumping of industrial solid waste occupies land, contaminates soil, damages human health and cause serious water pollution when dumped into water. Dumping of industrial solid waste is 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 between 1991-2006. Figure 7 shows that the changes of China's industrial solid waste emissions can be separated into two phases, 1991-1998 and 1999-2006. One reason for this dramatic change was that since 1996 the pollution data of township enterprises has been added to China's Environment Statistics, resulting in a sudden increase in industrial solid waste production and emissions in 1997. Nevertheless, the trend of industrial solid waste emissions was declining. Due to improved use (re-cycling) of solid waste, industrial solid waste emissions decreased while the generated solid waste increased. These two opposite trends indicate successful pollution control in the second half of the period.

Figure 7 Production quantity of industrial solid waste Unit: 100 million tons

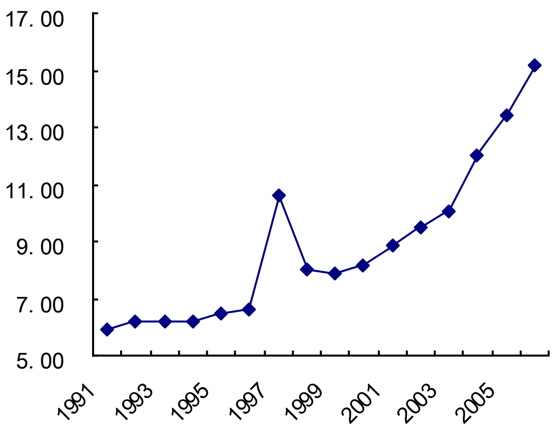
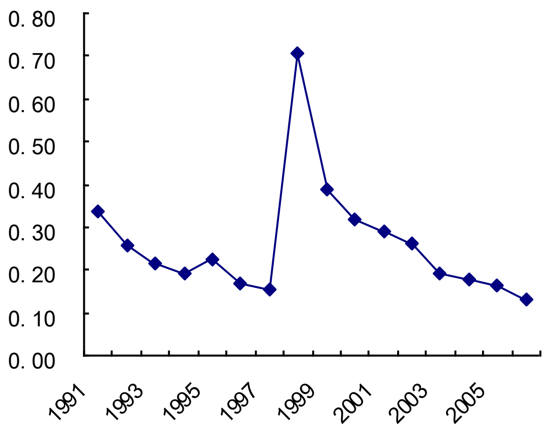


Figure 8. Emissions of industrial solid waste Unit: 100 million tons



Provincial level data indicates a decline in all provinces except Xinjiang during 1991-2006. Provinces with the largest current solid waste emissions include Shanxi, Guizhou and Sichuan (due mainly to increased coal production and consumption).

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%).

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

As indicated in Table 2, 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 2. China’s Sea Water Quality in Different Areas, 2001; 2007

Sea Area (Square kilometers)	Moderately polluted		Seriously polluted	
	2001	*2007*	*2001*	*2007*
Bohai	710	5380	1370	6120
Yellow Sea	590	3790	1260	2970
East Sea	27380	5500	27380	16970
South Sea	2580	2090	2580	3660
Total	15650	16760	32590	29720

Source: *China’s Marine Environmental Quality Bulletin*, *2001-2007*, 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 diverstiy. 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 largest bio-diversity degradation. Using endangered species as an indicator, 74 of 250 known seed-bearing plants are endangered. 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 3. 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 (presented in Table 4), the area of water and soil erosion was around 3.7 million square km^2 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^2, while the wind erosion area was 1.9 million km^2. In mid-1990s, the soil erosion area was 3.6 million km^2, reduced by some 0.11 million km^2. 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 4. Soil Erosion Area (unit: 1 000 000 km^2) 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)

At the provincial level, the distribution of soil erosion differs significantly. According to the data of the *National Soil Erosion Monitoring Bulletin* (Ministry of Water Resources of PRC, 2003), the top seven soil erosion provinces were Xinjiang, Inner Mongolia, Gansu, Qinghai, Sichuan, Yunnan and Xizang

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.

Figure 9. Change of China's Forest Area Unit:100million ha.

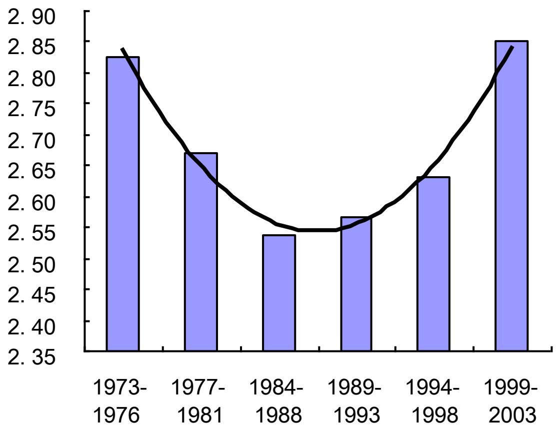
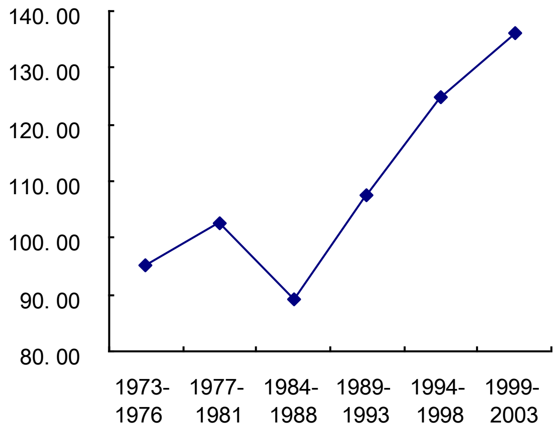


Figure 10. Change of the Volume of Live Standing Tree Unit: 10million trees



While forest resources overall have improved, there have been regions with continuous forest decline. Comparing the 3rd forest inventory (1984-88) with the forest resources in the 6^{th} forest inventory shows that the forest area decreased in 11 provinces, with Heilongjiang, Jilin and Sha'anxi ranked as the top three. All provinces increased their standing forest volume, except Ningxia.

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

Region	Natural grassland area	Seriously degraded area (10,000 ha.)		
		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

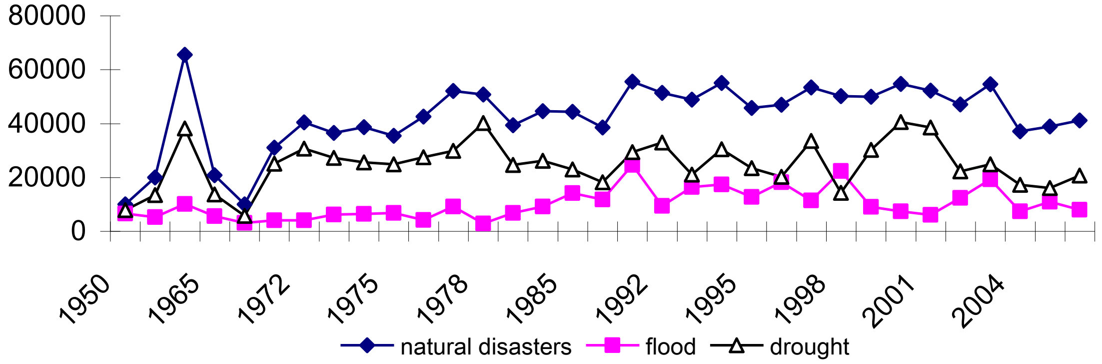
Source: Xie (2005)

Natural Disasters: China is one of the countries in the world which is 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 e.g. earth quakes, pests and cyclones. Since 1950, the area subject to natural disasters has basically remained they 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. To exemplify, people can cope with drought using irrigation system to sustain crop production, but have limited capability and capacity to mitigate flood damage.

At the provincial level, the total natural disaster covered area grew in 17 provinces between 1984-2006. The five provinces with highest growth rate are Hubei, Jiangxi, Xinjiang, Ningxia and Qinghai.

The flood covered area grew in seven provinces (Jiangsu, Ningxia, Jiangxi, Hunan, Fujian, Guangxi and Yunnan) between 1984-2006.

Figure 11. Area affected by natural disasters in China 1950-2006 (unit: 1.000 ha.)

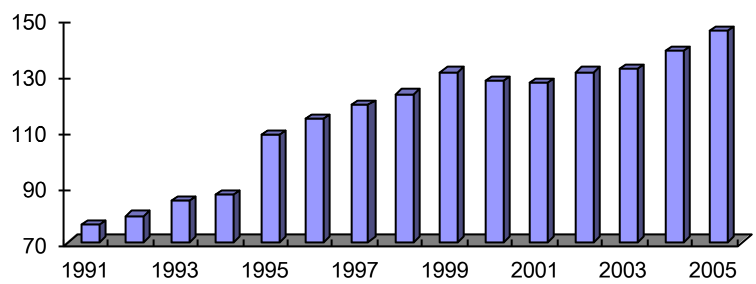


Sources: Chinese Academy of Sciences, Institute of Geographic Science and Resources: China's natural resources database (http://www.naturalresources.csdb.cn/index.asp); *China Statistical Yearbook 2007*

Inspections of the trend in natural disasters across time shows that the economic progress during the last couple of decades has not reduced the area coverage

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 transfered 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. As indicated in figure 12, 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.

