The People's Republic of China

Initial National Communication on Climate Change

中华人民共和国气候变化初始国家信息通报

Beijing . 2004

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Foreword

Global climate change is one of the key common concerns of the international community, which would have significant impacts not only on the global environment and ecosystem but also on many other social-economic domains of production, consumption and life-style of the human society. The United Nations Framework Convention on Climate Change (UNFCCC, hereinafter referred to as the Convention) clearly stipulates that all parties to the Convention, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities, should protect the climate system for the benefit of present and future generations of mankind, and the developed countries should take the lead in addressing climate change and its adverse impacts. The Convention also requires all Parties to submit national inventories of anthropogenic emissions by sources and removals by sinks of greenhouse gases, and develop, implement and publish the national program, which include measures to mitigate and adapt to climate change, promote the development and application of technologies for the mitigation and prevention of the anthropogenic emission of greenhouse gases, enhance the sinks of greenhouse gases, develop program to adapt to climate change and promote information exchange on climate change and measures to cope with it as well as education and training and raise the public awareness to climate change.

In accordance with the Convention, each party has the obligation to submit its national communication on climate change, including the national inventories of anthropogenic emissions by sources and removals by sinks, the overall description of the measures taken or envisaged for the implementation of the Convention as well as other information that the party considers suitable to submit. The Chinese government attaches great importance to the international obligation. In accordance with the Guidelines for the Preparation of Initial National Communications by Parties Not Included in Annex I to the Convention, China has completed, by consulting officials and experts from relevant government departments, social organizations, scientific research institutions, universities and enterprises, and with 3 years of efforts by over 400 experts from more than 100 organizations, the Initial National Communication on Climate Change of the People's Republic of China. The report was approved by the State Council after it was discussed and adopted by the National Coordination Committee on Climate Change.

This report covers national circumstances, national greenhouse gas inventory, impacts of climate change and adaptation, policies and measures related to climate change mitigation, research and systematic observation, education, training and public awareness, and needs for funds, technologies and capacity building, basically reflecting China's national situation. In accordance with the relevant provisions of the

Convention, the report provides a 1994 national greenhouse gas inventory in Chapter 2, and general descriptions in other chapters on China's situation of years up to 2000, with some up to 2003. The contents and nationwide data in this report do not cover that of the Hong Kong Special Administrative Region, the Macao Special Administrative Region and Taiwan Province except for division of administrative areas, territory and other points as specified.

Global climate change is the common challenge of the human society. China is ready to join the international community in addressing climate change under the framework of sustainable development. Chinese government's approval of the Kyoto Protocol has fully demonstrated China's willingness and determination to actively participate in promoting international environmental cooperation for global sustainable development. China will honor its commitments as it has under the convention, and hope that the international community will give full consideration to the need of funds and technologies stated in the report so as to further strengthen the capacity and capability of China in addressing global climate change.

Chapter 1 National Circumstances

1.1 Natural conditions and resources

1.1.1 Location, territory and administrative division

The People's Republic of China (hereinafter referred to as China) is located in the eastern hemisphere and the west coast of the Pacific, and in East Asia (Figure 1.1). It has a land territory of 9.6 million square kilometers and an adjacent sea area of some 4.73 million square kilometers. The whole country is divided into 23 provinces (including Taiwan), 5 autonomous regions, 4 municipalities directly under the central government and 2 special administrative regions of Hong Kong and Macao (Figure 1.2).

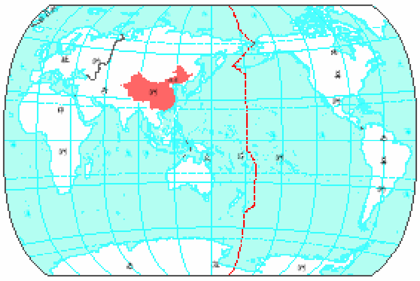


Figure 1.1 China's location in the world

Figure 1.2 The administrative divisions of the People's Republic of China

1.1.2 Climate and climate disasters

China's climate is characterized by the distinct continental monsoon climate and the complex climate types, which provides complex and multiple natural background and different environments for various human activities. In the meantime, it also frequently gives rise to natural disasters, threatening social and economic activities. East China is one of the regions in the world with typical monsoon climate. The warm and humid airflow, which the summer monsoon brings from the sea, carries abundant rainfalls and provides a desirable natural environment. However, a concentrated rainfall also tends to cause disasters such as floods, storms and storm tides. Located deep in the hinterland, Northwest China lacks surface water owing to its inactive water circulation, and has a typical continental dry climate, which results in a fairly fragile natural and ecological environment. Because of its high elevation, the Qinghai-Tibet Plateau has a special plateau climate with annual average temperature below 0 °C in most part.

The seasonal change of temperature in China is quite prominent. In most regions, there are 4 distinct seasons, with cold winter and hot summer. According to the temperature indicator, the country is divided into 5 zones from south to north, i.e. tropical, subtropical, warm temperate, temperate and frigid zones. The seasonal changes of temperature in most regions of China are fiercer than that of other regions in the world with the same latitude.

The temporal and spatial distribution of rainfall in China is of disequilibrium. Most rainfall occurs in summer. The rain and heat in the same season provides favorable conditions for agriculture. Nevertheless, the concentration of rainfall in a particular season and its imbalanced coverage always cause floods or droughts. The volume of rainfall in various regions differs vastly. The annual volume of rainfall in Southeast coastal regions may reach up to 1,500 mm, gradually decreasing towards the inland. In the Northwest regions inflicted by extreme drought, the annual volume of rainfall is less than 50 mm. In line with water conditions, regions to the south of the Qinling Mountains and Huaihe River are humid regions, accounting for 32% of China's total area. Most regions of Northeast and North China are semi-humid, accounting for 15% of the total area. The Inner-Mongolian Plateau and the Loess Plateau belong to semi-arid regions, accounting for about 22% of the total area. And the northwestern inland belongs to arid regions, accounting for about 31% of the total area.

China is seriously affected by climate disasters, which, with high frequency and intensity, involve large areas and cause great direct losses. Such climate disasters as floods and droughts cause the greatest direct losses, which account for over 76% of the total losses.

1.1.3 Physical features and topography

China's surface slopes down from west to east, and forms an obvious three-step staircase. The top of the staircase is the Qinghai-Tibet Plateau, with an average elevation of 4,000 to 5000 meters and accounting for a quarter of China's total area. To the north and east of the Qinghai-Tibet Plateau, the average elevation drops to 2,000 ~1,000 meters, which forms the second step, composed of the Inner Mongolia, Loess and Yunnan-Guizhou plateaus, and the Tarim, Junggar and Sichuan basins. The third step, generally below 500 meters in elevation, begins from the linear region of Greater Xing'an, Taihang, Wushan mountain ranges and the Yunnan-Guizhou Plateau eastward to the seacoast, composed of the undulating hills in the province of Liaoning, Shandong, Zhejiang, Fujian, Guangdong and Guangxi autonomous region, and the northeastern plain, the North China plain, the plains in the middle and lower reaches of the Yangtze River, and the Zhujiang River Delta (Figure 1.3). The east terrene of China are dotted with its inner sea, the Bohai Sea, and the adjacent seas----the Yellow Sea, the East China Sea and the South China Sea----with their depths gradually increasing from north to south. Beyond the long coastline are broad expanses of continental shelves.

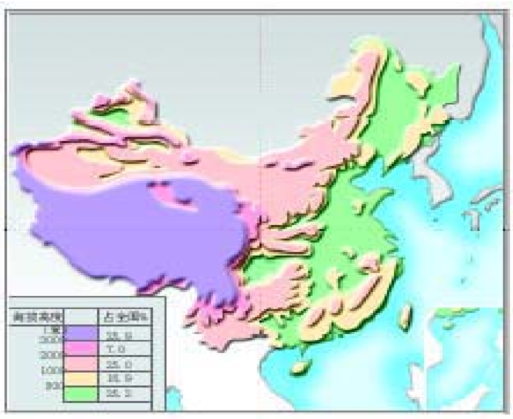


Figure 1.3 General situation of China's topography

Mountainous regions, undulating hills, and plateaus make up 66% of China's total area. The Everest mountain with an elevation of 8848 meters, located in the boundary of China and Nepal, is the highest mountain in the world. Meanwhile Takla Makan Desert, one of the largest deserts in the world, is located in the northwest of China.

1.1.4 Land resources

The composition and distribution of China's land resources have 3 major characteristics. First, there are various types of lands, with large area of cultivated land, forest grassland and desert. Second, mountainous areas and plateaus outnumber plains and basins. Third, the lands are not distributed in balance. Cultivated lands are chiefly located in the east and grasslands largely in the north and west, with forests mainly in the northeast southwest and the south.

In 2000, China had 130.04 million hectares of cultivated land; 108 million hectares of wasteland, of which 35.35 million hectares can be reclaimed for agriculture; 263.3 million hectares of lands for forestry, of which 63.03 million hectares can be afforested; 400 million hectares of grassland, of which 313.33 million hectares can be utilized (Figure 1.4).

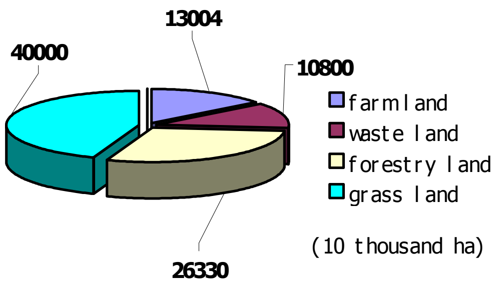


Figure 1.4 China's land resources in 2000

In 2000, China's average cultivated land area per person was 0.10 hectares, about 43% of the world average. The northeastern plain, the north China plain, the plains in the middle and lower reaches of the Yangtze River, the Zhujiang River delta and the Sichuan basin are the regions where cultivated lands, population and economic activities are mostly concentrated. Though large in area, China's grasslands have a relatively high percentage of high frigid and vast grasslands. Given the negative impacts of drought, deterioration of ecological environment, excessive grazing and land reclamation, the temperate-zone grasslands in the north are facing a crisis of degeneration and desertification.

1.1.5 Water resources

China is a country with a shortage of water resources and an uneven temporal and spatial distribution of it. The average gross volume of surface water resources over the last few years is 2,810 billion cubic meters and the per capita water resources is about one-fourth of the world average level. The average annual gross volume of rainfall over the last few years is 6,200 billion cubic meters, equivalent to 648mm-depth rainfall and about 20% less than the average annual rainfall in the land mass globally. As a result of climatic and topographic effects, rainfall is quite unevenly distributed regionally, showing a tendency of progressive decrease from the southeastern coastal areas to the northwestern islands. While the average annual rainfall of China's Taiwan province over the last several years is 2,535 mm , that of the Tarim and Qaidam Basins are less than 50 mm.

The volume of runoff of China's rivers and creeks is 2,710 billion cubic meters, accounting for 5.8% of the world's total volume. Of this, the replenishment volume of melting water from iced creeks is 56 billion cubic meters. The average volume of China's national underground water resources over many years is about 828.7 billion cubic meters. Of all the rivers within the Chinese territory, there are over 1,500 with drainage area more than 1,000 sq kilometers. Most rivers, including the Yangtze River, the Yellow River, the Heilongjiang River, the Zhujiang River, the Liao River, the Hai River, the Huai River, the Qiantang River, the Lancang River, etc run into the Pacific Ocean. The Nu River and the Yalu Tsangpo River flow into the Indian Ocean and the Erqis River, northwest of Xinjiang into the Arctic Ocean (Figure 1.5). China has a deposit of 676 million kilowatts of water resources, of which 379 million kilowatts are available for exploitation. With a mainstream length of 6,300 kilometers, the Yangtze River is China's longest and the world's third longest river. The Yellow River, with a mainstream length of 5,464 kilometers, is China's second longest river. The Beijing-Hangzhou Grand Canal is a gigantic water-conservancy project of ancient China. Starting from Beijing in the north and terminating in Hangzhou in the south, it has an overall length of 1,801 kilometers and is the longest canal in the world.

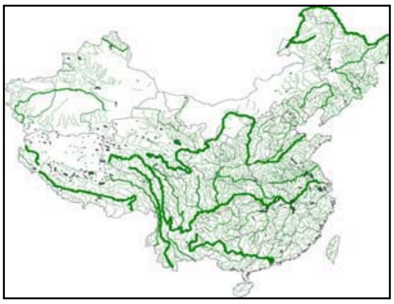


Figure 1.5 China's river basin system

1.1.6 Forest resources

In 1994, China's forest area was 128.63 million hectares, the standing volume was 10.868 billion cubic meters, of which the stock volume of forests accounted for 86%, with a volume of 9.31 billion cubic meters, and the forest coverage rate was 13.4%. In 2000, forest area increased to 158.94 million hectares, the stock volume of stumpage rose to 12.49 billion cubic meters, of which the stock volume of forests accounted for 90%, with a volume of 11.27 billion cubic meters, and the forest coverage rate reached 16.6% (Figure 1.6).

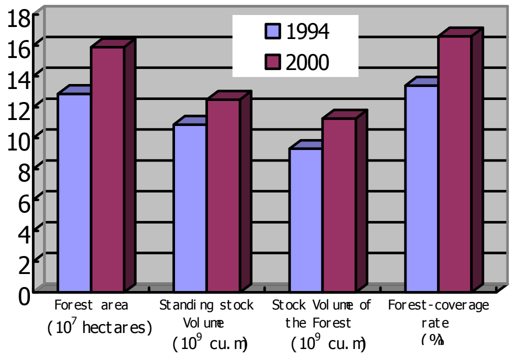


Figure 1.6 China's forest resources from year 1994 –2000

1.1.7 Energy and other mineral resources

In terms of China's proven conventional energy resources through exploration (including coal, oil, gas and hydro-energy, the latter being renewable energy, calculated on the assumption of 100 years usage), the aggregate volume of these resources that is available for development technologically exceeds 823 billion tons of coal equivalent, representing 2.5% of those in the world. The reserve volume that remains to be developed economically is 139.2 billion tons of coal equivalent, about 10.1% of the world's total. The energy resources per person are less than half of the world average. The total proven reserves of energy resources are composed of the following resources: crude coal 87.4%, crude oil 2.8%, natural gas 0.3%, hydro-energy 9.5%. The remaining exploitable energy is shown as follows: crude coal 58.8%, crude oil 3.4%, natural gas 1.3% and hydro-energy 36.5% (Figure 1.7).

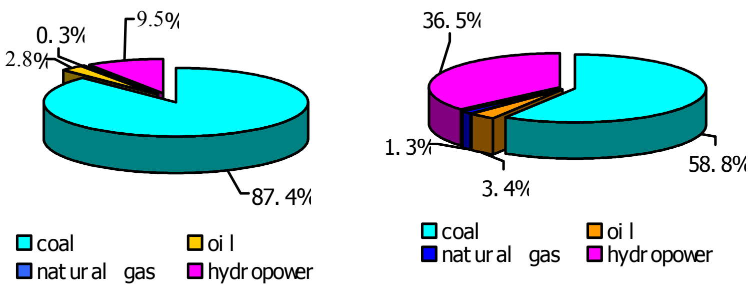


Figure 1.7 Composition of aggregate volume of China's proven energy resources and remaining exploitable energy resources

China has discovered 168 varieties of minerals, and nd 153 of them with proved reserves. There are 8 energy-related minerals, 54 metallic minerals, 88 non-metallic minerals and 3 liquid minerals.

1.1.8 Marine resources

China borders on the Bohai Sea, the Yellow Sea and the East China Sea in the east and the South China Sea in the south. The total sea area amounts to about 4.73 million sq kilometers. The continental coastline extends over 18,000 kilometers. There are more than 6,500 oceanic islands with an area over 500 sq meters. The sea-beach area is 20,800 sq kilometers and that of the coastal zone is 280,000 sq kilometers. China has a many varieties of marine resources and is rich in marine organism, oil and natural gas, solid minerals, renewable energy and coastal tourist resources, all of which have a great potential for further development. Of the above, marine organism runs to over 20,000 varieties including more than 3,000 types of marine fish. The deep-water coastline extends over 400 kilometers with more than 60 deep-water ports. There are 124,000 sq kilometers of shallow sea areas ranging from 0 to 15 meters in depth. In addition, in the international seabed area, China is in possession of a 75,000 sq kilometers area of metal combination mining area. Until year 2000, China has set up 69 natural protective areas with the sea and the ecological systems along the coast plus rare marine fauna and flora as the main objects for protection, the total area of which is 13,000 sq kilometers.

1.1.9 Biodiversity

China's vast territory, broad sea area and the complex and diverse natural conditions breed highly abundant species of fauna and flora and microorganism. It is among the richest countries of the world in species. China has 599 types of land ecosystem, 32,800 kinds of higher plants, including 17,300 types of unique higher plants, about 6,300 kinds of vertebrates and 667 kinds of special species. China is abundant in biological species in the marine space, amounting to 20,278 types that have been evaluated. China also boasts of a number of rare animals and plants such as panda, white-flag dolphin, dawn redwood and ginkgo, which are referred to as living fossils. It has over 1,900 varieties and kinds of domestic animals, over 50,000 local strains of rice, over 20,000 strains of soybeans and more than 1,000 seedlings of cash/economic trees. The various kinds of crops, the multiple breeds of domestic animals, the wild prototype and close inbreeding etc. constitute a gigantic pool of resources with their various forms of heredity.

1.2 Population and society

1.2.1 Population

China has the largest population country in the world, which is 119.85 million and accounts for 21.3% of the world population by the end of 1994. At the end of 2000, the number rose to 126.743 million, occupying 21% of the world population.

China's population is distributed quite unevenly in location. In eastern China where the population density is high, especially in the coastal regions, there are 300 or more people per sq km, or more than 800 in some localities. In western China where the population density is low, there are 40 or so people per sq km. On the basis of 1994 statistics, the number of population in Northeast, North, East and Central South China constituting 44% of the territory, makes up 77.2% of the national total population.