Figure 12. Pesticides use in China 1991-2005 (10 000 tons)

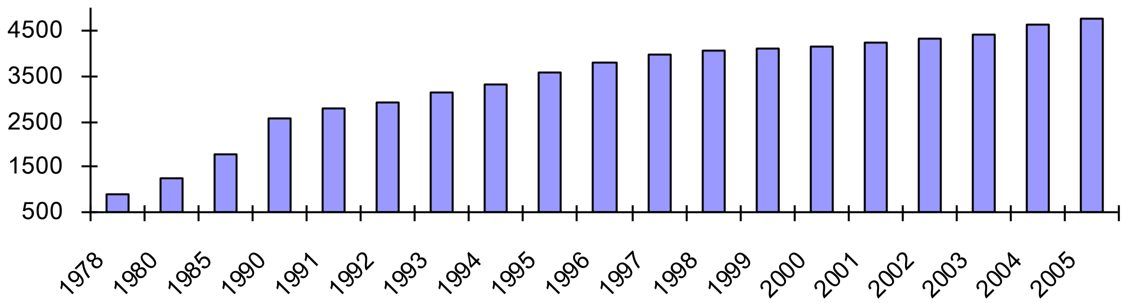


Source: *China Statistical Yearbook 2007*

The change and use patterns vary considerably across provinces; the provinces with the highest growth rate are Hainan, Gansu, Heilongjiang, Inner Mongolia and Jiangxi.

Regarding agricultural fertilizer, the use continues to grow. Between 1978 to 2005, the fertilizer application volume increased 439% (16% annual growth). Undoubtly 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).

Figure 13. Fertilizer application in China 1978-2005 (unit:10,000 tons)



Source: *China Statistical Yearbook 2007*

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 the agricultural production. In addition, 960 000 tons of mulching film was used, which is somewhat less environmentally polluting. At the provincial level, the use of plastic film increased all over, except Beijing and Heilongjiang.

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 biggest source of energy supply. China's quest for energy increasingly continues to affect global energy production and energy prices (Yang Xiongnian 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 and structure coal remains the dominant energy type for 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).

Table 6. 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

The gap between domestic crude oil supply and demand are estimated to continuously widen in the future. Specifically, the estimated proportion of the supply-demand-gap in total domestic demand will be 46.0 % in 2010 and 53.4 % in 2015, respectively (Zhou 2004).

At the provincial level, energy consumption increased in all provinces between 1991-2006. 22 provinces increased its energy consumption more than 150% during the period. The top five provinces are Hainan (653%), Zhejiang (412%), Guangdong(386%), Fujian (371%) and Inner Mongolia (361%). Due to the large coal dependence, a similar pattern is observed for China's coal consumption: coal consumption increased in all provinces 1991-2006. 13 provinces increased their coal consumption with more than 177% (i.e. the national average). The top five provinces with highest energy consumption growth are Hainan (388%), Zhejiang (356%), Fujian (313%), Inner Mongolia (310%) and Shandong (300%). As indicated in the sections on climate change in this Brief, China's (projected) increase in energy consumption - especially coal – will cause significant challenges in the efforts to curb CO_2 emissions and climate change.

1.1 Key environmental problems and their causes

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. In addition, low awareness of environmental problems, ignorance of environmental regulations, lax enforcement of environmental laws and regulations, lack of monitoring, lack of investment in environmental protection, weak institutions and lack of appropriate technology, are important factors behind China's environmental deterioration. In terms of institutions and law enforcement, the conflict between local economic growth and environmental protection by local governments, has been pointed out as a key factor for the lack of law enforcement.

A stylized fact is the growing share of heavy and chemical industry and its negative environmental impacts. Since the late 1980s, heavy industry experienced fast growth (Li 1998). Between 2002-2006, the output value share of heavy and chemical industry has increased from 61% to 69%. The relative size of the share and the increase characterizes China's economic development in recent years, but has also caused much of the pollution. In hindsight, the environmental situation would have been better if pollution control were introduced early on in this industrialization process. Now it is important to speed up pollution control (making use of appropriate policy instruments) in these sectors.

Insufficient investment in environmental protection can be illustrated by the proportion of environmental investment to GDP. During the 8th five-year-plan period (1991-1995), the share was 0.69%. In the 9th five-year-plan period (1996-2000), the share was 1%. And in the 10th five-year-plan period (2001-2005), it was 1.3%. The share declined in year 2006 to 1.22%. Moreover, the cost of pollution control technologies has increased sharply due to the increased complexity in pollution abatement.

Lack of suitable technology is considered a key obstacle for China to improve air quality. Much effort has been made in reducing air pollution but lack of useful, cost-effective (affordable) technology is in the way of making significant progress. The weakest areas have been technologies for clean coal treatment, pollution abatement technologies suitable for controlling pollution from industries, and affordable technologies to reduce emissions form public and private transport, especially private cars and trucks (Guang 2008).

2. Effects of the Environmental Problems – Poverty, Economic Development and Health

Poverty: The environmental deterioration is highly correlated with poverty in China (Li 1994, Zhao et al 1996). For instance, in the case of land degradation, the key areas of soil erosion are distributed in the area west of Daxinganling to Taihang Mountain and Xuefengshang, east of the Tibetan Plateau and the dry area of Inner Mongolia. This ecological fragile area highly overlaps with China's major poverty area (CAS 1989). The dual challenge of meeting human basic needs and environmental conservation/management of land resources has been acute in these areas. For more information on poverty end environmental links please see Appendix 4.

Economic Development: Based on a report published by SEPA[5] (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 7. 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 etal, 1999
1997	54.0(US$)	8.0%	World Bank 1997, "Clean Water, Blue Sky"
2004	511.8	3.1%	SEPA, 2005

Source: Qi, 2005

Health: While China's economic growth has raised living standards and life expectancy for many of its citizens, the increase in pollution has also increased the health related problems. As forecasted by the "World Resource Report 1998-1999", around 2 million deaths per year result from air and water pollution. The 2007 World Bank report "Damage Caused by Environmental Pollution in China" also reported increasing incidence of lung cancer and various respiratory diseases. Diarrhoea, especially among children under 5 years old, caused by water contamination were also rising. The economic cost of environment-related health problems was estimated at the level of 100 billion dollar per year, or 5.8% of GDP.

[5] SEPA was until spring 2008 the lead agency for China's environmental and natural resource management. In spring 2008, SEPA was upgraded to the Ministry of Environmental Protection (MEP).

Table 8. Share of death due to cancer and respiratory diseases in total population, 1996-2006

Area; disease category			1996	2000	2004	2006
Urban	Cancer	%	21.7	24.4	23.9	27.3
		Rank	2	1	1	1
	Respiratory	%	13.7	13.3	13.1	13.1
		Rank	4	4	3	4
Rural	Cancer	%	16.4	18.4	23.7	25.1
		Rank	3	2	1	1
	Respiratory	%	25.2	23.1	13.3	16.4
		Rank	1	1	3	3

3. China and Climate Change

3.1 Trends and future climate

The average temperature over China increased by 0.79°C over the period 1905-2001, slightly above the global average, with greatest warming experienced in the North of 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 Bothai. (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 using a range of Global Circulation Models and different emissions scenarios show that average national temperatures (compared to the period 1961-90) are likely to increase faster than the global average, by 2.3-3.3C by 2050 and 3.9-6C by 2100 (NDRC 2007) but that there will be significant regional differences, for example warming will be greatest in the North and on the Qinghai-Tibet plateau (IPCC 2007b). Average precipitation over China is expected to increase by 10-12% by 2100, but the changes will again vary from region to region, for example while the Northwest and Northeast are expected to see the largest increases, precipitation in central China may decrease (Yin et al 2006, Yihui et al 2007). There are likely to be more extreme rainfall events and the intensity of tropical cyclones in expected to increase, however, it is difficult to say what changes will occur in the frequency or path of these storms (IPCC 2007a).

3.2 Impacts of climate change

Economically vital low-lying areas such as the Pearl River delta and North China Plain are vulnerable to sea-level rise, particularly cities such as Tianjin and Shanghai where land subsidence is also occurring. A 30cm rise in sea-level would increase by 5-6 times the flooding area in the Changjiang (Yangtze) and Zhujiang deltas compared to the present and exacerbate the effects of storm surges (IPCC 2007a). Wetland areas and coastal mangroves are also threatened by rising sea-level and increased saltwater intrusion. Glaciers in China store 5590km^3 and play a vital role in regulating river run-off and water supply to W. China, however an expected decrease in area of 27% by 2050 may lead to negative impacts on the sustainability of water supply for some 250m people in China (NDRC2007, IPCC 2007a). The extent of permafrost on the Qinghai-Tibet Plateau could decrease by 57% with a warming of 3C, which would cause land subsidence and threaten projects such as the Qinghai-Tibet railway (National Communication 2004, Zeng et al 2008). Despite small increases in precipitation in the North of China, studies using infiltration models indicate that there will be reduced run-off in much of the continental interior of China. Demand is expected to increase, placing pressure on water supply in areas such as Tianjin, where water availability per capita is already low. A study of future water supply in Tianjin shows that with current policies, even with the South-North water transfer project, the gap between demand and supply in 2020 would increase to 23%, indicating that water conservation and regulatory measures are needed to reduce this gap (Zhou 2004). This study may be indicative of water supply problems in many other areas of northern China.

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 destabilised. Warming is expected to increase demand for irrigation thus putting more pressure on water resources and wetland areas, and will favour the spread of agricultural pests such as armyworm (National Communication 2004). Positively, the boundaries for double and triple cropping will move North with warmer temperatures, increasing the opportunity for productive agriculture in the North of the country (National Communication 2004). There are likely to be more deaths from heat-related diseases and an increase in the range of diseases such as Malaria and Dengue Fever, but a reduction in cold-related mortality. Droughts and floods (both inland and coastal) are both expected to increase.