China is a united multi-ethnic nation of 56 ethnic groups. The Han nationality is the most populous nationality, accounting for 91.6% of the entire population in 2000. The minority nationalities make up the remaining 8.4%.

Since the 1970s, the implementation of the family-planning policy has made it possible for China to bring the momentum of an excessively fast population growth under control (Figure 1.8). The natural growth rate of population has declined from 25.83‰ in 1970 to 11.21‰ in 1994, which is noticeably lower than the world's average rate of 16‰ during the corresponding period. In 2000, China's natural growth rate of population showed a further decline to 7.58‰ (Figure 1.9).

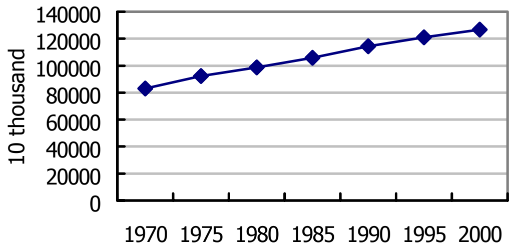


Figure 1.8 Change of China's population from 1970 to 2000

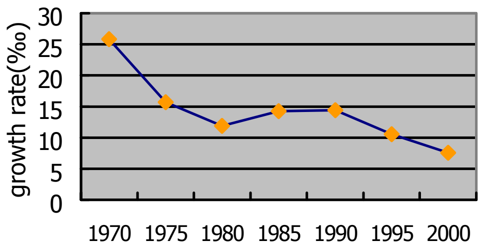
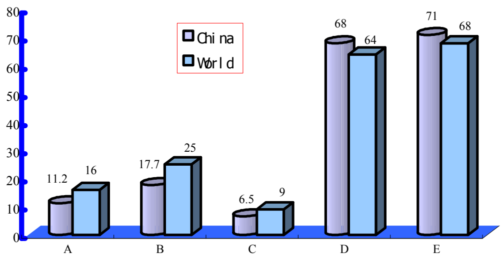


Figure 1.9 Changes of China's growth rate of population during 1970-2000

With the improvement of the living standard of the people, the average life expectancy of the Chinese people has also steadily increased. Statistics in 1994 showed 68 for men and 71 for women (Figure 1.10). These figures rose to 69.6 and 73.3 respectively in 2000, significantly higher than the world average (Table 1–1). Nevertheless, China still has a fairly long way to go before it can catch up with the developed countries in this regard.



A:growth rate(‰) B: birth rate(‰)

Figure 1.10 Comparison of population growth and life spans between China and the world in 1994

The level of China's urbanization in 1994 was 28.5%, far lower than the world average. With the rapid economic growth, China has experienced a remarkable urbanization process. The figure of 2000 in this regard rose to 36.2% and is expected to be higher in the years to come.

Table 1-1 International comparison of China's population growth in 2000

	Population growth rate (‰)	Birth rate (‰)	Mortality rate (‰)	Expected average life expectancy (men, age)	Expected average life expectancy (women, age)
China	7.6	14.0	6.5	69.6	73.3
World	12.4	21.5	9.1	64.6	68.6

1.2.2 Employment

Employed people in l994 was 674.55 million in China, and the number in the primary, secondary and tertiary industries are 366.28 million, 153.12 million and 155.15 million, accounting for 54.3%, 22.7% and 23% of the total respectively. Labor force in the primary industry takes up over half of the national total labor force. Those working in urban area are 186.53 million and those working in rural areas are 488.02 million. Therefore, the ratio of employed persons between the urban and rural areas was 27.4 : 72.6.

In the 1990's, about 20 million persons were borne annually. Net growth of population annually is about 14 million. In other words, more than 20 million people in China reach the age of employment every year.

In 1994, the number of staff and workers in the whole country is 148.49 million. The number of the increased employed persons in urban areas is 7.15 million. The number of unemployed persons in urban areas is 4.764 million. Unemployment rate in urban areas is 2.8%.

The number of employed persons in 2000 was 720.85 million, of which the number of employed persons in the primary, secondary and tertiary industry was 360.43 million, 162.19 million and 198.23 million respectively, accounting for 50%, 22.5% and 27.5% of the total (Table 1-2).

Table 1-2 Change of employment structure of China's labor force from 1994 to 2000

Year	Primary industry (%)	Secondary industry (%)	Tertiary industry (%)
1994	54.3	22.7	23.0
2000	50.0	22.5	27.5

1.2.3 Education

In 1994, China had 128.226 million students enrolled in primary schools, 57.071 million in regular secondary schools and 2.799 million in regular institutions of higher education. On the average, there are 23.4 college students, 476 secondary school students and 1,070 primary school students for every 10,000 people. In 2000, the number of China's enrolled students was 130.133 million in primary schools, 85.185 million in regular secondary schools and 5.561 million in regular institutions of higher education. On the average, there are 43.9 college students, 660 secondary school students and 1,028 primary school students for every 10,000 people.

China has an elementary education system of the largest scale in the world, but does not have sufficient funds for education. In 1994, education expenditures for the whole society amounted to 148.88 billion Yuan, of which 117.47 billion Yuan were from fiscal budget for education. According to the data from the 2000 population census, China had 85.07 million illiterate people, the illiterate rate being 6.72%. Therefore, China has an arduous task in developing science, technology, culture and education.

1.2.4 Medical care and public health

In 1994, China had 192,000 institutions of public health, 4.199 million health workers. Health-care institutions had 3.13 million beds. There were 15.7 doctors and 23.6 beds in hospitals and clinics for every 10,000 people.

In 2000, China had 325,000 institutions of public health, 4.491 million health workers. Health-care institutions had 3.18 million beds. There were 16.8 doctors and 23.8 beds in hospitals and clinics for every 10,000 people. Apparently, China still has a long way to go before its standard of medicare and medical facilities can match that of the world average, especially that of the developed countries(Table 1-3).

Table 1-3 Comparison of medical infrastructure facilities between China and high-income countries in 2000

	Number of doctors for every 10,000 people	Number of hospital beds for every 10,000 people
China	16.8	23.8
World	30[(1)]	74

Note: [(1)] figure of 1999

1.2.5 Poverty

With its low-level economic development, China has a large number of poverty-stricken people over many years in rural areas. Since 1986, the Chinese Government has taken a series of major steps to strengthen poverty-relief work. Thanks to persistent efforts, in keeping with the poverty standard set by China, the number of poverty-stricken people in the rural areas was reduced from 125 million in 1986 to 70 million in 1994, with an annual reduction of 6.88 million people on the average. In 2000, the number was further reduced to 30 million (Figure 1.11). A considerable number of the poverty-stricken people, whose food and clothing are yet to be provided steadily, inhabit in "zones of natural barriers" that are unfit for human survival or in places where environment and ecosystem are seriously overloaded. For them, poverty reduction is a fairly difficult task.

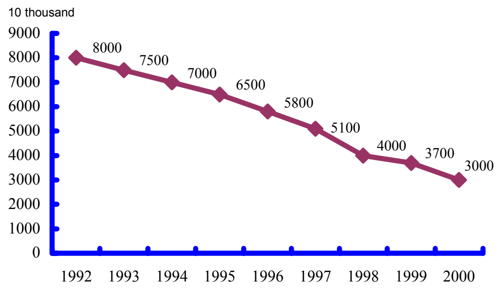


Figure 1.11 Trend of change on China's poverty-stricken population

1.3 Economic development

1.3.1 Level of economic development

China is a low-income developing country. The GDP in 1994 was 4675.9 billion Yuan and the per capita income was 3,901 Yuan (equivalent to $453). The GDP in 2000 was 8946.8 billion Yuan with the per capita income rising to 7,086 Yuan (equivalent to $856), which was 1/6 of the world's average level and 1/30 of the high-income countries. In 1994, China leads the world in the production of grain, meat, cotton, peanuts and rapeseed. Of the industrial products the output of coal, cement, cotton cloth and TV sets rank first in the world. That of steel, electricity, chemical fertilizer and chemical fiber ranked second, and that of crude oil ranks third of the world.

In 2000, the China's per capita level of major products was higher than that in 1994. The per capita level of iron and steel, crude oil, electricity was still lower than that of the world average, while that of cement output was higher than that of the world (Table 1-4).

Table 1-4 Comparison of China's per capita output of major products with world average level

Item	Unit	1994		2000	
		China	World average	China	World average
Steel	Kg	77	128	101	119
Crude oil	Kg	121	440	129	587
Cement	Kg	351	226	472	248
Coal	Kg	1035	794	790	813
Electricity	KWh	774	2128	1073	2448
Grain	Kg	329	334	323	338

1.3.2 Economic structure

In 1994, the proportions of added value of primary, second and tertiary industries to GDP in China was 20.2 : 47.9 : 31.9 while the proportions in 2000 was 16.4 : 50.2 : 33.4 (Figure 1.12). The proportion of the primary industry in GDP fell by 3.8 percentage points and that of the tertiary industry rose by 1.5 percentage points from 1994 to 2000.

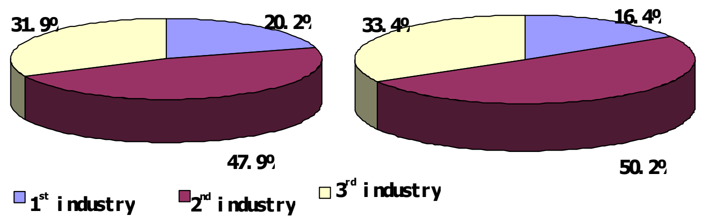


Figure 1.12 China's economic structure

In 1994, the ratio of China's agriculture, forestry, animal husbandry and fishery was 58.2 : 3.9 : 29.7 : 8.2 while in 2000 it was 55.7 : 3.8 : 29.6 : 10.9.

In 1994 the total output value of industrial enterprises with independent accounting was 5135.3 billion Yuan, of which the output from light and heavy industries made up 42.2% and 57.8% respectively. In 2000, the total output value of all state-owned and non state-owned and large-scale enterprises reached 8567.4 billion Yuan, of which the output from light and heavy industries made up 39.8% and 60.2% respectively.

The value added of the tertiary industry rose from 1493 billion Yuan in 1994 to 2990.5 billion Yuan in 2000 (Table1-5), with changes taking place in its structure.

Table 1-5 Sectors contributing to the added value of China's tertiary industry

(Unit %)

Industrial sectors	1994	2000
Communication and transport, storage and post and telecommunications	18.0	18.1
Whole-sale, retail and catering	27.1	24.5
Finance and insurance	18.5	17.4
Real Estate	5.8	5.7
Social services	8.0	10.9
Other sectors	22.6	23.4

1.3.3 Income and consumption level

In 1994, the per capita net income of rural residents was 1,221 Yuan. The per capita annual disposable income of urban households was 3,496 Yuan. The per capita dwelling area of rural residents was 20.2 square meters and the per capita building area of urban residents was 15.7 square meters. In 1994, the average level of consumption of Chinese residents was 1,737 Yuan, of which that of the farmers was 1,087 Yuan and that of non-agricultural residents was 3,956 Yuan.

In terms of material consumption, China's per capita consumption of major products remained fairly low. With the growth of the economy, the level of consumption will have increase steadily. This newly-increased amount of consumption needs to be addressed through the expansion of the production output. In 1994, there was 0.8 automobile for every hundred Chinese persons, representing approximately 1.3% of the average level of the developed countries. On the average, every hundred households of the urban areas had 62.1 refrigerators, 87.3 washing machines, 86.2 color TV sets. The per capita energy consumption throughout the country was 721 kilograms of oil equivalent. The per capita consumption of electricity for daily life was 72.7kWh.

In 2000, the per capita net income of rural households was 2,253 Yuan. The per capita disposable income of urban households was 6,280 Yuan. The average level of consumption of residents was 3,397 Yuan, representing 12.4% of the world average level, 2.3% of high-income countries' level, and 32.3% of medium-income countries' level. Every hundred people had 1.3 automobiles, representing about 2% of that of the developed countries. On the average, every hundred households of rural residents had 80.1 refrigerators, 90.5 washing machines, 116.6 color TV sets. The per capita energy consumption throughout the country was 905 kilograms of oil equivalent, representing 53% of the world average level (Figure 1.13). The per capita consumption of electricity for daily life was 132.4 kWh.

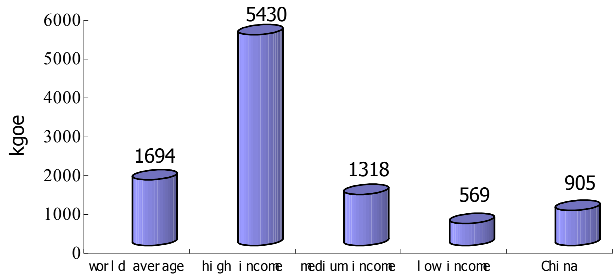


Figure 1.13 Comparison of per capita energy consumption between China and the world

1.3.4 Regional development

There is a sharp imbalance in regional economic development that characterises China's economy as a whole. The development level in the eastern coastal regions is much higher than that of the west and middle regions; and the gap of regional economic development has a tendency toward further widening. The GDP of the eastern coastal regions in 1994 accounted for 57.1% of the total national GDP while that in 2000 rose to 59.4% (see table 1–6).

Table 1-6 Changes of development gaps between the east, the middle and the west region of China

Area	1994			2000		
	GDP (Billion Yuan)	Percentage (%)	Per Capital (Yuan)	GDP (Billion Yuan)	Percentage (%)	Per Capital (Yuan)
The East	2660.8	57.1	5438	5774	59.4	10.768
The Middle	134.15	28.8	3147	2626.6	27.0	5978
The West	656.2	14.1	2402	1320.3	13.6	4606

1.3.5 External economy and trade

In 1994, the China's total value of imports and exports reached 236.62 billion USD, of which exports reached 121.1 billion USD, while imports were 115.61 billion USD. The China's total volume of imports and exports accounted for 2.8% of the global total. In 2000, the China's total volume of imports and exports rose to 474.29 billion USD, with exports of 249.20 billion USD and imports of 225.09 billion USD, and the total volume of imports and exports accounting for 4.0% of the global total. In terms of product structure, ever since 1980 the ratio of primary products in the total export volume has been greatly decreased, whereas that of industrial finished products has been continuously increasing (Table 1-7).

Table 1-7 Ratio changes in primary and medium products and industrial finished products in China's import and export products

Date	Amount of Imports & Exports (Billion USD)		Ratio of Primary Products (%)		Ratio of Industrial Finished Products (%)	
	Imports	Exports	Imports	Exports	Imports	Exports
1980	20.2	18.12	34.8	50.3	65.2	49.7
1990	42.25	27.35	12.4	50.6	87.7	49.5
1994	115.61	121.1	14.2	16.3	85.8	83.7
2000	225.9	249.2	20.8	10.2	79.2	89.8

In 1994, 24.39 million tons of coal were exported, while 1.22 million tons were imported; 18.94 million tons of crude oil and 3.78 million tons of refined oil were exported, while the net import of crude oil was as high as 12.35 million tons. In 2000, 55.07 million tons of coal were exported; 10.31 million tons of crude oil and 8.27 million of refined oil were exported; the imported crude oil increased to 70.27 million tons and the imported refined oil increased to 18.05 million tons.

In 1994, total amount of foreign capital actually utilized reached 43.2 billion USD, in which 33.8 billion USD were foreign direct investments. In 2000, the foreign capital actually utilized totaled 59.4 billion USD, in which 40.7 billion USD were foreign direct investments.

1.4 Brief introduction of the major sectors

1.4.1 Energy

China's primary energy production and consumption is mainly in coal. In 1994, China's total primary energy consumption stood at 1.23 billion tons of coal equivalent, in which coal consumption was 1.29 billion tons, accounting for 75.0% of total.

In 2000, China's total primary energy consumption was as high as 1.3 billion tons of coal equivalent, in which coal was 66.1% (see table 1 – 8). Out of the aggregate consumption, the agricultural sector accounted for 4.4%, the industrial sector 68.8%, the transportation, post and telecommunication sector 7.6%, household consumption 14.4% and the others 4.8%.

Table 1- 8 The structure of China's consumption of primary energy

Year	Total Energy Consumption (billion tons of coal equivalent)	Overall Energy Consumption Percentage (%)			
		Coal	Petroleum	Natural Gas	Hydro-power & Nuclear Power
1994	1.22737	75	17.4	1.9	5.7
2000	1.30297	66.1	24.6	2.5	6.8

The petroleum consumption accounted for 17.4% of the overall primary energy consumption in 1994 and increased to 24.6% in 2000, natural gas consumption rose from 1.9% in 1994 to 2.5% by 2000, while the hydraulic power and nuclear electricity consumption increased from 5.7% to 6.8%.

China's per capital energy consumption in 1994 was 1.02 tons of coal equivalent while the energy consumption per unit of GDP was 4.15 tons of coal equivalent /10,000 Yuan (constant price in year 1990). Per capita energy consumption in 2000 was 1.03 tons of coal equivalent while the energy consumption per unit of GDP was 2.68 tons of coal equivalent /10,000 Yuan (see table 1-9).

Table 1-9 Major indicators of China's energy consumption in 1994 and 2000

Year	Per Capita Energy Consumption (kg)	Energy Consumption of GDP (Tons of coal equivalent /10,000 Yuan, Constant Price in 1990)
1994	1029.8	4.15
2000	1031.9	2.68

1.4.2 Electric power

China's power industry has initially been established mainly based on thermal power generation, supplemented by the hydro-power generation and then by the nuclear power generation and power generations from other new energies; the scale of the power plants is expanding and the installation capacity is constantly increasing, therefore, large power plants and large power generation units have played a major role in the power grid.