Many of China's diverse ecosystems such as the mountain ecosystems of the Qinghai-Tibet Plateau, the arid grasslands of the North and inland wetlands are expected to be very sensitive to climate change, particularly where they are under pressure from existing stresses such as over-grazing (Yin et al 2006).

3.3 Response to Climate Change - Mitigation

Emissions of carbon dioxide reached 1.6Gt in 2006 and China is now widely regarded to have overtaken the US as the world's largest emitter of greenhouse gasses (Zeng et al 2008). With CO_2 emissions of 5.1 tonnes/capita, however, China remains significantly below the EU average (8.6 tonnes) and US average (19.4 tonnes), and accounts for only 7% of accumulated historical emissions pre-2002 compared to 29% for the US and 26% for the EU (The Climate Group 2008). However, 5.1 tonnes/capita is still slightly above the world average of 5 tonnes/capita (The Climate Group 2008), and if a per capita target similar to the 2 tonnes proposed by Sir Nicholas Stern was adopted, China would have to significantly reduce its emissions (Stern 2008). Analysis also shows that 23% of China's emissions come from the manufacture of goods for export, which has raised debate over whether these emissions should be attributed to China or to the country of final consumption (Zeng et al 2008). In addition China's energy intensity (kgCO_2/\$GDP), has fallen by 60% between 1980 and 2006, and there is a national target for a further reduction of 20% by 2010 (NDRC 2007). The latest IEA statistics (from 2005) show that China must continue to reduce its energy intensity from 2.68kgCO_2/\$ to reach the world average of 0.75kg CO_2/\$ (IEA 2008). What is clear is that with primary energy needs set to double by 2030, and increases in emissions by 2015 expected to far outweigh reductions from the Kyoto Protocol, China is a vital part of any future agreement on emissions reductions (Aufhammer and Carson 2007, IEA 2007). China's focal point for international climate negotiations is the Ministry of Foreign Affairs (MOFA), and its position is one of supporting *common but differentiated responsibilities* and addressing climate change *in the context of sustainable development* (NDRC 2007).

The *National Coordination Committee on Climate Change* (NCCCC), coordinated by the National Development and Reform Commission (NDRC), was set up in 2003 to combat climate change and involves 17 government agencies and ministries. The most significant actors in the NCCCC are the NDRC and the MOFA. The State Environmental Protection Agency (SEPA) is in charge of environmental protection but only plays a marginal role in the NCCCC. In 2007 China published its *National Climate Change Programme*, the first climate change strategy from a developing country, bringing together many existing policies which contribute to mitigation activities A *National Leading Group to Address Climate Change, Energy Conservation and Pollutant Discharge Reduction* was set up in 2007 with Premier Wen Jiabao as director, and there is also a *National Expert Advisory Committee on Climate Change*, and *Leading Group of Combating Climate Change* (led by MOFA). NDRC is in charge of the institutional coordination of these groups and is well placed to integrate climate concerns into economic planning, but only if it looks beyond its economic focus (Richterzhagen and Scholze 2007).

There are many laws relating to energy conservation and the promotion of renewable energy, such as the *Law on Energy Conservation of the People's Republic of China* and the *Law on Renewable Energy of the People's Republic of China*, and there are ambitious targets to decrease energy intensity by 20% in 2010 compared to 2005 and to increase the use of renewables from 8% in 2006 to 15% in 2020 (The Climate Group 2008). For comparison, the EU, regarded as a world leader in emissions targets, has set a target of 20% renewables by 2020. China is already the world's leading manufacturer of renewable technology and boasts a rapidly growing clean technology sector. In 2007 China accounted for 73% of the total number of projects funded through the Clean Development Mechanism (CDM)[6], with investment totalling $5.4bn, however there is some evidence that these projects do little to reduce China's carbon emissions, which is an issue requiring further scrutiny as the CDM is one of the main mechanisms through which the UNFCCC aims to reduce emissions (Zeng et al 2008, The Economist 2008). China is aware of the need to avoid 'locking-in' inefficient technologies into its development pathway, such as inefficient power stations, but this will require a concerted effort to make clean technology available and ensure that it is taken up (NDRC 2007).

3.4 Response to Climate Change - Adaptation

Adaptation to climate change is necessary in order to reduce the negative impacts of climate change on China, and to take advantage of any opportunities which may arise. Adaptation options will vary depending on the sector and region of interest; however several themes appear to be important across different areas. One of the most important factors in determining ability to adapt is access to relevant information on climate change, and the dissemination of this information, and ability to use it, needs to be improved to enhance adaptive capacity at all scales. The conservation and restoration of fragile ecosystems, such as mangrove forests and wetland areas by reducing existing stresses such as fertilizer run-off will increase their ability to adapt to climate change and to perform valuable ecosystem services such as flood control and coastal protection (National Communication 2004, IPCC 2007a). Water access and availability will be a major issue in the future and has cross-cutting sectoral implications. Measures to conserve water, both technical such as drip-irrigation, and social such as changing the perception of water as an inexhaustible resource and strengthening regulations on water management and allocation, will be needed if China is to meet its water needs (Guoyu et al 2008, Yin et al 2006). As the driver of economic growth, it is clear that China's productive coastal strip must be protected from sea-level rise and storm damage. Strengthening coastal defences (including natural defences such as mangroves), improving coastal monitoring and early warning systems, and adopting an Integrated Coastal Zone Management (ICZM) approach are all important steps to ensure coastal protection (National Communication 2004). Please see Appendix 1 for China's technology needs for adaptation and Appendix 2 for suggestions of regional priorities for adaptation.

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[6] The Clean Development Mechanism (CDM) was set up under the Kyoto Protocol and allows industrialised countries to receive 'carbon credits' for investing in projects that reduce greenhouse gas emissions in developing countries. To qualify as a CDM project, however, the emissions reductions must be shown to be 'additional to those that would have taken place without the project'. These credits then count towards the industrialised countries' obligations on emissions reductions under the Kyoto Protocol.

It is the poorest and most marginalised members of society who have the least capacity to adapt to climate change, due to other social and economic stresses such as lack of access to information and resources. Any policy to adapt to climate change must be aware of this, and include measures to reduce existing stresses on the poor, perhaps by providing access to healthcare or microfinance facilities so that they do not remain trapped in poverty, and as a result can enhance their capacity to adapt to climate change (Yin et al 2006). Local level participation in decisions on adaptation measures has been shown to be vital to their success, and often prioritises more locally appropriate options that a top-down approach would not capture. In addition to increasing the likelihood of a successful outcome, local participation also acts to increase community awareness and capacity to deal with the problem (Yin et al 2006, IPCC 2007a). Stronger public participation in these decisions in China would improve the chances of successful action to both adapt to and mitigate climate change.

3.5 Capacity for Adaptation and Mitigation

Whilst many good laws, policies and targets have been developed aimed at reducing emissions the monitoring and regulation processes to ensure that these targets are met are poor at present, which decreases their effectiveness, for example it appears that the ambitious target to reduce energy intensity by 20% by 2010 will not be met (Richterzhagen and Scholze 2007). Implementation of national policies at provincial level is poor due to a lack of incentives, lack of resources and conflict with other local priorities. For example wealthier provinces are investing in energy efficient power generation; however neither the incentives nor resources are available in poorer provinces, with the result that inefficient technology continues to be used (Richterzhagen and Scholze 2007, Aufhammer and Carson 2007).

China has made large steps towards developing its capacity for climate-related research and development, and is continuing to further strengthen this capacity, however better international exchange of information and best practice would enhance this process (NDRC 2007). Public awareness is low and must be improved, in particular in rural areas, but the establishment of several high-profile Leading Groups to tackle climate change, and planned integration of climate change into education on sustainable development should improve this situation (NDRC 2007). The role of NGOs in China is still limited and if participation of environmental NGOs was increased this could support the effort to raise awareness (Richterzhagen and Scholze 2007).

Capacity for climate projections and adaptation is improving but must be strengthened, There is a particular need for an improved climatological monitoring network in the Northwest, more regional studies using RCMs (or other downscaling techniques) developed for China, and sectoral assessments of the impacts and options for adaptation, in particular for the Health and Transport sectors (Lin et al 2007, National Communication 2004). Research into changes and impacts of extreme events, the costs of climate change and adaptation and uncertainties in climate projections would help to guide provincial and national level policy on climate change. Effective implementation of this research will require multi-disciplinary partnerships and lasting cooperation between actors at the local, provincial and national levels (Lin et al 2007). For a comprehensive list of China's identified capacity needs please see Appendix 3.

The overarching issue for China is how to decouple economic growth from growth in emissions of carbon dioxide. The top three challenges to achieve this will be:

- How to ensure that the ambitious national level targets on issues such as energy intensity and adoption of renewables are met and implemented at the provincial level.
- Meeting energy needs without increasing reliance on the large domestic reserves of coal, which will require the rapid adoption of both energy efficiency measures and varied sources of renewable energy.
- Taking advantage of the opportunity to build low-carbon infrastructure from new, rather than taking the conventional route followed by industruialised countries and 'locking-in' inefficient and

energy intensive technologies into the current rapid expansion in infrastructure and then having to retro-fit it in the future to reduce emissions.

4. What key actors are doing to manage the environmental problems

Government and Planning: China's development policy guidelines are set out in its 11th five year plan (adopted in 2006) which is the main government planning instrument. Central in the 11th FYP are efforts to balance economic growth with social equality and environmental protection (EU, 2007). Protection of resources and preservation of the environment is one of the main priorities and seven priority environmental programs are proposed; water pollution control, air pollution control, urban environmental protection, nuclear safety, rural environmental protection, ecological protection, financial support with a focus on state environmental protection projects (ADB, 2006). One of the few quantified targets in the 11th FYP is a decrease in energy consumption by 20% by unit of GDP over the period of the plan. Targets have also been set for strengthening macroeconomic control over environmental issues (EU, 2007).

One significant positive development is the progress that has been made in capacity building for Environmental Impact Assessments (EIA). After the new law was issued in 2003, certification procedures have been established for EIA organizations and nearly 1000 organizations are certified to prepare EIAs. Between 2003 and 2006 the number of personnel working with EIA doubled, from 10 000 to 20 000 people.

Departments under the State Council have worked hard to support environmental policy implementation. A range of regulatory and economic instruments (e.g. taxes, emission tradings) and policy approaches that combine markets and public interests in the environment has been developed (OECD, 2006).

Environmental institutions: A comprehensive policy framework for natural resources and environmental management has been established in China since the beginning of the economic reform in late 1970s. Natural resources and environmental management is a shared responsibility between a numbers of agencies across different levels of Government. In March 2008, the lead agency within natural resource and environmental management, SEPA, became the Ministry of Environmental Protection (MEP). The MEP formulates environmental protection guideline, policy and law. As a ministry the MEP has received a stronger position within the field of natural resource and environmental management, although the role it plays within energy- and climate change issues is limited.

The National Development and Reform Commission (NDRC) is a macroeconomic management agency under the State Council and plays a leading role in formulating the overall environmental and natural resource plan as a part of the national development planning process. NDRC is the most important government agencies for the energy sector at national level. Other relevant and important agencies at the national level include the Ministry of Water Resources (MWR), Ministry of Agriculture (MOA), Ministry of Land Resources (MLR), Ministry of Construction (MOC), State Forestry Administration (SFA), and State Ocean Administration (SOA) with each being charged with environmental responsibility within its own sector.

The State Forestry Administration (SFA)
SFA is an important agency managing large land areas and natural resources. Around 27% of the land is designated as forestland, which is to be afforested by 2030. Through three decades of efforts, forest cover increased from 12% to 18%. However, large challenges remain in deforested natural forests in the state owned forest areas and in preventing the negative economic and social effects of this resources degradation. In collectively owned forest areas, tenure reform is underway to strengthen

farmers' property rights and to give farmers longer term management contract for the purpose of enhancing forest management and attracting private sector interests in forest investment.

Ministry of Agriculture (MOA)
In addition to pursue the goal of meeting food needs of the country, MOA is also responsible for policy making and supervision of grassland management and protection. In order to control grassland degradation and improve livelihood of herdsmen communities, a grassland responsibility system was implemented. It started in the 1980s and large areas of grassland were contracted to herdsman families for grazing use. Grassland degradation remains a major problem today. And whether current attempts to individualize grassland management is successful to curb grassland degradation is still a topic of hot debate.

Ministry of Water Resources (MWR)
MWR is responsible for water resource management, allocation and the development of hydro-power. MER is also the main agency for water and soil conservation. Micro watershed management was developed as a standard model for water and soil conservation in the 1980s and 1990s. The role of the MWR and the water resource sector in water and soil conservation was cut back in the last decade due to the new emphasis on afforestation (via the Natural Forest Protection Program and the Sloping Land Conversion Program) administered by SFA. Other responsibilities of MWR, i.e. water allocation and hydro-power development, have had tremendous impacts on erosion control, agricultural development and biodiversity and cultural conservation. Lots of debates have been generated around the development of hydro-power system and China's water use policy.

Local Government
Local governments are responsible for implementing national policies in environmental protection and natural resource conservation. However, due to the overarching responsibility of economic growth, failure to enforce national environmental policy at local level is widespread. Lack of effective incentives at local governments characterizes the agency problem and hampers realization of the ambitious national goals for environmental protection.

At provincial and municipal levels there are Environmental Protection Bureaus (EPB) set up. The provincial EPBs are the main executing agencies for environmental protection policies (although they have limited policy making function). The environmental monitoring and supervision divisions under the EPB have enforcement functions, such as stopping and imposing fines and penalties for environmental violations (ADB, 2006).

China subscribes to all the major Multilateral Environmental Agreements (EU, 2007). The Kyoto Protocol and China is an ongoing debate about China being a non-Annex I country under the UNFCCC, and not bound by targets for the reduction of greenhouse gas emissions under the Kyoto protocol.

<u>Civil Society and NGOs:</u> Only a few environmental Non Governmental Organizations (NGOs) exist in China. International NGOs, such as WWF, TNC, IUCN and Environmental Defense, played pivotal roles in bringing in new concepts, such as emission trading, carbon trading, biodiversity offsets into Chinese environmental policy making, and facilitating dialogue between international stakeholders and the Chinese government, on issues such as illegal timber trade. In 2000, the number of environmental NGOs active in China was slightly more than 2 100.[7] Although NGOs are starting to play an important role in environmental protection they do not have the same opportunities or autonomy as NGOs in developed countries. Domestic NGOs have been particularly effective in increasing awareness of local communities on issues closely related to their wellbeing. Citizen complaints are also growing, reflecting a growing trend of social pressure toward polluters and ineffective governments.

[7] http://earthtrends.wri.org/pdf_library/country_profiles/env_cou_156.pdf

Media has begun to play an increasing role informing the society by exposing cases of violation of environmental laws and regulations, providing environmental data, and reporting on pollution episodes and accidents. Better access to information regarding these matters have according to media reports reduced the abuse of power and misuse of pollution charges (ADB, 2006).

5. How and to what extent are the responses to environmental problems implemented and followed-up?

China's environmental problems are historically caused by policy failures, largely driven by the fact that environmental protection has been controlled by government, and that economic planning and production has been centrally planned. With the economic liberalization this has changed; many of the environmental problems are now caused by substantial market failures as well as institutional failures.

Ambitious plans have been made to improve environment and mitigate climate change impact that has caught the attention of national leaders in recent years. In the 11th five year plan, concrete targets of energy saving and pollution reduction were set despite the general doubt over feasibility of the goals. It is foreseeable that larger amounts of investment will be necessary and indeed allocated in environmental management. In addition, the following developments should be of notice:

Environmental Protection Authority
Recognizing the agency problem in the hierarchy of the governmental environmental protection system, some degree of administrative adjustment has been made. Most prominently was the establishment of 6 regional monitoring offices directly under the command of MEP. The new principle of Water Basin Level Project Approval System was also adopted by MEP in an effort to impose bigger costs non-compliants. Over the last decade, media exposure and social pressure were recognized by central authority as useful instrument to control industrial pollution. This lead to the issuance of "The Measure of Environmental Information Disclosure" in 2007.

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. The levy system has been criticized for imposing too low costs (fees) for the polluting firms and too loosely enforced. 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. The second most influential measure was the closure of all under-sized mills in 15 sectors recognized as most pollution intensive. The success or failure of these dramatic actions have been discussed. Although industrial pollution has been growing in a rate slower than industrial output, a lot remains to be done to effectively reduce industrial pollution.

Many of the market failures have worked in conjunction with a weak property rights system, which have reduced the incentives to make environmental investments. To address the situation, the current emphasis has been to strengthen the national and local environmental authorities, in terms of staff size and budget, especially at the national level. This has enabled substantial national environmental investment programs, as well as more command and control measures to manage the environment and curb pollution. However, measures and policy instruments which have been used to a lesser extent includes the use of market instruments (eg pollution taxes, environmental fees, subsidies etc), and involvement of civil society and the private sector.

Moreover, environmental policies have not acknowledged or been adjusted to the large regional disparities within the country. Policies and follow up are made with uniformed provisions and approaches, without due attention to disparities across regions and industries in e.g. costs and benefits of environmental abatement, and ecological differences, respectively. Frequently, this has imposed too high marginal cost for environmental improvements, e.g. introduction pollution control technologies.

Measures for improvement include developing an environmental policy framework that embraces regional disparities and is flexible enough to adjust for substantial regional differences (socially, ecologically and economically). Moreover, there is a need to make greater use of economic instruments and market mechanisms for improved environmental governance, for instance reformed taxation system (introduction of a carbon tax!), emissions trading system(s) for key pollutants, payments for ecosystem services, subsidies to introduction or development of environmentally friendly technologies, etc. The role of local initiatives, civil society and the private sector in environmental protection, ecological restoration and biodiversity conservation needs also recognition and increased support.

Using the payment for environmental services vehicle to enhance funding and effectiveness of environmental improvement and reduce cost of environmental service provisions may be a useful policy instrument to encourage cost-effective environmental management. A successful model in this regard was created by Beijing Municipal Government when payment to upstream farmers was made in order for them to stop growing water consuming paddy rice and yield clean water for Beijing use. By doing so they obtained large volume of water with relatively small cost (around 15% of the cost of the project alternative – the South-North water transfer project).

State Forestry Administration
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. Recent development and policy changes are as follows:

<u>New policy on Sloping Land Conversion:</u> The Sloping Land Conversion Program is the largest land set-aside program in the developing world. To ensure acceptable success rate, the central government recently approved a new policy to prolong the compensation period (double the initially stipulated compensation period with reduced payment) and to stop further expansion of the program.