China's overall installed capacity of power generation in 1994 was 199.90 million kilowatt while in 2000 rose to 319.32 million KW, in which the overall installed capacity of hydro-power increased from 49.06 million KW in 1994 to 79.34 million KW in 2000, and that of thermal power rised from 148.74 million KW to 237.53 million KW. Out of the overall installed capacity of power generation in 2000, the share of hydropower was about 25% and thermal power 74%. At present, there are still 30 million people with no electricity available.

China's overall power generation in 1994 stood at 927.8 billion KWh with the hydropower 166.8 KWh and thermal power 747.70 billion KWh, accounting for 18.0% and 80.5% respectively of the overall power generation. China's overall power generation in 2000 was 1368.5 billion KWh, with the hydropower 243.1 billion KWh, thermal power 1107.9 billion KWh, and nuclear power 16.7 billion KWh, representing 17.8%, 81.0% and 1.2% of the total power generation respectively.

In 1994, China's power transmission lines of 220 kilovolts or above spanned as long as 107337 kilometers and its power transformation capacity was as much as 208.51 million kilovolt-ampere (KVA). The power transmission lines of 220 kilovolts or above in 2000 extended to 163620 kilometers and its power transformation capacity was 414.89 million KVA.

1.4.3 Transport

China's transportation system is composed of 5 transport means: railways, highways, water transport, civil aviation and pipelines, all of which made a headway to a various extent between 1994 and 2000 (Table 1 –10). With the continued enhancement of urbanization, the urban public transport in China as a whole has seen a rapid growth.

Table 1-10 China's major transportation means

Item	Unit	1994	2000
Length of Railways in Operation	km	59000	68700
of which: Electrified Railways	km	9000	14900
Length of Highways	km	1117800	1402700
Number of Civil Aviation Routes	Lines	727	1165
of which: International Routes	Lines	84	133
Total Length of Civil Aviation Routes	km	1045600	1502887
of which: International Routes	km	352000	508405
Length of Navigable Inland waterways	km	102700	119300
Length of Petroleum and Gas Pipelines	km	16800	24700

In 1994, the total passenger traffic (TPR) in China was 10.929 billion persons. In 2000, this number increased to 14.786 billion. The share of railway TPR decreased from 9.95% in 1994 to 7.11% in 2000, while the share of highway TPR increased from 87.29% to 91.13% (Table 1-11).

Table 1-11 Total passenger traffic (TPR) change in China

(Unit: 10,000 persons; %)

Year	TPR	Railways		Highways		Water transport		Civil aviation	
		TPR	percentage	TPR	percentage	TPR	percentage	TPR	percentage
1994	1092883	108738	9.95	953940	87.29	26165	2.39	4038	0.37
2000	1478573	105073	7.11	1347392	91.13	19386	1.31	6722	0.45

In 1994, total passenger-kilometers in China was 859.1 billion passenger-km. This number increased to 1226.1 billion passenger-km in 2000. The share of railway decreased from 42.32% to 36.96%, the share of highway increased from 49.12% to 54.30%, and the share of civil aviation increased from 6.42% to 7.91% (Figure 1.14).

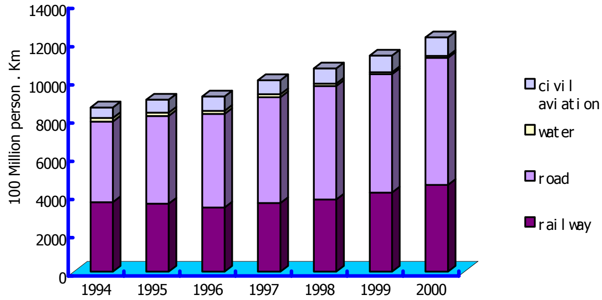


Figure 1.14 China's total passenger-kilometers from 1994 to 2000

Total freight traffic (TFR) in China rose to 13.581 billion tons in 2000 from 11.803 billion tons in 1994. About 75% of the TFR was taken by highways, while railways and water transport took respectively 13% and 9% (Table 1-12).

Table 1-12 Total freight traffic change in China

(Unit: 10,000 tons; %)

Year	TFR	Railways		Highways		Water transport		Civil aviation		Pipelines	
		TFR	percentage	TFR	percentage	TFR	percentage	TFR	percentage	TFR	percentage
1994	1180273	163093	13.82	894914	75.82	107091	9.07	82.9	0.01	15092	1.28
2000	1358124	178023	13.11	1038813	76.49	122391	9.01	196.7	0.01	18700	1.38

China's total freight ton-kilometers (TFTK) increased from 3326.1 billion ton-km in 1994 to 4421.2 billion ton-km in 2000. The railway TFTK proportion decreased from 37.45% in 1994 to 31.27% in 2000; the water transport proportion, including by oceans, off-shores and inland rivers , increased from 47.16% to 53.39%; and highway TFTK proportion was kept at about 13%.

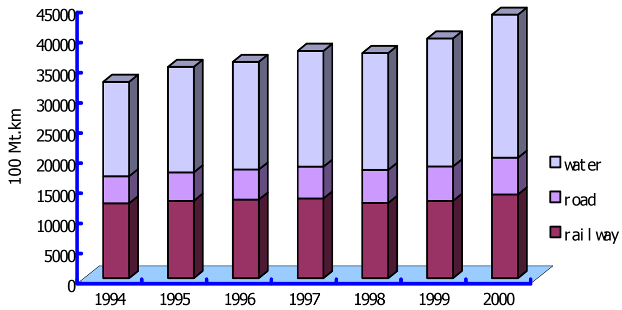


Figure 1.15 China's total freight ton-kilometers of major forms of transport from 1994 to 2000

By the end of 1994, the total number of locomotives in the railway system in China was 15085, of which 4928 were steam locomotives, 7801 diesel locomotives, and 2356 electric locomotivs; the total number of civil vehicles was 9419500, of which 3497400 were passenger vehicles and 5922100 various cargo-carrying trucks; the number of farming vehicles (tyre-tractors, etc.) was 5850000; the number of other motor vehicles was 12.09 million, of which 10940000 were motorcycles; and the total number of civil aircrafts was 681.

By the end of 2000, the total number of locomotives in the railway system in China was 15253, of which 911 were steam locomotives, 10826 diesel locomotives, and 3516 electric locomotives; the total number of civil vehicles was 16.09 million, of which 8.54 million were passenger vehicles and 7.55 million various cargo-carrying trucks; the number of farming vehicles (tyre-tractors, etc.) was 8.21 million; the number of other motor vehicles was 41.68 million, of which 37.72 million were motorcycles; and the total number of civil aircrafts was 982.

1.4.4 Agriculture

In 1994, there were 326.9 million rural laborers in farming, forestry, animal husbandry and fishery, with a gross output value of 1575.05 billion Yuan, of which gross output value in farming was 916.92b Yuan, accounting for 58.2% of the total. In 2000, there were 327.975 million rural laborers in farming, forestry, animal husbandry and fishery, with a gross output value of 2491.58 billion Yuan, among which the gross output value in farming was as much as 1387.36 billion Yuan, accounting for 55.7% of the gross output value in farming, forestry, animal husbandry and fishery.

In 1994, total sown area of farm crops was 148.241 million hectare, of which the area of grain crops took 109.544 million hectare, including the area of cereal planting, which was 87.537 million hectare. Total output of grain reached as high as 445.101 million tons, with the output of cereal of 393.891 million tons included. Rice growing in China plays an important role in the crop plantation as a whole, in 1994, the area of rice planting was 30.17 million hectare, accounting for 27.5% of the area of grain crops. In 2000, total sown area was 156.3 million hectare, of which the area of grain crops accounted for 108.463 million hectare, including the area of cereal planting of 85.264 hectare. (Rice planting area is 29.96 million hectare, making up 27.6% of the grain crop area). The total output of grain was 462.175 million tons, with an output of 405.224 million tons of cereal included.

In 1994, total agricultural machinery power in China was 338.025 million kilowatts, with the total power of agricultural tractors being 98.632 million kilowatts. In 2000, total agricultural machinery power in China was 525.736 million kilowatts, with the overall power of agricultural tractors reaching 145.382 million kilowatts.

Total consumption of chemical fertilizers increased from 33.179 million tons in 1994 to 41.464 million tons in 2000. Total consumption of nitrogen fertilizers increased from 18.82 million tons to 21.616 million tons, while the proportion of consumed chemical fertilizers decreased from 56.7% to 52.1% (Table 1-13).

Table 1-13 Consumption of chemical fertilizers on farmlands in China

(Unit: 10000 tons)

	1994	1995	1996	1997	1998	1999	2000

Chemical fertilizers	3317.9	3593.7	3827.9	3980.7	4083.7	4124.3	4146.4
Nitrogen fertilizers	1882.0	2021.9	2145.3	2127.7	2233.3	2180.9	2161.6

There is a large number of livestock in China. Total large animals on hand were 149.187 million heads at the end of year 1994. By the end of 2000, that number has risen to 151.515 million, with an increase of cattle, pigs and sheep by 5.2%, 7.8%, and 20.7% over 1994 respectively (Table 1-14).

Table 1-14 Number of major livestock on hand in China

(Unit: 10000)

Year	Cattle	Horses	Donkeys	Mules	Camels	Pigs	Sheep
1994	12231.8	1003.8	1092.3	555.2	35.6	41461.5	24052.8
2000	12866.3	876.6	922.7	453.0	32.6	44681.5	29031.9

1.5 Strategies and objectives of national development

In the first two decades of this century, China will devote itself to building a well-off society of higher standard in an all-round way to the benefit of more than one billion people. China will further develop the economy, improve democracy, make advancement in the science and education, enrich the culture, foster the social harmony, and upgrade the texture of life for the people. Building on what is already achieved at this stage and continuing to work for several more decades, China will have in the main accomplished the modernization program and turned into a strong, prosperous, democratic and culturally advanced socialist country by the middle of this century.

The objectives of building a well-off society in an all-round way are as follows:

-- On the basis of optimized structure and better economic returns, efforts will be made to quadruple the GDP of the year 2000 by 2020, and China's overall national strength and international competitiveness will increase markedly. China will in the main achieve industrialization and establish a full-fledged socialist market economy and a more open and viable economic system. The proportion of urban population will go up considerably and the trend of widening differences between industry and agriculture, between urban and rural areas and between regions will be reversed step by step. China will have a fairly sound social security system. There will be a higher rate of employment. People will have more family property and lead a more prosperous life.

-- Socialist democracy and the legal system will be further improved. The basic principle of rule of by law will be implemented completely. The political, economic and cultural rights and interests of the people will be respected and guaranteed in real earnest. Democracy at the grassroots level will be better practiced. People will enjoy a sound public order and live and work in peace and contentment.

-- Ideological and ethical standards, scientific and cultural qualities, and the health of the whole people will be enhanced notably. A sound modern national educational system, scientific, technological and cultural innovation systems as well as nationwide fitness and medical and health systems will take shape. People will have access to better education. China will make senior secondary education basically universal in the country and eliminate illiteracy. A learning society in which all the people will learn or even pursue life-long education will emerge to boost their all-round development.

-- The capability of sustainable development will be steadily enhanced. The ecological environment will be improved. The efficiency of using resources will be increased significantly. China will enhance harmony between man and nature to push the whole society onto a path to civilized development featuring the growth of production, an affluent life and a sound ecosystem.

According to *the Outline of the Tenth Five-Year Plan for National Economic and Social Development of the People's Republic of China*, which is now under implementation, from 2001 to 2005, China's natural population growth rate will be controlled within 9‰. The total population of the whole country in 2005 will be controlled within 1.33 billion. The annual economic growth rate on average is expected to be around 7%. By 2005 the GDP calculated at the price of 2000, will reach about 12500 billion RMB Yuan, while the per capita GDP will be 9400 RMB Yuan. The proportions of the added value of primary, secondary and tertiary industries to GDP will account for 13%, 51%, and 36% respectively, while the proportions of the employees in those industries will respectively occupy 44%, 23%, and 33%. The average annual growth rate of per capita disposable income of urban dwellers and per capita net income of rural residents will reach by around 5%. The forest coverage rate will rise to 18.2%. The performance of the Plan in the past few years shows that both economic and social development will be faster than expected.

1.6 Institutional arrangement for the preparation of Initial National Communication

China attaches great importance to climate change issues. As early as 1990, a Coordination Committee was established under the then Environmental Protection Committee of the State Council. Mr. Song Jian, State Councillor, chaired the Committee. Office of the Committee was in State Meteorological Administration. During the governmental restructure in 1998, the National Coordination Committee on Climate Change(NCCCC), chaired by Mr. Zeng Peiyan, Chairman of State Development and Planning Committee, was set up. The update of NCCCC, was approved by the State Council in 2003, and Mr. Ma Kai, Chairman of the National Development and Reform Commission (NDRC), was appointed as the chairman of the Committee. Under the coordination of the Committee, the Chinese Government has participated actively in the climate change negotiations and the work of the Intergovernmental Panel on Climate Change. These efforts have made contributions to the effective implementation of sustainable development strategy and mitigation of and adaptation to climate change.

In accordance with the decisions of NCCCC, NDRC is responsible for the preparation of China's Initial National Communication on Climate Change, including national greenhouse gas inventory.

The major institutions involved in the development of the national greenhouse gas inventory include: the Energy Research Institute (ERI) of NDRC, Institute of Atmospheric Physics (IAP) of Chinese Academy of Sciences, Forest Ecology & Environment Institute (FEEI) of Chinese Academy of Forestry, and Center for Climate Impact Research (CCIR), Chinese Research Academy of Environmental Sciences, Agrometeorology Institute of Chinese Academy of Agricultural Sciences. A Project Steering Committee was established by the National Coordination Committee on Climate Change, with a view to ensure overall guidance to the preparation of China's Initial National Communication on Climate Change. The members of the Project Steering Committee are officials and experts from NDRC, Ministry of Foreign Affairs, Ministry of Science and Technology, Ministry of Finance, State Environmental Protection Administration and China Meteorological Administration. Meanwhile, a Project Management Office was established by the Office of National Coordination Committee on Climate Change to strengthen the unified management and implementation of the project.

Table 1-15 Summary of China's National Circumstances in 1994

Criteria	1994
Population (10000,by the end of the year)	119850
Surface area (square kilometer)	9,600,000
GDP (Billion US$, US$ 1 = 8.6187 RMB Yuan)	542.534
GDP Per capita (US$)	455
Estimate share of the informal sector in the economy in GDP (percentage)	not applicable
Share of industry in GDP (percentage) [1]	41.4
Share of service in GDP (percentage)	31.9
Share of agriculture in GDP (percentage) [2]	20.2
Land area used for agriculture purposes (square kilometer) [3]	949070
Urban population as percentage of total population	28.51
Number of livestocks (10000)	14918.7
In which: Cattle (10000)	12231.8
Horses (10000)	1003.8
Pigs (10000)	41461.5
Sheep (10000)	24052.8
Forest area (10000 square kilometers)	128.63
Population in absolute poverty (10000) [4]	7000
Life expectancy at birth (year)	Male 68, female 71
Literacy rate (%)	81.9

Notes:

1. Industry includes mining and manufacturing, excludes constructing industry. The constructing industry took a share of about 6.5%.
2. Agriculture includes farming, forestry, animal husbandry, and fishery.
3. It refers to the plough area.
4. In 1994, the poverty line admitted by the Chinese Government referred to those whose annual net income per capita was under 440 Yuan.

Chapter 2 National Greenhouse Gas Inventory

Decision 10 of the Second Session of the Conference of the Parties to the Convention specifies the contents of the report to be submitted by Parties not included in Annex I to the Convention concerning the national greenhouse gas inventories submitted as part of the initial national communication. In accordance with the requirements of the relevant UNFCCC reporting Guidelines and the specific conditions in China, China has prepared the 1994 national greenhouse gas inventory covering the estimates of greenhouse gas emissions from energy, industrial processes, agriculture, land-use change and forestry and waste. The reported greenhouse gases covers carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).

2.1 Scope of the national greenhouse gas inventories

2.1.1 Energy

Greenhouse gas inventory for energy sector include carbon dioxide and nitrous oxide emissions from fossil fuel combustions, methane emissions from coal mining and post-mining activities, fugitive methane emissions from oil and natural gas system, and methane emissions from burning biomass fuels.

2.1.2 Industrial processes

In the light of the specific situation of industrial production in China, the key emission sources chosen for reporting in this inventory include carbon dioxide emissions from the production processes of cement, lime, iron and steel and calcium carbide and nitrous oxide emissions from adipic acid production. These are the major sources of greenhouse gas emissions from industrial processes in China.

2.1.3 Agriculture

Greenhouse gas inventory for agriculture mainly includes methane emission from paddy rice field, nitrous oxide emission from cropland, methane emission from animal enteric fermentation, and methane and nitrous oxide emissions from animal waste management systems.

2.1.4 Land–use changes and forestry

Greenhouse gas inventory of land-use change and forestry mainly covers changes in forest and other woody biomass stocks, including the removals of carbon dioxide due to the growth of living trees (forests, open forests, scattered trees and “four-sides trees” – trees growing in the house side, village side, roadside and waterside), bamboo stands and economic stands, and carbon dioxide emission caused by biomass loss of forest consumption, and carbon dioxide emission caused by conversions of forestland to non-forestland.

2.1.5 Waste treatment

Greenhouse gas inventory for the waste sector mainly includes methane emissions from municipal solid waste (MSW) and domestic and industrial wastewater.

2.2 Methods for preparing the greenhouse gas inventories

In the course of preparing China's 1994 national greenhouse gas inventories, the inventory agencies basically applied the methods provided by the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (hereinafter referred to as "IPCC Guidelines") and made reference to the IPCC Good Practice Guidance and Uncertainty Management for National Greenhouse Gas Inventories (hereinafter referred to as "IPCC Good Practice Guidance"). Based on the actual conditions in China, including the definition of emission sources, the determination of key sources, the availability, reliability, verifiability and sustainability of activity data and the availability of emission factors, the inventory agencies analyzed the applicability of the IPCC methods to China and selected the appropriate approaches for preparing China's 1994 national greenhouse gas inventories.