<u>Collective Tenure Reform:</u> In July 2008 the central government issued policy of tenure reform on collectively owned forests. 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.

<u>Policy Dialogue on Illegal Timber Trade:</u> The fast growing timber imports and exports in China have caught wide contention in the conservation world. Recently, the Chinese government engaged in international dialogue for the development of viable measures to curb illegal logging of some of the supplying countries. With laws (Lacey Act) approved and put in effect, more serious action is expected to be taken from the Chinese government and forest industry to reduce demand for tropical timber. The improved productivity of plantation forests in China, due to tenure reform and private sector involvement, will help in the long run.

<u>Corporate Social Responsibility:</u> Through efforts from environmental authorities over the past decade, industrial water pollution has been growing in slower speed and was surpassed by urban and rural non-point source pollution. Nevertheless, *more than 70% of China's water surface remains heavily polluted*. *<u>International companies</u>* operating in China are generally perceived to be transporting pollution into the country. The international companies are however in a good position to bring in

clean technology and business approaches that are more environmental friendly than their domestic counterparts. Their pursuits of business and environmental integrity are usually highly visible and respected, and the model effect is usually strong. Environmental indicators also show that international companies operating in China are generally more environmentally sound than domestic comapnies, and their production contributed to lower environmental pollution. Nevertheless, there are cases that international corporations constantly raised dispute over environmental consequences of their operations. The most prominent cases involved APP and Stora Enso, both of whom are large forest products companies and have been acquiring forest land in south China for plantation works.

Domestic businesses have become more and more environmentally sensitive in recent years due to tougher environmental regulation and enforcement, and due to increasing public environmental awareness. In the last couple of years, some leading businesses in China started developing their own initiatives to mitigate environmental degradation. One distinguished example is that around 100 Chinese businesses formed an NGO in Alasha Region in Inner Mongolia to help restoring grassland ecosystem and has apparently been successful. Some energy companies have been active in piloting carbon sequestration projects. There is reason to believe that there is big potential and need in the business sector for better environmental performance. However, for this to be realized, policies that provide appropriate incentives for the business sector still lacks behind and needs to be developed and implemented.

6. Implications for Sida – Issues for Consideration

Regarding China's key environmental challenges (except climate change; addressed separately below), the most important issues to consider include:

(i) Capacity building for policy analysis that emphasizes economic theory and tools, and facilitates enhanced/increased use of environmental economics policy instruments;
(ii) Facilitation of technology transfer to meet China's needs to control industrial pollution;
(iii) Support to policy dialogue on choice and implementation of cost-effective policy instruments;
(iv) Exchange of experience in terms of effective policy and governance structure to control point source- and non-point source pollution; and
(v) Facilitating transfer of new energy technologies, especially technologies used to expand production and use of bio-energy and bio-fuels for transportation.

Regarding climate change challenges, potential areas for consideration include:

(i) Cooperation and enduring partnerships between actors in different sectors and at different scales to enhance effective adaptation, e.g. urban planning, coastal management, afforestation etc.;
(ii) Promoting 'no-regrets' adaptation options which contribute to current economic growth and increase adaptive capacity, such as water conservation techniques;
(iii) Supporting protection and improved management of fragile ecosystems in order to restore ecosystem services. This will benefit those who rely on these ecosystems and increase adaptive capacity for the future;
(iv) Strengthening complementarities between disaster-risk reduction and climate adaptation; Projects showing how an integrated approach to both could be beneficial would provide valuable information;
(v) Studying how a tax on carbon dioxide, such as the current Swedish one, could be applied in China to reduce emissions (which also would inform Chinese policy);
(vi) Sharing lessons learned on the implementation of policies to reduce greenhouse gas emissions and improve energy efficiency. This would help improving the success of

China’s ambitious targets on energy intensity and renewable energy. Especially important is improving the implementation of national policies by provincial authorities;

(vii) Developing activities and material to raise awareness about mitigation activities at the individual level, but also amongst companies would be a useful way of building a collective consciousness about mitigation of climate change;

(viii) Assessing how partnerships between Swedish renewable energy or clean technology companies and their Chinese equivalents could improve the transfer and uptake of clean technologies in China; and

(ix) Many studies are being undertaken on adaptation in different regions and sectors. It would be valuable for some of the recommended adaptation options to be piloted to show what benefits they can have and in what contexts they are appropriate.

References

Aufhammer, M. and Carson R.T. 2007, Forecasting the path of China's CO2 emissions using province level information. CUDARE working paper 921

ADB, 2006, "Country Environmental Analysis of the People's Republic of China", Asian Development Bank

Chen, Ling, 1999, *Species in Severe Danger and the Protection*, Acta Zoologica Sinica, Vol.45 No.3, 350-35.

Chen, Tongbin, Xibo Zeng and Qingxiu Hu, 2002,*Utilization Efficiency of Chemical Fertilizers among Different Counties of China*, Acta Geographica Sinica, Vol.57, No.5, 531-538.

European Commission, 2008, "China Country Strategy Paper 2008-2013"

Fang, Xiuqi, Wenbo Zhang, Benyong Wei and Ling Hu, 2008, *History of Soil Erosion Evolution in China*, Bulletin of Soil and Water Conservation, Vol.28, No.1, 158-165.

Guoyu, R. et al 2008 Climate Change and its potential impacts on water availability in three basins in N. China.

Hang Leiming, 2007, *Research on Energy Structure in China.* PhD Dissertation submitted to Shanghai Jiao Tong University for the Degree of Philosophy Doctor, 17-34.

IEA 2007, *World Energy Outlook 2007*: China and India Insights. Paris: IEA

IPCC 2007a, Cruz, R.V. et al Asia. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 469-506.

IPCC 2007b, Christensen, J.H. et al: Regional Climate Projections. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Li, Zhiguang, Wei Cao, Bingzheng Liu and Zhidong Luo, *Current status and developing trend of soil erosion in China* , Science of Soil and Water Conservation, No.2, 57-62.

Li, Zhou and Ruomei Sun, 2000, *China's Environmental Problems*, Henan People's Publishing House, Zhengzhou, p 9

Lin, E. et al 2007 China's national assessment report on climate change (II): Climate Change Impacts and Adaptation. *Advances in Climate Change Research 3 (supp): 6-11*

Liu, Zhiqiang and Jiling Chen, 2007, Research on Present Situation and Development Tendency of Atmospheric Environmental Quality in China, Electric Power Environmental Protection, Vol. 23, No.1:,23-7.

National Development and Reform Commission (NDRC), People's Republic of China 2007 China's National Climate Change Programme. Beijing

OECD, 2006, "Environmental Performance Review of China: Conclusions and Recommendations (Final)"

People's Republic of China 2004 Initial National Communication on Climate Change. Beijing

Research Group of China's Energy Demand and Supply, 2007, *Analysis on China's Energy Demand and Supply*, Statistical Research. Vol.24, No.10, 4-8.

Richerzhagen, C. and Scholze, I. 2007 *China's capacities for mitigating climate change*. DIE Discussion paper

Shi, P.J. et al 2008 *Trends and pro-active risk management of climate related disasters*. In Fu, C., Freney, J.R. and Stewart, J.W.B. (eds.) Changes in the Human-Monsoon system of East Asia in the Context of Global Change. World Scientific Publishing.

The Climate Group 2008 China’s clean revolution. London

The Economist 2008 Briefing: China, India and Climate Change: Melting Asia.

Wang, Cuihong, 2004, *An Analysis on the Distribution Patterns of China’s Terrestrial Biodiversity*, A Doctoral Dissertation of Shanxi University, 16.

Wen, Yali, 2004, *An Economic Analysis on China’s Protective Policy of Biodiversity*, A Doctoral Dissertation of Beijing Forestry University, 25.

Xie, Shuanghong, 2005, *A Research on the Grassland-livestock Balance and Prairie Management in Northern Pasturing Area of China*, A Doctoral Dissertation of Chinese Academy of Agricultural Sciences, 12-37.

Yang, Lei, 2003, *An Analysis of Dust Pollution Conditions in Main Industries and its Control*, Journal of Zhongyuan Institute of Technology, , Vol. 13, No.1,69-72.

Yang Xiongnian,FengYongzhong,RenGuangxin,DingRuixia,YangGaihe,2005, *Characteristics of energy supply and consumption and analysis of the strategies to solve these problems in China,* Jour. of Northwest Sci-Tech Univ. of Agri. and For.(Nat. Sci. Ed.), Vol.33 No.5, 147-150

Yihui, D. et al (2007) China’s national assessment report on climate change (I): Climate Change in China and Furture trends. *Advances in Climate Change Research 3 (supp): 1-5*

Yin, Y. et al 2006 Vulnerability and Climate Change in Western China. A final report submitted to the AIACC project.

Zeng, N. et al 2008 Climate Change – The Chinese Challenge. *Science* 319: 730-731

Zhao, Xikang, 2003, *Environmental Regulation and Industrial Competitiveness in China*, Publishing House of Chinese Social Sciences, 238-256.

Zhang, Haipeng, Ningzekui, 2007, Analysis on Regional Factors of Rural Industry Pollution, Journal of Huazhong Agricultural University(Social Sciences Edition), No.5, 101-107.

Xie Zhenhua, 2005, “Construction of Environmental Strategy in the New Era”, Environmental Economics, 6: 12-17.

Zhangh Yanguang li Maoning ,2008, *EMD Analyses and Dynamics Predictions of Energy Supply and Demand in China*, Geography and Geo-Information Science, Vol.24,No.3 , 68-70.

Zhou Shengxian, 2008, “Actively Construct Ecological Civilization”, Economy, 1: 20-21.

Zhou Zongying,2004, *Discussion on Petroleum Safety Strategy in China Judged byPetroleum Gap of Supply and Demand*, Resources Science, Vol. 26 ,No. 6 , 111-117

Appendix 1: Technology needs for Adaptation.

Water resources	Capability building on methods and rules for regional water resource management
	High-efficiency water-saving agro-technology of spray & drip irrigation
	Technology for economizing and reusing industrial water resources
	Day-life water-saving technology and water-saving appliance transformation
	Technology for the treatment, recycling and reusing of industry and daily-life wastewater
	High-efficiency flood-controlling technology
	Water and soil preservation technology
	Technology for the observation and pre-warning against floods & droughts
Agriculture	Technology for deep and intensive processing of agro-productes
	Technology for observation & pre-warning against agriculture calamity
	Capability for research & development of agro-biological technology
	Agricultural seedling technology
	Capability for research & development of technologies for new-type fertilizer and prevention & killing of agricultural pests
	Technological support for the prevention and treatment of salinity & alkalinity and water-soil erosion
	Technology for improving agricultural water-use efficiency
	Modern agro-technology on basis of automatization and intelligence
Natural ecology & forestry	Technological support for eco-protection of forestry and grassland
	Capability for research & development of technology for the prevention & treatment of forest & grassland pests
	Public welfare eco-forest, speedy & lush growth forest, forest for high-efficiency coke & charcoal, and afforestation technology
	Education and training for forestry & grassland management
Sea level & coastal zone	Support and training for the protection of eco-system of marshland, mangroves & coral reefs, etc.
	Technology for the observation, pre-warning & forecast of sea level rise and coastal and marine eco-environment
	High-standard dyke & embankment construction technology
	Research on the impact of global climate change on China's marine eco-environment
	Technology for the recovery and reconstruction of marshland, mangrove and coral-reefs
Desertification & natural disasters	Technological support for the prevention & treatment of desertification
	Technology for the observation & pre-warning of natural disasters
Others	Protection of bio-diversity, construction and function preservation of nature reserve, protection of marshland, prevention and recovery of soil deterioration and other relevant technologies

Source: National Communication 2004

Appendix 2: Regional priorities for Climate Change adaptation

Northeast China: Move winter wheat cultivation areas northward and enlarge rice paddies as suitable.
North China: Adaptation could involve establishing water saving systems, preventing and managing desertification, and promoting regional social and economic sustainable development.
Northwest China: Reasonable allocation of water resources, development of water saving agriculture, protection and improvement of ecosystems and the environment and enhancement of adaptive capacity of dryland agriculture
Central China: Capacities should be built for controlling and mitigating droughts, floods and other disasters, for strengthening water retention and drainage, and for monitoring and preventing of schistosomiasis.
Southwest China: Strenghtening prediction and early-warning systems for landslides and mud-rock flow, speeding up and improving water and soil conservation, and protecting the prairies in Tibet.
Coastal areas of East China and South China: Increase height of levees and strengthen ability to monitor and to issuse early warnings for typhoon and storm surges.

Source: Lin et al 2007.

Appendix 3: Capacity-building needs in China

Institutional capability building	Strengthen & consolidate relevant departments for "Convention" negotiations, and departments in charge of climate change coordination & policy development and implementation
	Strengthen & consolidate relevant key research organizations & non-governmental organizations
	Strengthen & consolidate organizations for climate change and vulnerability and monitoring
Capacity buildingunder the clean development mechanism	Establish the regulations required by the implementation of clean development mechanism
	Promote the establishment & operation of project management entities
	Project identification, design and development, & determination of project procedures
	Monitoring, validation, verification and certification of project activities
	Development of a standard & indicator system
	Baseline study and demonstration project
	Project negotiation capacity

	Channeling the project development fund & financing
	Demonstration project for strengthening capacity building in clean development mechanism, including risk assessment of short-term investment & the assessment of impacts on the environment, society, and economy.
	Acquire & share information, especially about the set-up & maintenance of relevant websites
Development of human resources	Fellowship & scholarship for high-level formal training, specialized training & informal training
	Construction of banks for professional knowledge & skills
	Researches and policy studies on climate change test & monitoring, climate variability, impact assessment, vulnerability and adaptation
	Plan for exchanges among different Parties
	Introduce the subject of climate change into school education program (curriculum/module development)
Technology transfer	Identification & assessment of technology needs
	Information on technology needs & supplies
	Barrier analysis and countermeasures for technological transfer
	Cooperation in the research & development technologies
	Information channel construction (including information collection & dissemination, etc), especially the construction of websites
National Communication	Research on emission factors
	Data collection, analysis & filing/storage
	Uncertainty analysis & assessment: including scope, type, method selection & report
	Inventory quality control & management system development
Adaptation	Guideline for the development of adaptation project
	Adaptation technology needs assessment & technology transfer
	Case studies on extreme climate events and research report compilation & dissemination
	Capacity building in ocean & water resource departments
	Capacity building in climate observation system
	Identification & enhancement of traditional knowledge, skills & practical experiences on adaptation
Public awareness	Projects for improving public awareness
	Developing and producing materials for the enhancement of public awareness
Coordination and Cooperation	Stakeholders coordination
	Participation and consultation of stakeholders
Decision-making improvement	Awareness & knowledge
	Research, data & information
	Technology & policy
	Regional environment and socio economic impacts & climate change

Source: National Communication 2004

Appendix 4

Poverty-Environmental Links in China[8]
As a result of the high economic growth during the last 15 years (~10%/year) a large number of people in China have escaped extreme poverty.[9] Further, the Human Development Index for China is rising (from 0,53 in 1975 to 0,78 in 2006)[10]. However, still many are poor and over 245 million people are living on less than US$1/day[11] and approximately 450 million people live on less than US$2/day[12]. Hence, poverty is still a serious challenge, especially in rural areas. Large migrations from rural areas have made the urbanisation rate increase from less than 30% in 1993 to 43% in 2006 and are predicted to reach 47% in 2010[13]. (See Annex for urban and rural projected trends)

Although urbanisation will most likely have a positive effect in terms of higher income levels it will also have severe negative effects if not dealt with in a sustainable manner. One issue of concern is that urbanisation is devouring agricultural land. China is losing one-third of 1 percent of its farmland every year. In a period of 25 years this is equal to 7% of the country's agricultural area.[14] Another issue is that energy and water demand and demand for improved infrastructure (roads, sanitation, waste management etc.) will increase significantly. For example sewage and waste disposal services are today struggling to keep up with the demand and still nearly one third of all urban residence lack these services.[15] Moreover higher energy consumption will lead to more emissions of e.g. CO_2 (affecting climate change) and SO_x (causing acid rain).[16]

Regarding distribution of income and wealth, the Gini coefficient for China has increased during the last two decades from around 0.3 to 0.5 which indicates that the rich are getting richer and the poor are becoming poorer. Income inequalities between urban and rural areas have increased. Regionally, income per capita is unevenly distributed where the coastal provinces are wealthier than the less developed western provinces[17] (See Annex for trends in rural and urban incomes). The poor western region is widely recognized as having the largest areas with inaccessible and poor agricultural land in China in the form of mountains, hills, plateaus and deserts.[18] Moreover, the poorer western provinces' fragile environment has suffered serious damage due to long-term overgrazing and inappropriate farming methods leading to natural resources degradation e.g. land degradation, deforestation and biodiversity loss which undermines the livelihoods of the poor[19].

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[8] *This analysis was carried out as a desk study in December 2008 at the request of Sida Stockholm (att: Åsa Hedén) by Emelie Dahlberg and Anders Ekbom at Sida Helpdesk for Environmental Economics, University of Gothenburg as part of Sida-EEU's institutional collaboration on environmental economics and strategic environmental assessment. Comments are welcomed and can be sent to emelie.dahlberg@economics.gu.se*The views expressed in this analysis are those of the authors and do not necessarily represent the views of Sida.
[9] OECD, 2006
[10] China Institute for Reform and Development, 2008
[11] ADB, 2006
[12] China HDI, 2008
[13] OECD, 2006
[14] Worldwatch Insitute, 2006
[15] Ysuf and Saich, 2008
[16] Ysuf and Saich, 2008
[17] Luo and Zhu, 2008
[18] Weiss, 2001
[19] UNDP China, 2008

In rural areas, most people are heavily dependent on the environment for their livelihoods, which makes them more vulnerable to environmental degradation and impacts of climate change e.g. local increases in rainfall, droughts, floods, storms and/or different weather-related extreme events. Empirical evidence shows that poverty is both a cause and an effect of environmental degradation in China.[20] The lack of daily necessities and basic needs for livelihood forces people to over-exploit the fragile ecosystems in their surroundings leading to biodiversity loss, soil erosion and deforestation that reinforce natural disasters and poverty. At the same time China's poor have very small means to handle environmental pollution, natural resource degradation as well as natural hazards, which are expected to increase as a result of climate change.[21]

Agriculture is the main income source and employment of the rural poor in China.[22] Land degradation has a significant negative effect on agricultural production. Almost 17% of the land in China is seriously degraded.[23] Furthermore, water scarcity and climate change could reduce China's agricultural output by 5-10 percent by 2030[24] which will have serious negative effects especially for the rural poor. Although China has been subject to significant deforestation of mature forests over time, China's efforts at afforestation has resulted in a net increase in total forest area during the last 15 years. This is an accumulation of natural wealth which holds large potentials for pro-poor growth as the current devolution of forest rights in the national forest sector reform is partly targeted at the poor by granting them increased access to, and ownership over, the country's forest resources.