2.2.1 Energy

Fossil fuel combustion is the major source of greenhouse gas emissions in China. The inventory agencies simultaneously adopted the reference approach and sectoral approach based on detailed information on technologies as recommended by the IPCC Guidelines. The classification of sectors and fuel types are basically the same as the classification in the IPCC Guidelines, in which the transport sector is defined as the transport of the whole society, somewhat different from the definitions in China's national energy statistics; the emission sources in the sector of electric power and heat supply were defined to be the power generation and heat supply of China's thermal power utilities while the emissions from auxiliary power plants and other sources of heat supply were reported in the relevant sectors. The equipments for fossil fuel combustion were composed of power generating boilers, industrial boilers, industrial kilns, household cooking ovens, farm implements, power-generation internal-combustion engines, different kinds of aviation vehicles, road transport vehicles, railway transport vehicles and shipping transport vehicles, etc.

In accordance with the availability of emission factors, the inventory agencies, in the course of emission estimates for biomass use as fuel, simultaneously adopted the reference approach and the sector approach as recommended by the IPCC Guidelines. For residential use, since emission factors by equipment (firewood-saving stoves and traditional stoves) and by fuel (crop stalks and firewood) were available and the activity volume of residential use accounted for over 90% of the entire biomass burning activity, sector approach based on the detail technology was adopted to estimate methane emissions from biomass burning. For commercial use, due to the lack of relevant emission factors by equipment and the fact that the share of commercial use activity is very small, reference approach was adopted for the estimates of methane emission from this source.

In the light of China's specific circumstances and data availability, the IPCC tier 2 method (coal mines average method), and tier 3 method (mine well survey method), were adopted to estimate methane emissions from coal mining and post-mining activities in China, where tier 3 method was adopted for the emission estimates of key state-owned coal mines.

The inventory agencies adopted IPCC tier 3 method for the estimate of fugitive methane emissions from oil and gas systems, collected China's activity data and utilized the default emission factors of the IPCC Guidelines and others as reference. All these efforts help to improve the reflection of the actual situation in China.

2.2.2 Industrial processes

The preparation of the industrial processes inventories was basically based on the IPCC methodology. Clinker production was adopted as activity data for the emission estimates of cement production, and the impact of magnesium oxide content in the clinker on emission factors was considered as well. For lime production, the inventory agency estimated the activity data of lime products by regions and/or sectors in 1994, and obtained the relevant data for calculating emission factors through investigations into lime enterprises. For iron and steel production, both emissions from carbonates used as flux such as lime stone, magnesite and dolomite and emissions due to carbon content reduction in the steel making process were estimated.

2.2.3 Agriculture

Method for estimating methane emission from paddy rice field was based on the IPCC Guidelines. In the light of specific conditions in China, paddy rice fields were divided into four major categories, namely, double-harvest early rice, double-harvest late rice, single-harvest rice and winter-flooding fields. Methane emission from winter-flooding fields referred to the emission from paddy rice fields submerged by water in winter without growing rice. With regard to the double-harvest early rice, double-harvest late rice and single-harvest rice, the CH4MOD method was adopted to calculate emission factors by different types of paddy rice fields. Direct field measurement was adopted to determine emission factors for the estimation of methane emission from winter- flooding paddy rice fields.

In estimating the direct emission of nitrous oxide from cropland, the inventory agencies basically followed the IPCC Guidelines and referred to the IPCC Good Practice Guidance. In the light of the specialities of cropland management in China and the availability of activity data as well as emission factors, the IPCC method was slightly modified. Firstly, the three-level hierarchy system was adopted for classifying the croplands of China. Secondly, a statistical method with Monte Carlo technique was applied to determine the direct emission factors based on field measurements. Thirdly, the regional nitrogen cycle model, namely IAP-N, was used to estimate direct nitrous oxide emissions from croplands.

With regard to the estimation of indirect emissions of nitrous oxide from cropland caused by runoff and leaching, the inventory agencies defined the specific rates for the nitrogen loss from various types of cropland and estimated the amount of emissions by adopting the IPCC methodology and default emission factors.

Emission sources of methane by animals were in conformity with the emission sources defined by the IPCC. Methane emissions mainly came from the enteric fermentation of ruminants, including dairy cattle, non-dairy cattle, buffalo, goat, sheep, horse, donkey, mule/ass and camel. At the same time, methane emission from swine, which was the domestic animal raised in the largest number in China, were also put into consideration. Due to the reason that swine was non-ruminant, the IPCC Guidelines provided no specific calculation method so far. IPCC tier 1 method was adopted to calculate methane emission from swine. IPCC tier 1 method was also adopted to calculate methane emission from camel. As to methane emissions from other key sources (non-dairy cattle, dairy cattle, buffalo, goat, and sheep), IPCC tier 2 method was adopted.

The inventories of methane and nitrous oxide emissions from animal manure management systems involved 11 main domestic animals and poultry (swine, non-dairy cattle, dairy cattle, buffalo, goat, sheep, camel, donkey, mule/ass, horse and chicken). Among them, emissions from manure management systems for swine, non-dairy cattle, goat, sheep and chicken were the key sources.

Based on data availability and the importance of the emission sources, methods were determined for calculating methane and nitrous oxide emissions from animal manure management systems. IPCC tier 2 method was adopted for swine, cattle, goat/sheep, and chicken. IPCC tier 1 method was used for the other emission sources.

2.2.4 Land-use change and forestry

Carbon dioxide emissions caused by changes in forest and other woody biomass stocks, and the conversion of forest, were estimated in accordance with the characteristics of activities in the land-use change and forestry in China and the IPCC Guidelines.

This inventory includes estimates of carbon absorbed due to growth increment of forests, open forests, four-side trees and scattered trees, and carbon emitted due to the consumption of forest. The estimation was based on the data at both national and provincial levels provided by the national forest resources survey, including data on the amount of standing volume, net annual increment and net consumption rate of forest, and in combination with data on average wood density, biomass expansion factor and carbon content. The carbon stock changes of economic forests and bamboo stands were calculated mainly on the basis of annual area changes, average biomass and carbon content of economic forests and bamboo stands in all provinces.

The forest conversion included the conversion of existing forests to other land uses, such as agriculture, pasture, town sites and roads. Carbon emissions caused by biomass burning and decomposition of biomass on the ground were estimated according to the IPCC Guidelines.

2.2.5 Waste treatment

Based on the situation in China, the inventory agency calculated the methane emission from municipal solid waste treatment using the default methodology of the IPCC Guidelines. To calculate the methane correction factor (MCF), the whole country was divided into 7 regions according to differences of city scale and regional economic development level. This helps to identify the differences of waste management modes between each region. To determine the degradable organic carbon (DOC) of municipal solid waste, the special feature of wide span of climatic regions between the north and south, the large expanse of land in China, and the difference in the composition of waste due to differences of resident customs in different regions were fully considered.

Based on the national statistics data of chemical oxygen demand (COD) in the wastewater, the inventory agency adopted the emission factors recommended by the IPCC to estimate the methane emission from treatment of domestic and industrial wastewater. Meanwhile, estimates based on urban population and per capita wastewater emission were done as recommended by the IPCC Guidelines and were applied for comparison with the previous estimates.

2.3 The 1994 national greenhouse gas inventories

2.3.1 Summary

In accordance with the requirements of the guidelines for the preparation of national communications by parties not included in Annex I to the convention, China's 1994 national greenhouse gas inventories covered the emissions and sinks of carbon dioxide, methane and nitrous oxide from 5 sectors , namely, energy, industrial processes, agriculture, land-use changes and forestry, and waste. As shown in Table 2-1, the national total amount of carbon dioxide emissions in 1994 was 3,073 million tons, and carbon sink from land-use change and forestry was about 407 million tons. After deducting the carbon sink, the net emission of carbon dioxide in 1994 was 2,666 million tons (about 727 million tons of carbon), and the per capita emission was about 0.6 ton carbon/year. The total amount of methane emissions in China in 1994 was approximately 34.29 million tons and that of nitrous oxide was about 0.85 million tons.

Table 2-2 listed the aggregation of greenhouse gas emissions with carbon dioxide equivalent as the unit. By using the global warming potentials (GWP) in the 100-year horizon given in the IPCC Second Assessment Report, methane and nitrous oxide were converted into equivalents of carbon dioxide. As a result, the total amount of greenhouse gases in China in 1994 was 3,650 million tons of carbon dioxide equivalent, of which carbon dioxide, methane, and nitrous oxide accounted for 73.05%, 19.73%, and 7.22% respectively (Figure 2.1).

In addition, it was estimated that carbon dioxide emission from international bunker fuels (international aviation and international navigation) in China in 1994 was 10.85 million tons.

Table 2-1 1994 national greenhouse gas inventory of China (Gigagram)

Greenhouse Gas Source and Sink Categories	Carbon dioxide	Methane	Nitrous oxide
Total (Net) National Emission (Gigagram per year)*	2665990	34287	850
1. All energy	2795489	9371	50
Fuel combustion	2795489		
Energy and transformation industries	961703		50
Industry	1223022		
Transport	165567		
Commercial-Institutional	76559		
Residential	271709		
Others (building industry & agriculture)	96929		
Biomass burned for energy		2147	

Fugitive Fuel Emission		7224	
Oil and natural gas system		124	
Coal mining		7100	
2. Industrial processes	277980		15
3. Agriculture		17196	786
Enteric Fermentation		10182	
Rice cultivation		6147	
Savanna Burning		N/A	
Others**		867	786
4. Land-use change and forestry	-407479		
Changes in Forest and other woody biomass stock	-431192		
Forest and Grassland Conservation	23713		
Abandonment of Managed Lands	Not estimated		
5. Others		7720	
Disposal of waste		7720	

Notes:

*Small differences may exist between the summation of each type and the total due to rounding errors.

**Methane emission source only includes animal wastes management system. Nitrous oxides emission source includes cropland soil, animal wastes management system and agricultural residue burning in fields.

Table 2-2 1994 greenhouse gas emissions in CO2 equivalent

Greenhouse gases	Emission amount (Gigagram)	GWP	Carbon dioxide equivalent (Gigagram)	Percentage (%)
Carbon dioxide	2665990	1	2665990	73.05
Methane	34287	21	720027	19.73
Nitrous oxide	850	310	263500	7.22
Total			3649517	100.00

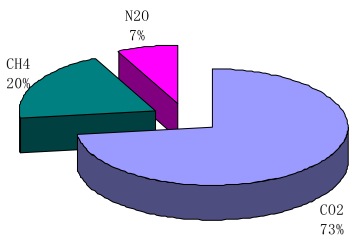


Figure 2.1 Breakdown of China's Greenhouse gas emissions in 1994

2.3.2 Carbon dioxide

Energy and industrial processes were the major emission sources of carbon dioxide in China in 1994. Carbon dioxide emissions in China in 1994 were 3,074 million tons, of which 2,795 million tons are emitted from the energy sector and 278 million tons from industrial processes. Land-use change and forestry was a net sink of carbon dioxide, which absorbed 407 million tons of carbon dioxide in 1994. The net emissions of carbon dioxide in China in 1994 were 2,666 million tons.

(1) Energy

The energy sector was the most important source of carbon dioxide emissions in China. In 1994, carbon dioxide emissions from the energy sector were 2,795 million tons, or about 763 million tons of carbon, accounting for 90.95% of the national total carbon dioxide emissions (excluding sinks from land-use change and forestry). Carbon dioxide emissions from the energy sector came entirely from fossil fuel combustion, of which industry, energy and transformation industries, transport, residential and commercial-institutional sectors emitted 1223, 962, 166, 272 and 76 million tons, accounting for 43.75%, 34.40%, 5.92%, 9.72% and 2.74% in the energy sector, respectively (Figure 2.2).

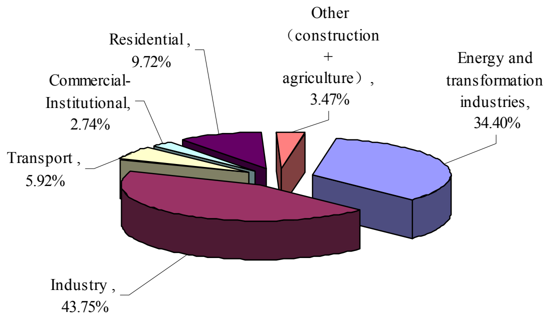


Figure 2.2 Carbon dioxide emissions by sources from the energy sector in China in 1994

(2) Industrial processes

Carbon dioxide emissions in 1994 from cement, lime, iron and steel, and calcium carbide production were estimated in the industrial processes sector.

In 1994, China produced approximately 420 million tons of cement, about 300 million tons of clinker and about 130 million tons of lime, which were mainly used in building materials, metallurgy and chemical industry, and about 92.61 million tons of steel and about 2.81 million tons of calcium carbide (converted at a standard purification of 300 litres acetylene gas per kilogram of calcium carbide).

In 1994, carbon dioxide emissions from industrial processes in China were about 278 million tons, accounting for 9.05% of the national total carbon dioxide emissions (excluding the carbon sinks from land-use change and forestry). Carbon dioxide emissions from industrial processes in 1994 mainly came from cement and lime production, which constituted about 90.42% of carbon dioxide emissions in this sector (Table 2-3 and Figure 2.3).

Table 2-3 Carbon dioxide emissions from industrial processes in China in 1994

Emission sources	Carbon dioxide (Gigagram)	Percentage (%)
Cement	157775	56.76
Lime	93560	33.66
Iron & steel	22678	8.16
Calcium carbide	3968	1.43
Total	277980	100.00

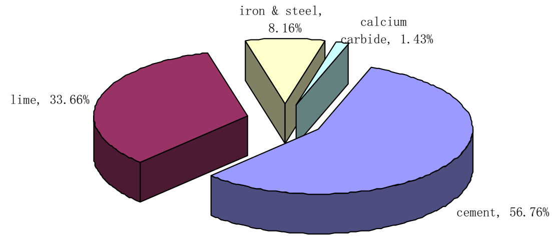


Figure 2.3 Carbon dioxide emissions by sources from industrial processes in China in 1994

(3) Land-use changes and forestry

In light of the characteristics in land use and forestry in China, the inventory of the greenhouse gases from land-use changes and forestry mainly covers carbon dioxide absorbed and emitted by changes in forest and other woody biomass stocks, and forest and grassland conversion, induced by anthropogenic activities.

Changes in forest and other woody biomass stocks included the removal of carbon dioxide by the growth of forests, bamboo, economic forests, open forests, scattered trees and four-side trees and carbon dioxide emissions caused by commercial harvest, trees for farmers' own use, forest disasters, fuel wood and other consumption of forests.

In 1994, changes in forest and other woody biomass stocks caused by changes of the growth of the standing volume, bamboo and economic forests, and forest consumption, were net sinks of carbon dioxide, which absorbed 431 million tons of carbon dioxide (or about 118 million tons of carbon). The growth of stands absorbed 749 million tons of carbon dioxide. The growth of open forests, scattered trees and four-side trees absorbed 131 million tons, the changes of economic forests absorbed 60 million tons, and the changes of bamboo absorbed 24 million tons. Carbon dioxide emission caused by consumption of standing volume was 533 million tons.

Carbon dioxide emissions caused by conversions of forests and grassland include those caused by the conversion of forests to un-forested land. In 1994, carbon dioxide emissions caused by the conversion of forests was 24 million tons.

By combining the above two figures, the 1994 carbon dioxide inventory of land-use changes and forestry sector is shown in Table 2-4.

Table 2-4 1994 greenhouse gas inventory of land-use changes and forestry sector in China

Emission source/sink	Sub-type	Emission/sink of carbon dioxide (10^3 tons)
Changes in forest and other woody biomass stocks	Forested land	-300365
	Of which, Growth of stands	-748742
	Consumption of forests	532569
	Economic forests	-60286

	Bamboo stands	-23907
	Open forests, scattered trees & four-sides trees	-130827
	Sub-total	-431192
Conversion of forests		23713
Total		-407479

2.3.3 Methane

Methane emissions in China mainly originates from agriculture, energy and waste treatment sectors. In 1994, methane emission was about 34.29 million tons, of which 17.20 million tons was from agriculture sector, about 9.37 million tons was from energy sector and about 7.72 million tons from waste treatment sector (Table 2-5). The agriculture sector was the largest source of methane emissions, accounting for 50.15%, including the emission of 10.18 million tons from the enteric fermentation of ruminants, 6.15 million tons from paddy rice fields and 0.87 million tons from animal manure management systems (Table 2-6). The energy sector was the second largest contributor, accounting for 27.33%, including the emission of 7.10 million tons from coal mining and post-mining activities, 2.15 million tons from biomass burning and 0.12 million tons of fugitive emissions from oil and natural gas systems. Methane emission from waste treatment was about 7.72 million tons, accounting for 22.52% (Figure 2.4).

Table 2-5 Methane emissions in China in 1994

Type of emission source	Methane (10^3 tons)	Percentage (%)
Total (I+II+III)	34287	100.00
I. Energy	9371	27.33
Burning of biomass	2147	6.26
Oil & gas system	124	0.36
Coal mining	7100	20.71
II. Agriculture	17196	50.15
Enteric fermentation	10182	29.70
Rice cultivation	6147	17.93
Animal manure management systems	867	2.53
III. Waste treatment	7720	22.52

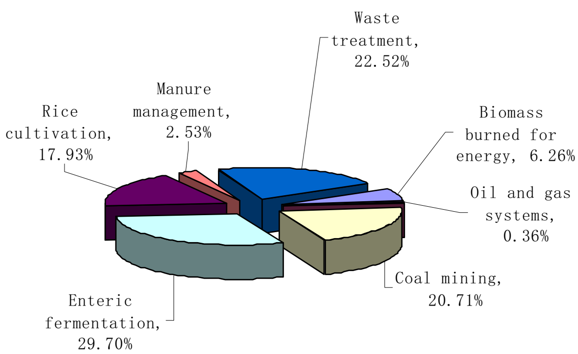


Figure 2.4 Methane emissions by sources in China in 1994

(1) Agriculture

Area of paddy rice field in China accounts for approximately 21% of the world total. Harvest area of paddy rice fields in China makes up about 25% of the national total cropland, spreading over 28 provinces, and municipalities directly under the central government and autonomous regions. They are most concentrated in the plains in the middle and lower reaches of the Yangtze River, the Chengdu Plain, the Zhujiang River Delta, the hilly area and the plains in Yunnan, Guizhou and Sichuan provinces as well as in the coastal areas in Zhejiang and Fujian provinces. In different areas where paddy rice grows, the climatic and soil conditions are different and there exists a great discrepancy among regions in factors such as the variety of paddy rice, the cropping system, the management practice for irrigation, and the type and application regime of fertilizers. All these factors affect the estimation of methane emission from paddy rice fields.

China has a large number of animals. In 1994, China had 92.40 million of non-dairy cattles, 3.84 million of dairy cattles, 22.91 million of buffaloes, 123.08 million of goats, 117.45 million of sheep and 414.62 million of swine.

Table 2-6 Methane emissions from agriculture sector in 1994

Source of emission	Methane (10^3 tons)	Percentage (%)
Enteric fermentation	10182	59.21
Rice cultivation	6147	35.75
Animal manure management systems	867	5.04
Total	17196	100.00

The total amount of methane emission from paddy rice fields in 1994 was estimated to be 6.15 million tons, of which emissions from double-harvest early rice fields was 1.988 million tons, accounting for 32.34% of the total; that from double-harvest late rice fields was 1.171 million tons, accounting for 19.05%; that from single-harvest rice fields was 2.041 million tons, accounting for 33.21%; and that from winter-flooding paddies during the non-growing period was 0.947 million tons, accounting for 15.4%.

The total amount of methane emission from enteric fermentation in China in 1994 was 10.18 million tons, of which emissions from non-dairy cattle was the mainstay, accounting for 59.2%; and that from buffaloes came second, accounting for 14.5%. In addition, though swine were not ruminants, the amount of swine in China was large. Methane emission from swine accounted for 4% of the total amount of methane emissions from animal enteric fermentation.

Methane emissions from animal manure management systems in 1994 was about 0.87million tons, of which the emission from the management system of swine manure was the mainstay, accounting for 61%, that from non-dairy cattle manure took second place, accounting for 18%, that from chicken manure accounted for 6% and that from buffalo and dairy cattles accounted for 4% each.

(2) Energy

Methane emissions from the energy sector mainly included emissions from coal mining, fugitive emissions from oil and natural gas system and emissions from the burning of biomass fuels.

In 1994, methane emissions from the energy sector was 9.37 million tons, of which methane emissions from coal mining and post-mining activities was 7.10 million tons, accounting for 75.76%; that from the burning of biomass fuels was 2.15 million tons, accounting for 22.91%; and that from the oil and natural gas systems was 0.12 million tons, accounting for 1.32%.

(3) Waste treatment

In 1994, urban non-agricultural population in China was about 176.7 million. They generated 75.64 million tons of municipal solid waste, and the daily-generated amount of solid waste was about 1.17 kilograms per capita. Total wastewater emissions in 1994 was 41.53 billion tons, in which industrial wastewater emissions was 28.16 billion tons with 16.629 million tons of chemical oxygen demand; and domestic wastewater emissions was 13.37 billion tons with 6.10 million tons of chemical oxygen demand.

In 1994, methane emissions from waste treatment in China was 7.72 million tons, of which emissions from municipal solid waste treatment was 2.03 million tons and emissions from wastewater treatment was 5.69 million tons, subdivided by 4.16 million tons from industrial wastewater treatment and 1.53 million tons from domestic wastewater treatment. Of the total emissions, emissions from industrial wastewater treatment accounted for 53.89% and emissions from municipal solid waste treatment accounted for 26.30% (Table 2-7).

Table 2-7 Methane emissions from waste treatment sector in China in 1994

Emission source	Methane (10^3 tons)	Percentage (%)
Treatment of municipal solid waste	2030	26.30
Treatment of industrial wastewater	4160	53.89
Treatment of domestic sewage	1530	19.82
Total	7720	100.00

2.3.4 Nitrous oxide

Nitrous oxide emission in China in 1994 mainly originated from agricultural activities. Moreover, there were small amount of emissions coming from industrial processes and the energy sectors. Nitrous oxide emission in China in 1994 was approximately 850,000 tons, of which emission from agriculture was about 786,000 tons, that from industrial processes was about 15,000 tons and that from the energy sector was about 50,000 tons. Emissions from agriculture approximately accounted for 92.43% while that from industrial processes and energy accounted for 1.75 % and 5.82% respectively (Table 2-8).

Table 2-8 Nitrous oxide emissions in China in 1994

Emission source	Nitrous oxide (10^3 tons)	Percentage (%)
Total	850	100.00

Energy	50	5.82
Industrial processes	15	1.75
Agriculture	786	92.43

(1) Agriculture

Nitrous oxide emissions from agriculture in China in 1994 was estimated to be 786,000 tons, of which emissions directly from cropland accounted for about 60.30%, those indirectly from cropland about 19.53%, those from grazing about 14.03%, those from animal manure management systems (excluding grazing and burning of manure) 5.56%, those from directly burning crop residues in fields 0.46%, and those from burning of animal wastes about 0.10%, respectively (Table 2-9**).**

Table 2-9 Nitrous oxide emissions from agriculture sector in China in 1994

Emission source	Nitrous oxide emission (10^3 tons)	Percentage (%)
Direct emission from cropland	474	60.30
Indirect emission from cropland*	154	19.53
Grazing	110	14.03
Burning of manure	1	0.10
Animal manure management systems**	44	5.56
Field residue burning	4	0.46
Total	786	100.00

Notes:

* Nitrous oxide generated by atmospheric sedimentation was incorporated into farmland direct estimation.

**Excluding nitrous oxide emission from grazing or burning of manure.

The application of synthetic nitrogen fertilisers was the most important source of direct emission of nitrous oxide from croplands. In 1994, 57.8% of direct emission of nitrous oxide from croplands in China originated from the application of synthetic nitrogen fertilisers, 22.9% from the application of organic manure, 7.9% from the biological nitrogen fixation in agriculture, and 5.1% and 5.8%, respectively, from the direct incorporation of crop residues into soils and the atmospheric deposition of nitrogen caused by application of fertilizers.

(2) Industrial processes

In the 1994 national greenhouse gas inventory, nitrous oxide emissions from adipic acid production was estimated. In 1994, China had a total of five enterprises producing adipic acid and the total output from them was about 57 thousand tons. The estimated amount of emission of nitrous oxide from adipic acid production in China in 1994 was about 14.8 thousand tons.

(3) Energy

Nitrous oxide emissions from the energy sector came mainly from thermal power generation. The amount of emission in 1994 was about 50 thousand tons.

*

2.4 Uncertainties

2.4.1 Major efforts to minimize uncertainties

The inventory agencies have made great efforts to reduce the uncertainties in the estimation of greenhouse gases inventories, especially in the area of data and methodology.

With regard to data, the emphasis was placed on ensuring the accuracy of the data used. The most important measure is to use official statistical data as much as possible. In the course of preparing the inventory, the inventory agencies work closely with the State Statistical Bureau, industrial associations and relevant professional institutions to ensure obtaining authentic and reliable official data. Under the circumstances of non-availability of official data, in order to guarantee the quality of the estimation in the inventory, a large amount of sample surveys and measurements were conducted, for instance, survey on industrial boilers, coal quality analysis, survey on methane emission from coal mines, survey on cement enterprises, survey on lime enterprises, survey on adipic acid producing enterprises, cement clinker sample measurement, experimental measurement on calcification of using lime, measurement of methane emission from rice fields, etc.

With regard to methodology, the inventory agencies persisted in following the method of the IPCC Guidelines modified in some areas to cope with specific situations in China, which guaranteed the comparability, transparency and consistency of the estimations in the inventory. In selecting the estimation approaches for preparing the inventory, the inventory agencies held many methodology seminars to solicit opinions extensively and listened to arguments fully so as to ensure that the methodology used for preparing the inventory was scientific, feasible and effective. When conditions permit, higher tiers methods were selected as far as possible.

2.4.2 Uncertainties existed in this inventory

In spite of the fact that the inventory agencies have made improvements in preparing the 1994 national greenhouse gas inventory in areas such as the scope and the quality of the inventory and the methods used developing the inventory, there still exist large uncertainties. The main reasons are:

First, China as a developing country is rather weak in terms of basic statistical data, particularly there are a lot of difficulties related to the availability of activity data in relation to the estimation of greenhouse gas emissions. Part of the index on the activity data has not yet been included in the statistical system.

Second, in the course of preparing the greenhouse gas inventory covering energy, industrial processes, agriculture, land-use change and forestry and waste management sectors, methods such as sample survey and on-site observation and measurement have been used to obtain information necessary for preparing the inventory. Owing to constraints such as funds and time, there are inadequacies in time-length for observation and measurement and in the representativeness of observation points and sample points. Due to lack of the country-specific emission factors, default emission factors provided by the IPCC guidelines have been adopted for some source categories.

This has led to uncertainties to some extent for the estimation.

The inventory agencies used the method of quality assessment and uncertainty analysis provided by the IPCC Good Practice Guidance, and carried out preliminary analysis on the quality of the relevant data involved in the inventory preparation. Major uncertainties in each sector were analysed in the following paragraphs.

Energy: Because existing statistical materials and data could not meet the needs for preparing the inventory, part of the activity data could only be obtained by adopting the methods of investigation and experts judgement. For example, activity data by device in some important industries such as building material and metallurgy was based on experts judgement; owing to the lack of the measured data on emission factors from coal combustion by sector and by device, the relevant potential emission factors and oxidation rates could only be determined through case studies, questionnaires and partial supplementary measurements; due to the lack of detailed measurement data, methane emissions under different circumstances from different types of biomass stoves could only be estimated by using the same emission factors. All those would affect the accuracy of energy inventory.

Industrial processes: The uncertainties in the emission estimates of cement production mainly came from statistical errors on the output of clinker, errors in the estimation of flue ash loss of cement kilns and errors in measuring the content of calcium oxide and magnesium oxide in the clinker. The uncertainties in the emission estimates of lime production mainly came from errors in the estimation of activity data, including possible incompleteness in the scope covered by the statistics on the production of lime used as building materials and statistical errors in the production of lime used in metallurgical and chemical industries. The uncertainties in the emission estimates of iron and steel production mainly came from statistical errors in limestone use, errors in the chemical detection of calcium carbonate content in limestone, the effect of water content in limestone, and errors in measuring content of carbon in pig iron and steel products. Uncertainties in the emission estimates of calcium carbide production came mainly from errors in measuring the purity of calcium carbide and limestone. Uncertainties in emission estimates of adipic acid production came mainly from enterprise-level statistic errors in adipic acid production, errors in measuring the gas concentration of nitrous oxide in the industrial tail gas and the errors in the measurement of the nitrous oxide emission control facilities.

Agriculture: The reason for the uncertainties in the estimation of methane emission from rice fields was mainly because of the shortcomings of the model adopted. The model does not possess the function for calculating emission factors for winter-flooding paddies during non-growing period. The effects of precipitation during non-rice period soil characteristic and applications of organic manure and nitrogen fertilisers which affected emission factors were not taken into account either. The reasons for the uncertainties in the estimation of the direct emission of nitrous oxide from croplands were mainly because the existing observations were poor in representing different climatic regions, different types of croplands and different practices of field management, and also the time span for observing individual direct emission factor was not long enough. In addition, because of the lack of actual observation data on the indirect emission of nitrous oxide from croplands, the default emission factors and other default parameters provided by the IPCC guidelines were adopted. In regard to the estimation of methane emission from enteric fermentation, and methane and nitrous oxide emissions from animal manure management systems, the uncertainties were mainly attributed to two aspects, that is, the investigation data used for estimating the emissions could not yet reflect the actual circumstances, and the lack of observation data on emission factors. For example, only methane emissions from non-dairy cattle was based on continuously measured emission factors, while there was no data of emission factors based on continuous observation for the other key emission sources, which will involve great uncertainties.

Land-use change and forestry: The uncertainties of the estimates of this sector mainly came from the following aspects: there was a great discrepancy in the growth rate of different tree species, different types of forests as well as that of open forests, scattered trees and four-side trees. As the national forest resources survey did not provide data on the growth rate of different tree species and different forest types except the growth rate of the standing volume, there was no way to calculate the emissions by different types. Owing to the lack of data on the annual increase of biomass per unit area of bamboo and economic forests, changes in the area and biomass storage per unit were used for calculation. This would give rise to certain uncertainties. The biomass expansion factors applied might lead to considerable uncertainties. Due to the lack of relevant domestic parameters, IPCC default emission factors were applied, which may cause some uncertainties. Owing to the lack of data, carbon dioxide emissions from forests conversion could not be calculated by province, tree specie or forest type. National average values were adopted for both the activity data and emission factors. This also caused some uncertainties.

Waste treatment: The uncertainties contained in the inventory of the municipal solid waste were mainly caused by the parameters of the proportion of degradable organic carbon and the proportion of methane in gas released from landfills recommended in IPCC Good Practice Guidance. The uncertainties contained in the inventory of the emission from wastewater treatment were mainly from the lack of measured values of degradable organic carbon contained in organic waste of domestic sewage and industrial wastewater.

2.5 Main factors affecting future emissions

2.5.1 Population growth and urbanization

China is the most populous country in the world. By the end of 2000, China's population had reached 1,267 million, approximately accounting for 21% of the world total. Population increase in China has entered into the stage of low birth rate, low death rate and low growth rate. In future decades, on the premise of realizing a stabilized low level of birth rate, the population in China will maintain a certain growth rate. It is forecasted that it will peak before 2050. Because of the large population base, the increase in the absolute number of the population will still be enormous even at a very low growth rate, and the increase in emission brought by it will maintain a certain scale.

Since a long time ago, urbanization in China has seriously lagged behind the level of economic and social development and the level of industrialization. In 2000, there were 663 cities in total and about 20,312 towns in the whole country. The urban population was 456 million, accounting for 36.0 % of the national total. This was much lower than the 70% urbanization rate in the medium-developed countries， and lower than the world average of 50% by 14% in 2000. In accordance with the requirements that China would reach the level of medium-developed countries by 2050 and preliminarily realize the goal of modernization, the urbanization in China may reach 70-80% by the middle of this century. This means that in the next 50 years China's urban population will increase by 720-880 million. The changes in production and way of life of a population of such size will produce great influence on the total emission of greenhouse gases in the future in China.

2.5.2 Economic development

During the past 20 years, China's economic development has made tremendous achievements. However, compared to China's huge population and large regional discrepancies, the economic base is still weak and people's living standard is still very low. Therefore, to develop the economy, to eliminate poverty and to raise people's living standard remain the tasks with the highest preference and most importance for China for a considerably long period of time in the future. In 2002, the Chinese Government put forward the development objective of building a well-off society in an all-round way. It was anticipated that by 2020 China's GDP would be quadrupled over that of the year 2000. At present, China is in the primary-secondary stage of industrialization. Economic development will engender very strong demands on such sectors as energy, raw materials, communications and transportation, which will still be important basic industries in China for a period of time in the future. With the continuous progress in large-scale construction of infrastructural facilities and the process of industrialization, outputs of various energy-intensive products will keep on increasing.

2.5.3 The basic demands in people's life and the changes in consumption mode

On the whole, the consumption level of urban and rural residents in China is in the stage proceeding from having enough to eat and wear to a well-off life. By the end of 2000, 23 million rural residents in remote areas in China were still unable to use electricity. In 2000, the per capita domestic consumption of electricity by urban and rural residents was only 132.4 kilowatt-hours and the per capita consumption of commercial energy was only 1.03 tons coal equivelent, far below the average level of developed countries (about 6.60 tons coal equivelent), and was also lower than the world average level (about 2.06 tons coal equivelent). In 2000, vehicle occupancy for every hundred persons in China was only 1.27, much lower than the average level of developed countries. In the next several decades, with the development of the economy and the raising of people's income level, there will be a sharp increase in the growth rate of civil-use cars, especially in family cars. The sustained and rapid development of the future economy and society in China will be a driving force not only in the increase of the in demands for energy and but also in the increase of emission of greenhouse gases.

2.5.4 Economic restructuring and technology improvement

Economic restructuring and technology improvement have played a vital role in coordinating economic growth, resources utilization and environmental protection. The Chinese Government has clearly stated that in the course of developing the economy, it is necessary to adhere to the view of development based on scientific principles which is comprehensive, coordinated and sustainable, and build a resource-saving society. A shift in the pattern of economic growth will be promoted substantially by curbing low-level duplicated construction, rigorously applying the standards in environmental protection, security, energy consumption, technology and quality, and by closing down enterprises that cause serious pollution and waste resources according to the law. At the same time, readjustment of industrial structure will intensify, tertiary industries will develop vigorously, high- and new-tech industry will develop actively and the recycling economy will develop energetically. With the development of the Chinese economy, it is expected that the proportion of energy-intensive industries in the industrial sector will lower, the proportion of the tertiary industry will raise gradually and the economic structure will further optimize. Technological innovation and technological advancement are major factors for promoting social progress. The development, introduction and popularization of some key technologies will play a decisive role in raising the energy efficiency and reducing emissions. If the international community can earnestly and effectively implement the relevant provisions in the Convention and the Kyoto Protocol and the developed countries can take the lead in taking actions to alleviate climate changes according to the principle of common but differentiated responsibilities under the Convention, it will be possible to bring on a new driving force for global technological advance, particularly the advancement of energy technology, and provide opportunities for all countries in the world including China to realize sustainable development.