The poor quality of China's scarce water resources has significant health impacts, particularly on vulnerable groups in rural areas, such as elderly and children. Findings indicate that the people in poorer provinces suffer the most from water pollution. Over 75% of low income households with children under five years of age do not have access to piped water, compared to 47% in the higher income categories. The poor households rely more on unsafe drinking water which is highly correlated with health risks.[25]

Similar findings apply to indoor air pollution, indicating that poor and rural households bear a disproportionately large share of this considerable health burden.[26]

In urban areas many heavily polluting industries are being reallocated to suburban areas where large numbers of poor live, especially rural migrants. For the people living in these areas this has serious consequences in terms of water and air pollution resulting in significant health problems.[27] As mentioned above the industrial and urban expansion has a large impact on people living in suburban areas and rural areas (particularly poor) as land used for agricultural activity is being transformed into urban and industrial land. This affects livelihood opportunities, opportunities for water extraction, and sanitary disposal of wastes. Moreover, urban poor are highly vulnerable as they tend to live in areas that lack basic

[20] ADB, 2006
[21] ADB, 2006
[22] Weiming *et al,* 2003
[23] Worldwatch Insititute
[24] Ysuf and Saich, 2008
[25] China Institute for Reform and Development, 2008
[26] China Institute for Reform and Development, 2008
[27] ADB, 2006

infrastructure and areas that are prone to natural hazards, e.g. floods.[28] Such events are likely to become more common in the future due to climate change. The increasing urban population increases demand on already over-stretched infrastructure services, including disposal of liquid and solid wastes. Further, more than 400 of China's 600 cities are believed to be short of water, and about 100 face serious water shortage problems.[29]

Although the past 20 years show rising incomes in China, this positive trend and poverty alleviation has a backside to it. The increasing growth patterns together with population growth are accompanied by higher consumption levels and extraordinary levels of natural resources depletion and environmental degradation.[30] For example, in the 1980s there were almost no private cars in China, in 2005 there were over 43 million cars and by the end of 2015 it is estimated that there will be over 150 million[31] cars in China.[32] (see also Annex) Air pollution in Chinese cities from nitrogen oxide, sulfur dioxide, and particulates (already among the most severe in the world) is likely to become even more intense. Of the 20 cities with the worst air pollution in the world, 16 are in China.[33] Moreover, out of 500 monitored cities in China, less than 1% meets the relevant World Health Organization's air quality standards.[34] From a poverty perspective rising levels of air pollution tend to hit the poor the most, and they are typically deprived of the capacities or resources to protect themselves from the health hazards associated with the pollution increases. Reducing emissions from (urban) transport and industries would be pro-poor investments.

[28] ADB, 2006
[29] Worldwatch Insitute
[30] ADB, 2006
[31] This can be compared to the amount of vehicles in the USA. 2006 estimates show that there are over 250 million vehicles in the USA out of 135 million are classified as automobiles and around 100 million as SUVs and pick-up trucks and the remaining 15 million is classified as motorcycles etc. Wikipedia, available 2008-12-01
[32] ADB, 2006
[33] Ysuf and Saich, 2008
[34] ADB, 2006

References:

Asian Development Bank, 2006, *Country Environmental Analysis for The People's Republic of China*

China Institute for Reform and Development, 2008, *China Human Development Report*, commissioned by UNDP

China HDI, 2008, http://hdrstats.undp.org/countries/data_sheets/cty_ds_CHN.html available 2008-12-09

OECD, 2006, *Environmental Performance Review Conclusions and Recommendations*

UNDP China, 2008, *Green Poverty Alleviation in Poor Rural Areas of China: Project Summary*

Weiming, T. Xiuquing, W. Fuyan, K. 2003, *The poverty alleviation role of agriculture in China*, Agricultural and Development Economics Division (ESA), Food and Agricultural Organization of the United Nations

Weiss, J., 2001, *Poverty in Western China: Exploring the Policy Option*, Asian Development Bank Institute

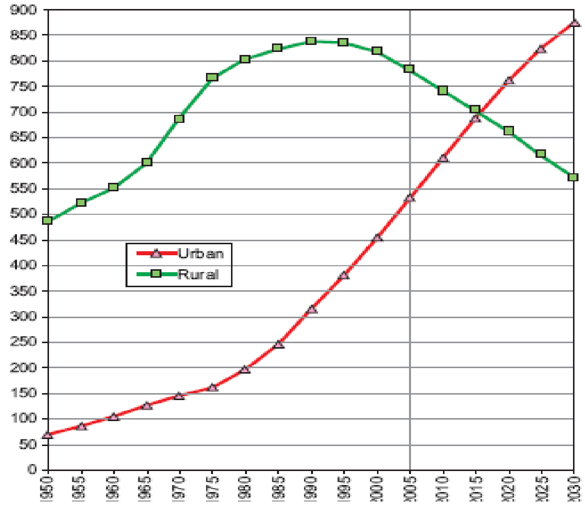
Wikipedia, http://en.wikipedia.org/wiki/Passenger_vehicles_in_the_United_States available 2008-12-01

Worldwatch Institute, 2006, *State of the World 2006 Special focus: China and India*

Ysuf, S. and Saich, T. 2008, *China Urbanizes: consequences, strategies and policies*, The International Bank for Reconstruction and Development, The World Bank, Washington D.C

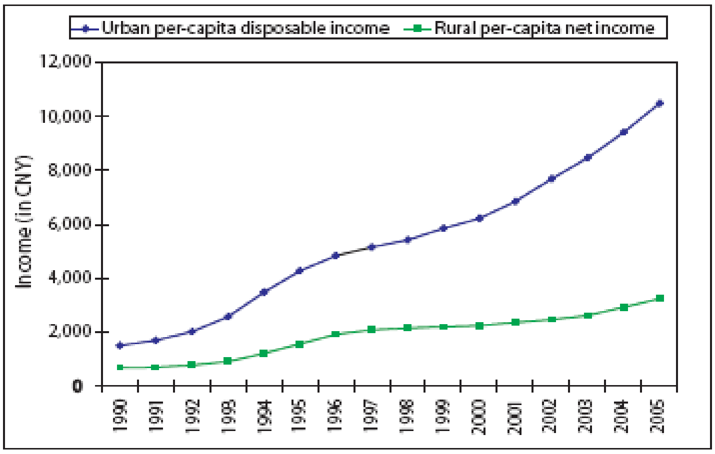
ANNEX

Actual and Projected Urban-Rural Population Trends, 1950-2030 (in millions)



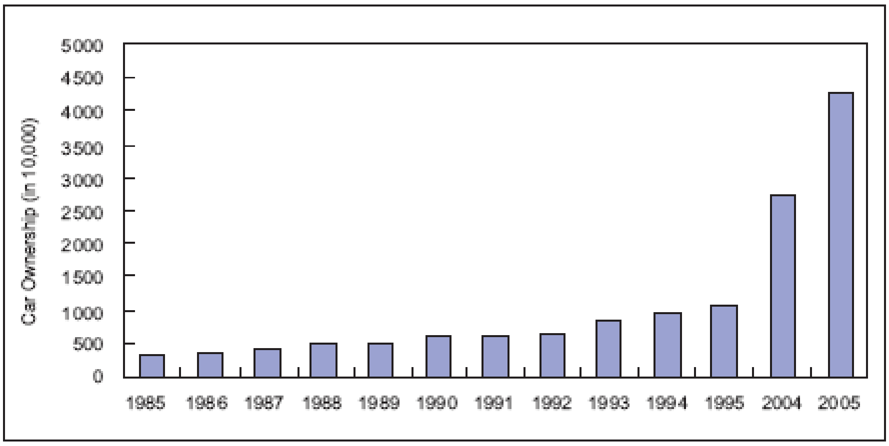
Source: ADB, 2006

Trends in Urban and Rural incomes, 1990-2005



Source: ADB, 2006.

Trends in car ownership, 1990-2005



Source: ADB, 2006

Appendix 5

Actor cooperation Sweden – China[35]

At present, there are several development-related cooperations between Swedish and Chinese actors and a history of contacts in the area of environment and climate change. Hence, this brief description is by no means exhaustive.

One can categorize the already existing co operations into four groups:

- i) Sida financed environmental projects with focus on capacity building
- ii) Promote environmental technology (EnviroTech) co operations
- iii) Research within the area of environmental economics and environmental technology
- iv) Municipal partnership

Focus in this brief analysis will be on group ii) – iv).

ii) Promote environmental technology (EnviroTech) cooperations[36]

SWENTEC[37] has done a mapping of all EnviroTech cooperations and how Swedish EnviroTech export to China could increase. The increase in Chinese environmental awareness, more developed environmental legislation, and lack of experience creates a window of opportunity for Swedish knowledge and know-how in the field of environmental technology. Out of 450 Swedish companies active in China, 30 companies have business connected to environment or environmental technology.

There are many organisations with the task to promote increase in export of Swedish environmental technology to China. One is the Sida-financed environmental technology centre CENTEC. Another is the Sino-Swedish Environmental Development Center (SEC).

Other "Swedish Chinese centers" planned to promote environmental technology:

- Wuhan, IVL
- Beijing, Sustainable Sweden SouthEast
- Beijing, KTH
- Wuhan, Borlänge Energi and IVL
- Guangshou, Sustainable Business Hub

For ongoing and planned actor/companies activities within the area of environmental technology see Annex I (in Swedish)

iii) Research within the area of environmental economics and environmental technology

[35] This brief analysis was carried out as a desk study in December 2008 at the request of Sida Stockholm (att: Åsa Hedén.) by Emelie Dahlberg and Anders Ekbom at Sida Helpdesk for Environmental Economics, University of Gothenburg as part of Sida-EEU's institutional collaboration on environmental economics and strategic environmental assessment with . The Environmental Economics Helpdesk has greatly benefited from information provided by Ms. Ping Höjding, First Secretary, Swedish Environmental Protection Agency /Embassy of Sweden. Comments are welcome and can be sent to emelie.dahlberg@economics.gu.se

[36] When nothing else is stated the information in this section comes from SWENTEC, 2007

[37] SWENTEC is the Swedish environmental technology council commissioned by the Swedish Government to strengthen and coordinate Swedish companies within environmental technology.

University of Gothenburg: The Environment for Development initiative is a capacity building program in environmental economics focusing on research, policy advice, and teaching in China and five other countries[38]. The EEU, Environmental Economics Unit, at University of Gothenburg, has initiated the EfD initiative and acts as coordinator and secretariat. The Environmental Economics Program at Peking University in China (EEPC) has three main tasks: building capacity of rigorous economic analysis into environmental policy in China, policy outreach, and graduate education that emphasizes systematic training in modern environmental economics. The research has a focus on forestry, payments of ecosystem services, agriculture and urban pollution. For more information please see http://www.efdinitiative.org/

KTH Royal Institute of Technology: KTH collaborates with IVL, SMTC (Stockholm Miljö-teknik center) in different environmental technology activities in China. KTH also has contacts with Chinese universities and the Shandong province, especially in Jinan and Nanjing.[39]

iv) Municipal partnership[40]

	Click on the links below for more information
Kalmarlän – Changxing, 2008	China Baltic Forum 2008
Kalmarlän – Changxing, 2007	Model for environmental cooperation
Kalmarlän – Changxing Government, 2006	Energy Management BRS-YDR
Borlänge – Wuhan, 2007	Environmental technology
Borlänge – Wuhan, 2007	Energy technology
Borlänge – Wuhan, 2006	Environment
Falkenberg – Shijiazhuang, 2007	Environment
Falkenberg – Shijiazhuang, 2007	Network for women

REFERENCES:

Environment for Development, 2008 http://www.efdinitiative.org/ available 2008-12-10

SALA-IDA, 2008, http://www.salaida.se/portal/kommunala-partnerskap/pdb-info available 2008-12-10

SWENTEC, 2007, *Hur kan svensk export av miljöteknik till Kina öka?*

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[38] Central America, Ethiopia, Kenya, South Africa, and Tanzania.
[39] SWENTEC, 2007
[40] SALA-IDA, 2008

ANNEX I

Pågående och planerade projekt/samarbeten

Aktör/initiativtagare	Aktiviteter	Plats	Tid	Beskrivning
SweDesign Connection	Möte med Ministry of Construction	Peking	Mars 2007	Möte mellan SweDesign Connection och Ministry of Construction
SweDesign Connection Sustainable Sweden SouthEast	3rd international Conference on intelligent Green and Energy Efficient Building & New Technologies and Production Actions	Peking	Mars 2007	SweDesign Connection inbjudna som enda utländska talare vid denna konferens
European Chamber of Commerce China	Workshop on Regulatory Policies and Technical Standards for Wind Power Development	Peking	Mars 2007	Workshop
European Chamber of Commerce China	"Environmental Tensions in Today's China"	Peking	Mars 2007	Monthly Dinner
Metso Paper	Kina-delegation	Kina	Maj 2007	Metso Paper delegation. Mest fokus på pappersindustrin, dock intressanta miljöaspekter
Generalkonsulatet i Shanghai	Säljande seminarium	Shanghai alt närheten av Shanghai	Augusti 2007 (förslag)	Uppföljning på rapporten ”A Study on Environmental Sector in Greater Shanghai Area 2007- 2010”
China/Shanghai City	Shanghai World Expo 2010	Shanghai	Maj-Oktober 2010	World Expo med fokus ”Better City – Better Life”
IVL ochTianjin Academy of Environmental Sciences	Joint Venture Centre F&U	Tianjin	De senaste 10 åren och framåt	Svenska miljöteknikföretag marknadsförs via direkta besök, mässor och seminarier. F&U-projekt av olika slag.
IVL	Various themes for collaborating with the Changxing County	Changxing County, Zhezhiangprovinsen	Nov 2006	Förslag på samarbete, dock ej slutgiltigt.
Borlänge Kommun, miljökontoret i Borlänge, Borlänge Energi och kommunen Wuhan IVL	Milötekniksamarbete inom ett flertal områden	Wuhan, Hubeiprovinsen	2000 och framåt	Samarbete inom VA, energi och avfallshantering, men även uppbyggnad av ett Miljöteknik-centrum.
UD och Exportrådet	The Sustainable City – review and action plan	Hohhot and Wuhai	2005 och framåt	MoC pekade ut två städer i inre Mongoliet. Studien finansierades av svenska regeringen.
UD och Exportrådet	Miljöteknikkontor (Sustainable City Office in Beijing)	Peking	Förhoppningsvis 2007 och framåt	Att med hjälp av svenska erfarenheter främja utvecklingen av hållbara urbana områden i Kina.
SweDesign Connection Sustainable Sweden Southeast AB	China-Sweden Sustainable Development Centre	Peking	2006 och framåt	Samarbete med Beijing Univiersity of Technology+ Ministry of Construction för att implementera svenska hållbara lösningar i Kina.
SweDesign Connection Sustainable Sweden SouthEast	”Swedish Sustainable Solutions in China”	By/samhälle utanför Peking	2007 och framåt	Byggnation av ett modernt samhälle utanför Beijing, med plats för 5000 invånare. Samarbete med Beijing University of Technology
SweDesign Connection	”Swedish Package”	Hela Kina	2007 och framåt	Samling av svenska miljötekniklevarantörer

Sustainable Sweden SouthEast				Med byggsektorn som målgrupp.
SweDesign Connection	Stadsplaneringsprojekt m.m. i Chengdu	Chengdu m.fl.	2006 och framåt	Samarbete i form av stadsplanering och enskilda projekt i ett flertal städer.
SWECO	”in-town-projekt” med ekologisk prägel	DongLi Hu, Tianjin	2006 och framåt	Ett stadsutvecklingsprojekt ”in-town-projekt” som kommer ge plats åt 30 00–40 000 invånare
SWECO	Eco-projekt på Chongming island	Chongming island, nordöst om Shanghai	2007 och framåt	Stadsutvecklingsprojekt med ekologisk satsning på Chongming island
Ahlqvist & Almqvist, HMXW och Landskapslaget	Stadsplan för Changsha	Changsha	2006 och framåt	En stadsplan för 25 000 invånare in Changsha
Envac	Automated waste collection	Shenzhen och Dongguan (båda i Guangdongprovinsen), samt Fujianprovinsen Och Tianjin	2006 och framåt	Ett antal miljörelaterade projekt i ett flertal städer och provinser, dock fortfarande i planeringsfasen
Envac och Jin Shazhou residential area	installation av 9 km2 automatiskt avfallshanteringssystem	Guangzhou	2006–2007	Automatiskt avfallshanteringssystem. Fler installationer är på gång.
Envac och Beijing Oil & Gas	Automatiskt köksavfallshanteringssystem	Peking	2007	Automatiskt köksavfallshanteringssystem, där avfall mals, torkas och kan spridas på åkrar som gödsel
Green Stream Network (nordiskt företag) och lokala myndigheter	Bio- och fjärrvärmeanläggning	Qiqihaer, Heilongjiangprovinsen	2006 och framåt	Bio- och fjärrvärmeanläggning med avsikt att stå färdigt i slutet av 2008, och om lyckat – ett flertal nya anläggningar.
Kalmar Kommun/ China Baltic Sea Business Forum	Pågående dialoger	Flertal platser i Kina	2006 och framåt	Efter China Baltic Sea Business forum pågår ett antal dialoger mellan regionala företag i Kalmar och kinesiska motparter.
Sustainable Business Hub/ Region Skåne	Bildandet av ”Sustainable Business Centre”	Guangzhou	2006 och framåt	Kinesisk samarbetspartner är Guangdongs provinsregering, Guangdong Association of Environmental Protection industry. Syftar till att exportera svensk miljöteknik.
Sustainable Business Hub/ Region Skåne	Bildandet av Nanhai National, Demonstration Eco-industrial Park	Nanhai	2006 och framåt	Ovan plus Nanhai National Demonstration Eco-industrial Park.
Sustainable Business Hub/ Region Skåne	Guangdong Pearl River Delta urban Environment	Foshan (Danzao Town)	2006 och framåt	Guangdongs provinsregering.
Respect Europe	Sustainable Solutions for cities	Bijie City/ Guizhou Province	Mars 2007	En besöksresa och prestudy genomförs. På resan deltar bl.a. Fortum, LVF, Stena Metall och Envac
KTH Skolan för Energi- och Miljöteknik	”Joint Centre for industrial Ecology” och demoanläggningar	Jinan, Nanjing	2007 och framåt	Universitetet + Shandong Province. Centret skall stärka forskningsutbytet och även vara en väg in för svenska milöteknikföretag på den kinesiska marknaden

Swentec, 2007