2.5.5 Forestry and ecological construction

Since 1980s, by devoting major efforts to forestation, China has successfully carried out 10 forest ecological construction projects, including shelter forests in three northern areas (northwest, central north and northwest), shelter forest systems in the middle and upper reaches of the Yangtze River, a coastal shelter forest system, the prevention and control of desert, forestation in the Taihang Mountain Ranges, a farmland shelter forest system and a shelter forest system in the middle reaches of the Yellow River. In 1990-2000, a scheme to reforest an area of 52.73 million hectares was carried out successfully. China now ranks first in the cumulative preservation of area of reforestation. China will continue to pursue the policy of afforestation and converting unduly reclaimed land to forestry and pasture, implementing projects for protecting natural forests resources, and increase the sink of carbon dioxide.

Chapter 3 Impacts of Climate Change and Adaptation

Chinese scientists began to assess the impacts of, the vulnerability and adaptation to climate change since 1990s. The studies were concentrated on the four areas closely related to the national economy, namely, water resources, agriculture, terrestrial ecosystem and coastal zone including offshore marine ecosystems. Because the research of assessing the impacts of and adaptation to climate change in China is still at the initial stage, what is contained in this chapter are mainly the results of a preliminary study by a part of Chinese scientists, and there still exist a lot of uncertainties in some conclusions.

3.1 Methods and models for the assessment

Early assessment of impacts of climate change was mostly qualitative studies on sensitivity under incremental scenarios. In recent years, the study has been carried out based on the quantitative models linked up with projected outputs of the global climate models (GCMs) under transient greenhouse gases (GHGs) emission scenarios.

When assessing impacts of future climate change over China, it is necessary to obtain the regional climate change scenarios in China. There are two sources for these data: the outputs datasets of GCMs issued by the IPCC Data Distribution Centre (DDC) and the simulated results of GCMs worked out by Chinese scientists.

At present, the horizontal resolution of GCMs used for projecting the climate change scenarios is coarse (the horizontal grid box is hundreds of kilometres). When different discipline models are used to assess the impacts of climate change, downscaling the GCMs outputs with statistics and regional climate models (RCMs) has been done by Chinese scientists.

The steps and methods for the impacts assessment are referenced to the IPCC Working Group II *Technical Guidelines for Assessing Climate Change Impacts and Adaptations*..

The discipline models used by Chinese scientists as assessment tools are as follows: hydrological models including Xin'anjiang model, monthly runoff dry model, variable infiltration capacity model (VIC), etc.; agricultural models including crop models (CERES), grass productivity model (SPUR2), etc.; ecosystem models such as mechanistic ecosystem model (CEVSA); and marine models such as coast-sea level rise projection model.

3.2 Characteristics of climate change in China

3.2.1 Surface air temperature and precipitation

The climate in China has also experienced obvious changes in the context of global warming. It is shown that the trend of the climate change in China in the past century is consistent with the general trend of global climate change, with the 1990s being the warmest periods in the recent 100 years. In terms of regional distribution, the most obvious climate warming is shown in the northwest, the northeast, and north China, while the warming trend is not obvious in the areas south of the Yangtze River. In terms of seasonal distribution, the warming increment is most obvious in winter. China experienced 18 successive warming winters throughout the country from 1986 to 2003 (Figure 3.1). The greatest precipitation occurred in China in the fifties of the 20th century, and then reduced gradually, particularly accompanying with the appearance of a trend of warm-dry climate in north China.

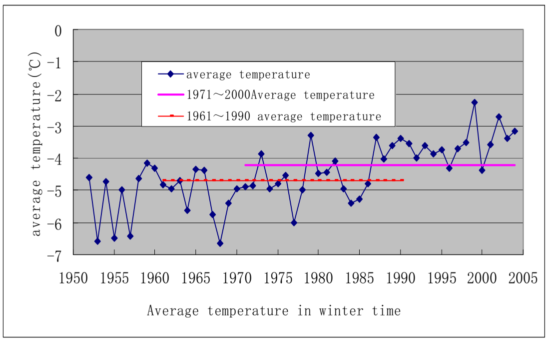


Figure 3.1 Trends of the changes of average temperature in winter from 1952 to 2003 in China

With the help of GCMs and RCMs (eg. RegCM2), the future climate changes in China were projected by Chinese scientists. The simulated results show that under the 2×CO_2 scenario, the temperature increment in the south of China is 2-2.5℃, while that in the north of China is higher to 2.5~3℃. The projected results of the changes in temperature in China in different seasons are shown in Table 3-1.

Table 3-1 Changes of surface air temperature and precipitation in China under 2×CO2 scenario

Season	Changes of surface air temperature (℃)	Changes in precipitation (%)
Winter	3.0	17
Spring	2.6	6
Summer	2.4	19
Autumn	2.1	6

It is shown in Table 3-2 the average results of the future climate change in China projected by about 40 GCMs under four GHG emission scenarios (GG: the equivalent CO_2 concentration of GHG increases by 1% per year from 1990; GS: the trend of GHG concentration change is the same with that of GG, with consideration of the interaction of sulphur aerosols at the same time; A2 and B2: they are two scenarios designed in the IPCC 2000 *Special Report on Emissions Scenarios* (SRES)). The surface air temperature in China would probably increase by 1.5-2.8℃ by 2030, 2.3-3.3℃ by 2050, and 3.9-6.0℃ by 2100. Compared with the surface air temperature, great bias is seen in precipitation projection. Generally speaking, the future precipitations simulated by most GCMs presents a trend of increase under GG, A2, and B2 scenarios. By the end of the 21st century, annual average precipitation in China would increase by about 20% under GG and SRES A2 scenarios and 10% under SRES B2 scenarios.

Table 3-2 Changes in future surface air temperature and precipitation in China projected by GCMs under four GHG emissions scenarios

(Relative to the average values of 1961~1990)

Year		2030	2050	2070	2100
Temperature (℃)	GG	2.8	3.3	4.4	6.0
	GS	2.0	2.3	3.4	5.1
	A2	1.5	2.3	3.8	5.6
	B2	1.5	2.4	2.9	3.9
	Average	1.9	2.7	3.6	5.2
Precipitation (%)	GG	9	14	22	17
	GS	-9	0	14	9
	A2	-6	7	8	16
	B2	10	9	7	12
	Average	1	8	13	14

3.2.2 Extreme climate events

At present, there are few researches undertaken on future extreme climate events in China. The results of limited researches show that under general circumstance of future climate warming, occurrence of extreme-cold events would reduce and that of extreme-hot events and droughts and floods would increase.

3.3 Water resources

3.3.1 Impacts of climate change on water resources

It is shown from runoff observation of the major rivers in China that measured runoff of the six major rivers has decreased in the past recent 40 years. The largest drop occurred in Huangbizhuang in the Haihe River basin, with a decreasing rate of 36.64% per decade, the second largest in Sanhezha of the Huaihe River, with a decreasing rate of 26.95% per decade, and the third in Bengbu of the Huaihe River and Huayuankou of the Yellow River, with a decreasing rate of 6.73% and 5.70% respectively. The smallest drops are 0.96% for the Pearl River, 1.01% for Yichang and 1.46% for Hankou of the Yangtze River as well as 1.65% for the Songhuajiang River.

There have been continuous droughts occurred over North China since 1980s, and annual average precipitations in 10 years in Beijing-Tianjin area, the Haihe-Luanhe basin and the Shandong Peninsula have fallen by 10-15%. Because of reduced precipitation and high surface air temperature, evaporation increased and flow volume reduced apparently. According to preliminary analysis by the Haihe Water Conservancy Committee, annual average surface runoff in the entire Haihe-Luanhe river basin in 1980-1989 was only 15.5 billion cubic metres, 46.2% lower than that in 1956-1979, 28.8 billion cubic metres. In 1990s, drought areas shifted southwestward. The annual average precipitation in the nine years from 1990 to 1998 in the middle and upper reaches of the Yellow River (Shaanxi, Gansu and Ningxia provinces), the Hanjiang river basin, the upper reaches of Huaihe river and the Sichuan basin fell by about 5~10%. From Lijin station of the Yellow River upwards, average precipitation in the same period decreased by 32% (Table 3-3). Moreover, annual runoff volumes in Haihe and Luanhe rivers and the Huaihe river were obviously decreased.

At the same time, flood disasters occurred frequently in China, particularly big-scale flooding that has occurred many times since the 1990s. For example, the flooding in the Huaihe river in 1991, the flooding in the water system of the Dongting Lake in 1994 and 1996, the flooding in the water system of Boyang Lake, the flood in the Yangtze, Zhuijang and Songhua Rivers in 1998 with water level breaking the historical record, the big flooding in the Taihu Basin in 1999 with water level breaking the historical record, and the big floods occurred in the Huaihe river, the Yellow River and the Weihe river in 2003 (Figure 3.3).

Table 3-3 Water resources of the Yellow River, Huaihe and Haihe rivers and the reduction of their runoff into the sea

Basin	Year	Annual precipitation (mm)	Annual runoff (mm)	Annual runoff (billion m^3)	Runoff into sea (billion m^3)	Proportion of runoff into sea(%)
Haihe & Luanhe rivers	1956-1979	560	90.5	28.8	16.0	55.5
	1994-1999	515	67.5	21.5	7.6	35.0
	Runoff reduced	45	23	7.3	8.4	
	percentage (%)	-8	-25.4	-25.4	-52.5	
Yellow River	1956-1979	464	83.2	66.14	41.0	62.0
	1994-1999	413	64.3	51.1	11.7	22.9
	Runoff reduced	51	18.6	15.0	29.3	
	percentage (%)	-11	-22.7	-22.7	-71.5	
Huaihe river	1956-1979	860	225.1	74.12	59.1	80.0
	1994-1999	790	172.2	56.3	30.9	54.9
	Runoff reduced	70	52.9	17.88	28.1	
	percentage (%)	-8.1	-24	-24	-47.8	

Figure 3.2 Shortage in supplying drinking water to residents caused by drought in North China

Figure 3.3 Inundation of vast rural areas caused by the flooding in Weihe river in China in 2003

It is shown from statistics that there are totally 46,298 modern glaciers in China, covering an area of 59,406 square kilometres, with ice storage reaching 5,590 cubic kilometres, thus China is one of the countries in the world with the largest number of mountain glaciers. Researches of Chinese scientists have shown the impacts of climate change on the glaciers. As shown in Figure 3.4, the glaciers started to retreat from the 16th century and the shrink rate of glaciers increased apparently in the 20th century. Due to climate warming in the 20th century, the mountain glaciers in China have widely shrunk, and total area of glaciers in mountainous areas in the west of China has reduced by 21% (Table 3-4). Under the scenarios of the climate warming, the melting of glaciers would alleviate to a certain extent the reduction of runoffs from mountains in the near future, but would pose a big threat to the long-term utilization of water resources in the future.

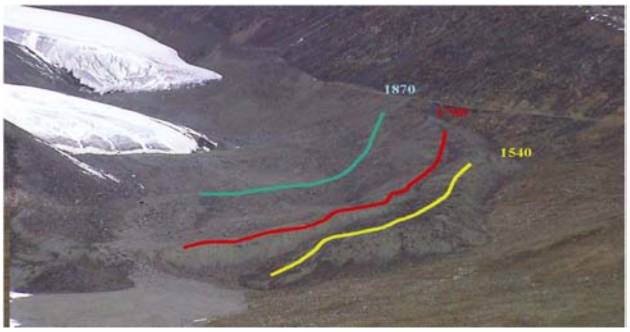


Figure 3.4 Change of Glacier No. I at the source of the Urumqi River in Tianshan

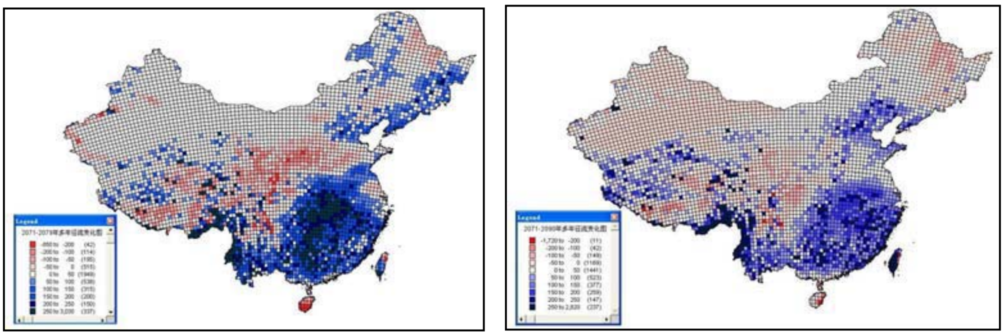
Table 3-4 Statistics on the changes of glaciers in west China since the Little Ice Age (LIA)

Mountain-chain	Area of modern glaciers (km^2)	Area of glaciers in LIA (km^2)	Area reduced since LIA (km^2)	Percentage of reduction (%)
Altay	280	431	151	54
Saygur	17	21	4	24
Tianshan	9236	11655	2419	26
Pamirs	2696	3100	404	15
Karakorum	6231	7602	1371	22
Kunlun	12266	13555	1289	11
Algin	275	319	44	16
Qiliang	1931	2390	459	24
Qiangtang	1802	1946	144	8

Plateur				
Tanggula	2213	2485	272	12
Gangdise	1766	2119	353	20
Nianqing Tanggula	10701	13633	2932	27
Hengduan	1580	2050	470	30
Himalayas	8412	10597	2185	26
Total	59406	71903	12497	21

3.3.2 Projection of water resources

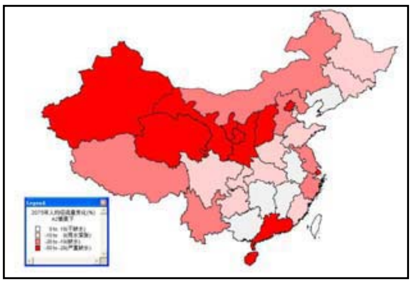
The simulated results (Figure 3.5) of the universal Variable Infiltration Capacity (VIC) distributed hydrological model show that in the next 70-90 years, annual average runoff depth would reduce by 2~10% in northern areas including Ningxia, Gansu, Shaanxi and Shanxi provinces and part of other provinces, while annual average runoff depth in southern areas including Hubei, Hunan, Chongqing, Jiangxi, Fujian, Zhejiang, Guangxi, Guangdong and Yunnan provinces would increase by 24%.

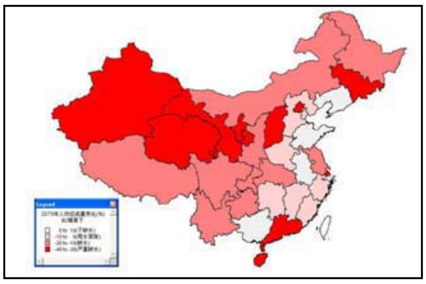


(a) Under SRES A2 scenario during 2071-2079 **(b) Under SRES B2 scenario under 2071-2090**

Figure 3.5 Changes of the average runoff depth under SRES A2 and B2 scenarios relative to baseline

In the next 50-100 years, climate change would not alleviate the shortage of water resources caused by the increase of population and social and economic development in China. On the contrary, the shortage of the per capita water resources in Ningxia, Gansu, Qinghai, Xinjiang, Shanxi and Shaanxi provinces would be further aggravated, with a reducing range of 20~40%. The increase of population and social and economic development might exaggerate the pressure on water resources due to climate change in the northern areas.





(a) Under SRES A2 scenario during 2071-2079 **(b) Under SRES B2 scenario under 2071-2090**

Figure 3.6 Distribution of vulnerable areas regarding per capita water resources in China in 2075

According to the trend of glacier shrinking since the Little Ice Age and the projected changes of summer temperature and precipitation in the future, by 2050, the area covered by glaciers in western China would reduce by 27.2%, and altitudes of the balance lines of oceanic glaciers, sub-continental glaciers and the mega-continental glaciers would be raised by 238mm, 168mm and 138mm respectively. This means that ice storage in the extremely high mountainous region in China would reduce by a large amount and the capacity of the melted water from glaciers for seasonal regulation of runoff in rivers would lose heavily.

3.4 Agriculture

3.4.1 Impacts of climate change on the conditions of agricultural production

Under the scenario of doubled concentration of carbon dioxide in the atmosphere, the majority of areas in China would experience climate warming and heat resources would increase. If the conditions of water, fertiliser and crop variety could meet the demands of such changes, it would be favourable for crop growing and photosynthesis.

After the climate warming, the areas north of the Yangtze River in China, especially in the middle-altitude and plateau areas, the crop growth season would start earlier and close later, and the potential growth season would be prolonged. However, after the climate warming, because the growth of crops is accelerated, the fertility period would be shortened generally. This would produce adverse effects on material accumulation and grain output. At the same time, the trend of drought and the deterioration of soil moisture condition after the climate change would be not beneficial to the wheat growth in China.

3.4.2 Impacts of climate change on the cropping system

The spatial and temporal distribution of climate resources would be affected by climate warming, and the present cropping system would change accordingly. The cultivated area of single cropping system might drop by 23%, the north boundary of double cropping system might move northward to the middle part of the region of the present single cropping system, and the proportion of triple cropping system might change from the present 13.5% to 36%. The northern boundary for triple cropping system would move northward by approximately 500 kilometres from the Yangtze River basin to the Yellow River basin.

With climate warming, a change would take place in the localities of major crop strains in China. Some crop strains currently popularized at some regions for specific climate conditions might not be able to adapt to the changed climate conditions. It is needed to cultivate new crop strains at appropriate time.

The problem of high temperature occurred with climate warming might be offset, to a certain extent, by the adjustment of crop pattern and structure and also by making use of temperature adaptability of crop. . However, because of the impacts ofother factors such as moisture content, it is hard to affirm whether the temperature increase would result in the increase of cropping index, or even total yield.

3.4.3 Impacts of climate change on the yield of major crops

Via simulation of the impacts of climate change on agriculture in China, some studies have shown the impacts of climate warming on the yield of major crops in China under $2\times CO_2$ scenario. It is found that impacts of climate warming on the yield of spring wheat would be larger than that of winter wheat; regarding single rice, the fall of crop yields would increase gradually from the south to the north with a rate between 6~17%; yield of early rice will drop and the least drop will occur in the central south part of the Yangtze River, while in the surrounding areas, particularly in areas in the west, there would be a considerable reduction in the yield (generally between 2~5%); yield of late rice in the north-western part of the areas south of the Yangtze River would all drop significantly, while that in the south-eastern part would drop less. Spring and summer maize yield would reduce by 2~7% and by 5~7% respectively, and irrigated and non-irrigated maize yield would reduce by 2~6% and about 7% respectively due to the climate warming.

With regard to cotton, each 1℃ increase of annual average air temperature would result in an increase of 10 days in frost-free duration. The accumulated temperature (≧10℃) in cotton growing season might rise by approximately 150~250 ℃·day and the growing season would extend for about 10 days, and the luxuriantly growing period (≧20℃) is estimated to continue for additional 7-10 days. When the ripening nature of a strain is not changed, because the air temperature rise in the cotton boll period is favourable to the increase of boll weight, the proportion of opening bolls before frost would increase by 5-10%, and the strength and maturity of cotton fibre would be somewhat improved.

3.4.4 Impacts of climate change on the total production of main crops

Along with the climate change, occurrence of unusual disasters such as drought, flood, high temperature and freezing events might increase. The results of simulation shown that under the assumption of no changes of the present planting system, planting varieties and production level, the total grain production might drop by about 10% due to climate change and extreme climate events during the period of 2030~2050. The production of three major crops – wheat, rice and maize – might all be reduced.

Though climate change would not shake China’s capacity of self-supply in grains, it would put a high demand on management techniques of agricultural production and extra input into agriculture.

3.4.5 Impacts of climate change on food quality

The rise of CO_2 concentration would result in the decline of crop quality. Experiments in China showed that if CO_2 concentration reached 565 ppmv, protein content in wheat would drop by 3~5%; and if CO_2 concentration doubled, amino acid and crude protein contents in soybean would fall by 2.3% and 0.83% respectively, but contents of crude fat, saturated fatty acid and kernel unsaturated acid would increase by 1.22%, 0.34% and 2.02% respectively; and crude fat, crude starch and moisture in maize kernel would increase to some extent, but the amino acid, crude protein, crude fibre, amylase and total saccharide would present a descending trend.

3.4.6 Impacts of climate change on the amount of pesticide and chemical fertiliser application and on the inputs in agriculture

According to statistics, the largest agricultural loss in China is caused by crop diseases and pests, accounting for about 20-25% of total agricultural production. The climate warming would change the distribution of agricultural diseases and pests. An analysis shows that under $2\times CO_2$ scenario, the occurrence of armyworm would generally increase by one generation; over the areas in Qinghai, Gansu and Sichuan where cross-summer wheat stripe rust exist, the surface air temperature increase in winter would be larger than in summer, which would be more favourable for wheat stripe rust to survive in winter and in summer and to spread southward; the warming in winter would be also favourable for weeds spreading. This means that the amount of pesticide and herbicide application would be increased due to the climate change.

The application amount of fertiliser would be altered by climate change. When the temperature increases by 1℃, the released amount of available nitrogen which can be directly absorbed and utilized by plants would increase by about 4% and the release period would shorten by 3.6 days. Therefore, if the original fertiliser efficiency was expected, the amount of fertiliser applied each time would increase by about 4%. The increase of the application amount of fertiliser would not only cause farmers to increase the input, but also cause damage to soil and environment due to the increase of volatilisation, decomposition and eluviation loss of fertiliser.

Because of the adverse impacts of climate change, cost of agricultural production would increase, including, for example, irrigation cost will increase in areas where the soil moisture would be reduced; increased investment is needed to improve water conservancy facilities, modify and improve soil and preserve water and soil in areas where the soil erosion has been aggravated and erosion by eluviation is serious; and increased input in fertiliser and pesticide is needed because of the loss of organic substance in soil, the decline of soil fertility and the occurrence of plant diseases, insect pests and overgrowth of grass and weeds resulting from the climate change.

3.5 Terrestrial ecosystem

3.5.1 Impacts of climate change on phenophase and vegetation

The vulnerability of an ecosystem is caused by many factors including natural and human factors. Among the natural factors, climate is the most important influencing factor. In accordance with the main causes for bringing about vulnerable ecosystems and assisted with estimation from remote sensing images, the distribution of vulnerable ecosystem in China is mapped (Figure 3.7). It can be seen that the area covered by vulnerable ecosystems in China is approximately 1.94 million square kilometres, exceeding one fifth of the total land territory of China. It is mainly distributed in seven regions, of which five are situated in west China.

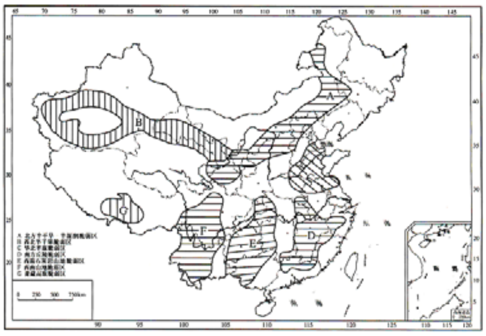
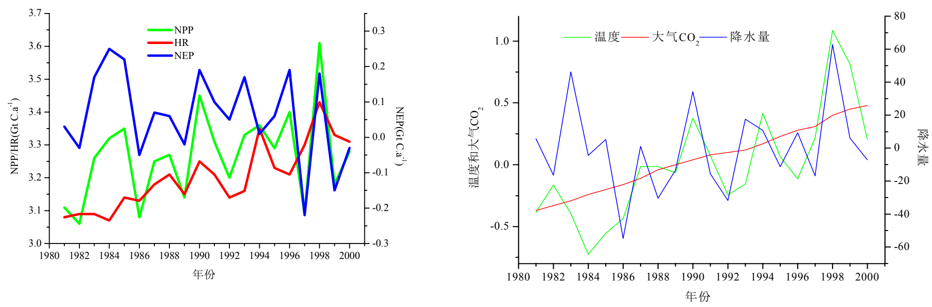


Figure 3.7 Distribution of the vulnerable ecosystem in China

There is an obvious impact of climate change on the phenophase in China. As a comprehensive indicator showing the sensitivity of the regional climate change and the organism and natural processes in the ecosystem, phenophase has been widely used in the assessment of the impact of climate change. It is found through analysing the data from phenological observation network for recent 30 years in China that the temperature is the principal factor affecting the phenophase of ligneous plants. The analyses on phenophase observation datasets for recent 40 years in China shown that with temperature increasing in spring in the northeast, north China and the lower reaches of the Yangtze River since 1980s, the phenophase period has been advanced; and with the temperature decreasing in spring in the eastern part of the southwest region of China, the middle reaches of the Yangtze River and south China, the phenophase period has been postponed. If the surface air temperature in spring increases by 0.5℃ and 1℃, the phenophase period would be advanced by 2 days and 3.5 days; conversely, if the surface air temperature drops by 0.5℃ and 1℃, the phenophase period would be delayed for 4 days and 8 days, respectively. Furthermore, if the annual average surface air temperature increase by 1℃ in the future, the phenophase period in spring in China would be advanced by 3-4 days and in autumn, the phenophase period would put off by 3-4 days, the green-leave period would extend by 6-8 days and the mature period for fruit and seeds would be advanced with a larger range than that in spring. Generally speaking, the range of advancement or postponement of the phenophase phenomenon is more obvious in the north than in the south.

With the help of various statistical models and climate scenarios, Chinese scientists have projected possible changes of various vegetation belts, and obtained the following consistent conclusions: under 2×CO_2 scenario, vegetation belts or climatic belts in China would move towards high altitude or west, and there would be corresponding changes for the scopes, areas and boundaries of the vegetation belts. It is projected that the areas covered by deciduous forests and coniferous forests would reduce obviously, even probably move out of China; In the future, north China and the Liaohe river basin in the northeast China could be transferred into grassland. The natural landscape in the base belt of mountain areas and surface course of plateaus could be changed and removed due to climate change, and even the vertical band spectrum of distribution boundaries would be displaced.

The productivity and carbon flux in the terrestrial ecosystem are highly sensitive to climate change. According to estimation, the total amount of the net primary production (NPP) and soil heterotrophic respiration (HR) were increased in China in 1981~2000 because of the impacts of increased CO_2 concentration and changes in temperature and precipitation. China's terrestrial ecosystem absorbed CO_2 due to the combined impacts of CO_2 concentration rise and climate change in the past 20 years, and has become a carbon sink (Figure 3.8). It should be pointed out that carbon emission and removal due to human activities, especially the land use changes and disasters, were not considered in the above calculation.



(a) **(b)**

Figure 3.8 Interrelationships between the terrestrial ecosystem productivity, soil heterotrophic respiration and climate change in China

3.5.2 Impacts of climate change on forest

It is shown from the combination of present forest vulnerability index compiled on the basis of the quality of forest land, the composition of forest age, the forest fire and the supply of firewood with the future climate change scenario researches that the forest zones most affected by the future global climate change in China would be mainly distributed in the southwest of, central and south China, roughly similar to the distribution of present vulnerability.

Under the circumstance of future global climate change, the pattern of geographical distribution of the forest primary productivity in China would not undergo any obvious change, namely, forest productivity would decrease progressively from the southeast to the northwest. , by various rates. In the tropical zone and sub-tropical zone, forest productivity would increase by 1~2%, in the warm-temperate zone, by about 2%, in the temperate zone by 5-6%, and in the cold-temperate zone by 10%. The productivity of main timber tree species in China would increase in an order from the biggest to the smallest: Xing'an deciduous pine, Korean pine, Chinese pine, Yunnan pine, masson pine and cedar, and the range of the increase would be 1~10%. The impacts of climate change on diseases, pests and forest fires were not considered in the above study.

Based on the GCMs scenario projection and ecological index of different tree species, the impacts of climate change in 2030 on the distribution of the main tree species for afforestation was assessed. The results shown that areas suitable for various tree species would decrease, for Xing' an deciduous pine, Chinese pine and masson pine by about 9% and for cedar by 2%. In the future

60 years, under the scenario of average surface air temperature increasing by 2~3℃ and precipitation increasing by 5%, the northern boundary for cedars would move northwards by 2.8 latitudes and the lower limit of the height above sea level would rise by 110 metres. The southern boundary for deciduous pine in north China would move northwards by 3 latitudes and the lower limit of the height above sea level would rise by 300~400 metres, but due to insufficient water in the northern boundary, it would not move very far and the distribution area would shrink to present a belt-form distribution. The northern boundary of the masson pine would move northwards by about 6 latitudes and the upper limit of the height above sea level would rise by 330 metres. There would be no obvious trend for Yunnan pine to move northwards, and the upper limit of the height above sea level would rise from the present 2,800 metres to more than 3,080 metres.

3.5.3 Impacts of climate change on grassland, frozen soil, wetland and desert

The population composition and the productivity of grassland would change corresponding to the CO_2 concentration rise and climate change. The impacts of climate change on the productivity of grassland varies in different grassland areas. Water is the principal limiting factor for the growth and development of pasture in the arid and semi-arid pastoral areas, therefore the impacts of the temperature rise would not be obvious for pasture growth; while in areas where water is in serious shortage, evaporation would be accelerated by temperature rise, leading to a drier soil and aggravated damage on pasture. In wet-cool and extreme cold regions where water supply is usually sufficient, temperature is the principal limiting factor for the productivity of grassland, so temperature rise might lengthen the growth period of pasture, increase the accumulated temperature in the production season and raise the efficiency of photosynthesis, thus lifting the productivity of grassland.

Under $2\times CO_2$ scenario, the climate in pastoral regions in northern China would become dryer and warmer, pasture lands would move forward to the humid areas and the present boundaries of grassland would move eastwards. The boundaries of alpine pasture and grassland in Qinghai-Tibet Plateau, Tianshan Mountains and Qiliang Mountains would move upwards correspondingly. If temperature increased by 3℃, corresponding boundaries of various grassland regions would move upwards by 380~600 metres.

Frozen soil is very sensitive to climate change. Since the 1980s, maximum frozen soil depth in China began to reduce. After 1990s, the scale of this reduction in many areas became more obvious. It is shown from the simulation assessment that intrinsic changes on frozen soil would not occur in the next 20~50 years for the permafrost, but if the average surface air temperature on the plateau rose by 3℃, permanent frozen soil in the Qinghai-Tibet Plateau would undergo a obvious change. The proportion of disappearance would be as high as 58%, and the majority of the permafrost in the eastern and southern parts of the Plateau would disappear.

Statistics shows that the amount and area of natural wetland in China would be reduced continuously, the capacity of retaining water, storing water and regulating floods would drop gradually, and many rare species dwelling on the wetland ecosystem would disappear. Besides human impacts, climate change would also be an important factor. Since 1950s, most of inland lakes and wetlands in the northwest China have shrunk, and even dried up. Apart from human impact, long-term warm-dry climate in the northwest China is an important reason for that. As simulated, the area of swamps in the northeast of China would reduce under the future climate change scenarios.

The area of desertification in China has expanded continuously, which is closely related with climate change. Based on the data of 1,914 weather stations over China from 1981 to 1990, Chinese scientists defined the scopes and boundaries of arid, semi-arid, and sub-humid regions in China, and at the same time, assessed changes of bioclimate-type areas due to future desertification in China. The results show that by 2030, with the global air temperature increasing, the area of desertification in the arid and semi-arid, and sub-humid areas in the north China would expand.

3.5.4 Possible impacts of climate change on biodiversity

The key areas of biodiversity in China are mainly located in Changbai area ofJilin Province, the north part of Hebei province, Qinling Taibai Mountains in Shaanxi Province, high mountain and canyon in western part of Sichuan Province, high mountain and canyon in western part of Yunnan Province, uplands in the neighbouring area of Hunan, Guizhou, Sichuan and Hubei provinces, Nanling upland in the neighbouring area of Guangdong, Guangxi, Henan and Jiangxi provinces, Zhejiang-Fujian upland, the central upland in Taiwan, the upland in the southeast part of Tibet, Xishuangbana of Yunnan Province, the limestone area in the southwest part of Guangxi Zhuang Autonomous Region, the south central part of Hainan Island, Hoh Xil of Qinghai province, etc. The future climate change would have impacts on the environment of those areas, thus affecting the distribution of biodiversity.

The future climate change would also pose a threat to species diversity in China. In particular, it might pose a threat to the habitat of endangered species and upland species adaptable to a narrow scope of climate, species that adapt to cold climate in the Qinghai-Tibet Plateau and species that are weak in the capacity of removal, such as giant panda, Yunnan golden monkey, *cevus albirostris, Taiwania flousiana, Ammopipthus monogolicus* and chiru, etc.

The future climate change might also influence the distribution of intruding species by means of impacting pests, diseases and weeds. Climate change might cause the spread of pests and diseases to an expanded scope, the increase of the insect density and the change in the geographical distribution of diseases and pests.

3.6 Changes in sea level, coastal zone, and offshore ecosystem

3.6.1 Change in sea level

According to the Bulletin on the Sea Level in China in 2000, in the past 50 years, China's coastal sea level has risen at an annual rate of 1.0~3.0 mm on average. In 2000, China's coastal sea level ascended by 51 mm compared with normal sea level (referring to as the mean sea level in 1975~1986). The general trend of the change in sea level rise is that: the change along the southern coast is relatively great, while that along the northern coast small; among the coastal provinces (autonomous regions or municipalities directly under the central government), the greatest sea level rise was recorded along the coastal zone in Hainan and Guangdong provinces, while the smallest along coastal zone in Tianjin, Hebei and Liaoning provinces. According to the Bulletin on the Sea Level in China in 2003, the sea level rise rate in the East Sea is highest among the sea areas of China, reaching 3.1 mm/a, slightly higher than the global average rate of sea level rise. Among key marine areas, the coastal sea level rise of the Yangtze River delta and the Pearl River delta is at an average rate of 3.1 and 1.7 mm/a, respectively.

Chinese scientists projected the relative sea level rise in five coastal zones in China in the future by using a Chinese sea level rise model. The results are shown in Table 3-5.

Table 3-5 Projection of the sea level rise in five coastal areas in China

(unit: cm)

Coastal area	2030		2050		2100	
	Amplitude of rise	Best estimation	Amplitude of rise	Best estimation	Amplitude of rise	Best estimation
Coast from Liaoning to Tianjin	10~13	11	16~23	20	49~69	60
Coast along Shandong Peninsula	-3 – 1	-1	-1 - 6	3	21-40	31
Coast from Jiangsu to eastern part of Guangdong	12-16	14	19-25	23	54-74	65
Coast adjacent to mouth of Pearl River	4-8	6	9-15	12	31-56	47
Coast from western part of Guangdong to Guangxi	12-15	14	19-26	23	54-74	65

3.6.2 Coast erosion

The coast erosion in China is rather serious, and presented a trend of continuous expansion since 1950s. According to statistics, about 70% of current sandy beaches and the majority of the muddy beaches in the open water areas are in the state of erosion-induced retreat. The length of the eroded coastal line has accounted for over one-third of the total length of the coastal line of the mainland of China. Generally speaking, it is more serious in the north of the mouth of the Yangtze River than in the south.

The storm surge disaster and sea level rise caused by climate warming are two most apparent natural factors for coast erosion. The death of coral caused by the sea water temperature rise, human exploitation and the destruction of mangrove are also the causes for coast erosion.

The interactions of waves and storm surges would be enhanced by continuous sea level rise and water depth increase caused by future global climate warming, which would aggravate the coast erosion process in China.

3.6.3 Sea water intrusion

Since 1970s, sea water intrusion in the coast areas of China has become increasingly serious, occurring mainly in the Liaodong Peninsula, Qinhuangdao area and the Shandong Peninsula. Currently, affected area of the sea water intrusion in the coasts of China has exceeded 800 square kilometres, with the greatest intrusion distance of approximately 10 kilometres and the greatest intrusion rate of 495 metres a year. Aside from the sea level rise, the drying up of the underground water and the decline of the underground water level are both causes of intrusion.

The sea water intrusion has brought about the salinization of large stretches of land, leading to the continuous reduction of agricultural production, erosion to coastal structures, the difficulties for plants to grow in areas of coastal zone and the destruction of shelter forests.

With the future global climate warming and the continuous sea level rise as well as the shortage of fresh water resources in coastal areas in China and the continuous over- extraction of underground water, the sea water intrusion would become more and more serious, affecting people's life and the economic development in the coastal regions.

3.6.4 Impacts of the sea level rise on the deltas

There is a large area of river mouth deltas and littoral plains with low altitude along the coastal zone in China. It is calculated that along the coastal line, land area with elevation being smaller than or equal to 5 m is 143,900 square km, of which key vulnerable areas are the Pearl River Delta (including Guangzhou), the eastern part of the East China Plain (including Shanghai), the North China Plain (including Tianjin) and the southern part of the Lower Liaohe Plain (including Yingkou). With the most developed economy, most concentrated city distribution and densest population along the coasts in China, those areas play a decisive role in the sustainable development of the Chinese economy. In accordance with the highest historic tidal level and the present state of coastal sea dykes, Chinese scientists estimated the scope of possible submerged area of the Pearl River Delta under the scenario of future sea level rise by 30 cm (Figure 3.9)

Figure 3.9 The possible submerged area by sea water under the scenario of sea level rise of 30 cm on the condition of the present tide-protecting facilities and the highest historic tidal level in the Pearl River Delta

The elevation in vulnerable areas along China's coastal zone is fairly low, generally between 1.5 to 5 m, subject to the attacks of floods. In the areas of the lower reach of river and the river mouths, due to silting at the river mouths in the lower reach caused by the soil erosion in the upper and middle reach, the sea level rise is bound to prop up and elevate the floods, thus increasing the threat of floods.

Owing to sea level rise, the tide moves upstream further along the rivers, affecting the supply of fresh water on river banks and lowering the water quality. Though the tidal range in the Pearl River Delta is not large (1.0~1.5 m), the tide flows far upstream along the river. The impact of salty tide would be more deep-going with sea level rise. The upward shift of the convergence point and the salty water wedge would not only bring about a change of the sedimentation of mud and sand in the riverbed, but also bring up new problems to urban water supply.

3.6.5 Impacts on the marine ecosystem

There is a large area of wetlands along the coastal zone in China. The sea level rise would not only reduce the area of wetlands, but also cause their functions to experience drastic regression. The loss of wetlands would seriously harm vegetation and animal communities living in low places, leading to a serious decline in their functions of ecological service such as water-body purification, nutrients transformation and transportation and biological habitat. Wetlands are closely related to climate change, particularly wetlands at river mouths. The wetland area would reduce due to the decrease of water and sand carrying caused by the reduction of river run-off volume, runoff break and a change of river course.

Figure 3.10 Wetlands at the Yellow River Mouth

Over 400 kinds of corals have been collected and identified in China, of which close to 200 are hermatypic corals, accounting for two thirds of total hermatypic corals in the region of the Indian-Pacific Oceans.

According to the survey on the coral reefs since 2000, bleaching and death of coral were found in different degrees in the coasts of Hainan, Guangxi, Taiwan, Hong Kong and other areas of the South China Sea (Figure 3.11 and Figure 3.12). Coral bleaching is mainly due to sea water temperature rise caused by global climate warming. The bleaching would make corals to lose nutrients gradually, and finally lead to death.

Figure 3.11 Coral bleaching in Weizhou Island in Guangxi, China

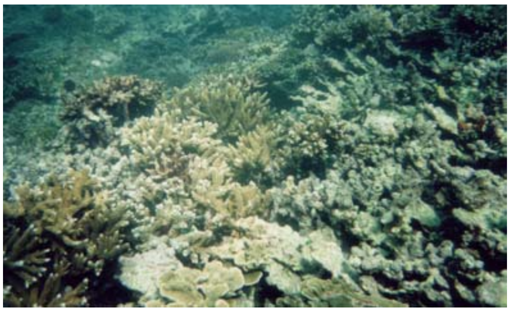


Figure 3.12 Coral bleaching in Qingge, Qionghai, Hainan, China

There are 16 families, 20 genera and 37 species of mangrove in China. They are naturally distributed in the coastal waters of Hainan, Guangxi, Guangdong, Zhejiang, Fujian, Taiwan, Hong Kong and Macao. The northern boundary of the natural distribution is Fuding City, situated in the northernmost part of Fujian Province. It is shown from the national survey of mangroves in 2002 that the total area of the existing mangroves in China is 15,000 hectares and most of them are secondary shrub forests (Figure 3.13).

Figure 3.13 Mangrove in Guangxi, China.

It is estimated by Chinese experts that natural distribution of various mangrove plants along the coasts in China may extend northward by 2.5 latitudes under the scenario of 2℃ increase of surface air temperature, and the northern boundary of the natural distribution of mangroves might move from Fuding City of Fujian Province at present to the vicinity of Chengxian County of Zhejiang Province in the future.

Sea water aquiculture on the coasts would be impacted by global climate warming. For example, in the winter of 1995, sea water temperature in the north part of the Yellow Sea were about 1℃ higher than the previous year, which made the mortality rate of scallop spat in the sea area to rise.

However, in Laizhou Bay of the Bohai Sea where water temperature was normal, scallop spat contracted fewer diseases. Similar situations occurred in regard to the growth of oyster spat in the Pacific Ocean.

3.7 Adaptation measures

Up to now, study in China on policies for adaptation to climate change is still at the initial stage, and a systematic strategy for adaptation to climate change has not yet taken form. However, some policies and measures that have been adopted have played a positive role in the adaptation to climate change. In a certain period in the future, China will, in its own capacity, continue to adopt policies and measures in favour of the adaptation to climate change.

3.7.1 Water resources

There are two objectives for adaptation policies with regard to water resources. One objective is to promote sustainable development and utilization of water resources in China, and the other objective is to reinforce adaptive capacity of the water resource system and reduce the vulnerability of the water resource system caused by climate change. In applying policies for adaptation, uncertainties about the impact of climate change should be taken into account and non-regret policies should prevail, namely, adopting all policies and measures which can be adapted under current standards and regulations.

(1) Adopted measures

The Law on Water Resources of the People's Republic of China has been promulgated to safeguard and normalize the management of water resources. The Project of South-to-North Water Diversion has been launched in order to alleviate the pressure of lack of water resources in Beijing, Tianjin and the Shandong Peninsula. Key water conservancy projects such as Three Gorges Project in the Yangtze River, Linhuaigang Project of the Huaihe River, Ni' erji Project of the Nenjiang River, Baise Project in Guangxi, Shapotou Project in Ningxia, and Zipingpu Project in Sichuan were constructed to increase the capacity for preventing floods and reducing disasters. The Project for Addressing the Supply of Drinking Water for People and Animals in Rural Areas were implemented, which supply drinking water for 15 million people in rural areas. The construction of upgrading projects for water-saving in 226 large irrigated areas and 200 demonstration projects for water-saving irrigation were launched to raise water use efficiency. The National Plan for Protecting Ecology and Safeguarding Water Resources in the Grassland of Pastoral Regions were formulated and the construction of water conservancy experimental projects in pastoral regions was launched. The construction of small projects for water conservancy and soil conservation was intensified. The Plan for Building Silt Dams in Loess Plateau Areas was completed and the project was launched. Experimental demonstration projects have been launched for restoring ecosystem in key areas in seven major river basins, in the origin regions of Three Rivers (the Yangtze River, the Yellow River, and the Lancangjiang River), in the ecologically vulnerable areas in the northwest and in the 'three transformations' (sandification, degeneration and salinization) areas, to give impetus to the implementation of closing hillsides to livestock grazing on a large scale in all parts of the country. Series pilot projects for building water-saving society in Zhangye of Gansu Province, Mianyang of Sichuan Province and Dalian of

Liaoning Province were launched and initial positive results were achieved. A series of measures to convert and supplement water for the Heihe river, the Yellow River and the Tarim River were carried out, which alleviated serious water shortage in some key cities and restored the ecosystem deteriorated by water shortage and pollution. The work of formulating a national comprehensive planning on water resources have been stepped up and achieved progressing results.

(2) Adaptive measures being and to be adopted

- Establishing a modern water conservancy management system and strengthening the unified management and protection of water resources;
- Building up a water-saving agriculture and industry, vigorously popularizing water-saving irrigation, developing sprinkle irrigation and dripping irrigation, extending the use of water-saving facilities so as to increase water use efficiency;
- Increasing the capacity of reservoirs and river dams to prevent floods, tapping water sources to increase water-supply capacity, planning and building the trans-valley water converting project and achieving optimized allocation and utilization of water resources cross valleys;
- Enhancing the protection and building of ecosystem, restoring vegetation cover, preventing and controlling soil erosion and loss; and
- Protecting the water environment, preventing and controlling the water pollution, increasing the rate of treating sewage, improving the renewal and utilization of sewage, as well as achieving the benign cycle of the ecology and environment.

3.7.2 Agriculture

With regard to the adaptation in agriculture, there are two aspects: first, the spontaneous adaptation; second, active and planned adaptation, namely, the government provides guidance for carrying out agricultural restructuring to raise the capacity of agriculture to resist the adverse impact of climate change and as a result, enhancing adaptation capacity.

(1) Adopted measures

- Adjusting the agricultural structure and the cropping system, i.e. expansion of the area of paddy-rice fields in the areas of northeast China, and a shift from the dual structure in the traditional farm production in some areas in China to a ternary structure of coordinated development of food crop, fodder crop and cash crop, etc.;
- Raising multiple cropping index;
- Selecting, cultivating and popularizing stress-resistant varieties;
- Improving management measures, i.e. active popularization of water-saving agricultural measures, technologies of optimized fertilization and deep fertilization and technologies of comprehensive prevention and control of soil erosion, etc.;
- Constructing and improving agricultural infrastructures, i.e. fundamental construction of farmland, fundamental construction of water conservancy, building of agricultural ecosystem, construction of farmland with high and stable yields, conversion of unduly reclaimed land to pasture, etc., which, to a certain extent, have increased the adaptive capacity of China's agriculture to climate change.

(2) Adaptive measures being and to be adopted

Adjustment of the structure of agricultural production. The cropping system would be adjusted in a scientific way to adapt to climate warming. In northeast China, due to warming of future climate, planting areas of winter wheat would be expanded and new varieties of maize and paddy rice with a long growing period and high yield would be selected. In North China Plain, because water supply in growing season would be affected and the water shortage would be enhanced in winter and spring, water-saving agriculture would be popularized vigorously. In the lower reaches of the Yangtze River, vertical climatic conditions in hilly and mountainous areas will be made full use to develop sub-tropical cash trees such as tea plants, oranges and tangerines. In South China, various kinds of one-year triple-cropping systems would be developed, and some rapid-developing and early-maturing crops with short growing period would be planted by means of inter-planting and mixed sowing. In southwest China, multiple cropping acreage would be expanded, patterns of planting wheat-rice-rice, rape-rice-rice or wheat-rice-secondary rice with inter-planted late rice would be popularized, and various philotherm and thermophilous crops and subtropical and temperate fruit trees as well as under-growth medicinal herbs with high economic value would be developed. In northwest China, multiple cropping index would be raised step by step and dry-land agricultural technologies would be popularized to store water and preserve soil moisture and foster soil fertility.

The selection and cultivation of new varieties. Stress-resistant varieties would be cultivated or selected, and new technologies, including biological technology, would be developed. On the basis of collection and screening of germplasm, a great number of new fine animal and plant varieties that have high yield potential, fine intrinsic quality, outstanding comprehensive resistance and widespread adaptability would be bred, so as to enhance the adaptability of agriculture to climate change.

The comprehensive management techniques. Techniques on optimised fertilization and deep fertilization would be popularised, and the problem of inadequate amount of fertiliser and improper fertilization would be solved. Apart from enlarging the proportions of concentrated fertiliser, complex fertiliser, formula fertiliser and biochemical fertiliser in the production of chemical fertiliser and a gradual input of trace nutrient elements, utilization of organic fertiliser (such as green manure, animal manure and biogas residue) would be encouraged. Techniques of precision management of soil nutrients and balanced application of fertiliser should be studied and popularized, and the technique of scientific method of applying fertilisers and scientific field management should be disseminated.

Research and manufacture of pesticide should be based on the research on pest insects, natural enemy and the physiology and ecology of crops, in order to achieve high effect, low toxicity and environmentally sound and prevent the generation and development of drug resistance of pests. The techniques for preventing and controlling the plant diseases, pests, overgrowth of weeds and multiplication of mice would be popularized.

Irrigation methods would be improved, research, popularization and application of water-saving agriculture and scientific irrigation would be strengthened, techniques for preserving soil moisture would be developed and other measures for field management would be taken. Unitary water-saving techniques used in the past would be changed and developed in the direction towards a highly synthesized comprehensive technique and fully use of integrated effects. Same importance would be given to the storage of water, the increase of water, the retaining of water and the highly effective use of water, and agronomic water saving, biological water saving and engineering water saving would be achieved at the same time. The water-saving agricultural technique should be encouraged to develop in the direction of the quantification, standardization, modelization and integration as well as in a high effectiveness and sustainable way, so as to raise water use efficiency.

The precision farming technique based on automization and intellectualization should be studied and popularized to realize modern management of agriculture, reduce production cost for agriculture and raise the utilization rate and output ratio of land.

Unduly reclaimed lands would be reconverted to pastures reasonably, vegetation of grassland would be restored, the covering rate of grassland would be increased, function of soil conservation would be enhanced and desertification would be prevented from further expansion. The number of livestock would be determined by the amount of grass. The animal carrying capacity would be controlled to bring a turn to the present situation of excessive grazing and the serious over-carrying of grassland. Artificial grasslands would be built and grass seeds with high temperature-resistance and drought-resistance would be chosen with a big attention being paid to the diversity of grass seeds to avoid the pasture degradation.

Agricultural infrastructural facilities would be improved to raise the capacity of agriculture to meet emergencies and the level of it in combating disasters and reducing disasters. Climate change would make rainfalls in some arid or semi-arid areas in the north become more unstable or dryer. For those areas, soil improvement and water control should be regarded as the central task in the future in order to strengthen farmland fundamental construction, improve the ecosystem of agriculture, build high-yield and stable-yield farmlands and continuously raise the capacity to meet emergencies caused by climate change and the level of combating disasters and reducing disasters. At the same time, farmland irrigation projects and facilities would be reasonably improved and construction of engineering facilities for a comprehensive prevention and control of natural disasters would be intensified.

3.7.3 Terrestrial ecosystem

The adaptability of terrestrial ecosystem comprises two aspects: one is the capacity of the self-regulation and self-restoration of the ecosystem and the nature; the other is the anthropogenic activity, especially the basic social and economic condition, the anthropogenic impacts and interference, etc.

(1) Adopted measures

Various laws and regulations related to the protection of terrestrial ecosystem have been formulated and implemented, including the Law on Forest of the People's Republic of China, the Law on Land Administration of the People's Republic of China, the Regulations on Returning Cultivated Land to Woodland, etc., in order to control and stop the deforestation, establish the natural conservation areas and forest parks, protect the existing forests and vigorously develop the projects for building forest ecosystem.

(2) Adaptive measures being and to be adopted

Enhancing the protection of the existing forests through management. Measures being adopted include: controlling and stopping the deforestation and the ecological damage, implementing the policy for the protection of natural forests, providing strict protection for preserving forest to resolutely stop the felling of forests, changing the current felling pattern of natural forests to achieve the transformation of the timber production by cutting and utilizing natural forests to the direction of managing and using artificial forests, improving and expanding the natural forests being protected, improving the national network of natural reserves to establish a corridor of natural reserves, and preventing and controlling other human damages and natural disasters such as forest fires and forest diseases and pests.

Enhancing the storage via management. The measures being adopted include: increasing the area and carbon density in the comprehensive ecosystem of natural forests, artificial forests and agro-forests, increasing the timber products, especially the long-lived and passivated timber products to expand the carbon storage, and expanding the soil carbon storage.

Developing the substitution via operation. The measures being adopted include: greatly developing the fuelwood forests to reduce or substitute for fossil fuels and developing the long-life timber products.

Developing a strategy of management and operation adaptable to the future global climate warming. The main measures include: developing high-quality varieties, developing drought-resistant tree species and formulating a policy for the management in the intermediate cutting and in the rotation.

3.7.4 Sea level and coastal zone

(1) Adopted measures

National and local laws on the sea have been enacted, including the revision of the Marine Environmental Protection Law of the People's Republic of China, the publication of Regulations on the Marine Environmental Protection and the formulation of the Regulations on Mangrove Protection and the Regulations on Coral Reef Protection by Hainan Province. The construction of the system for stereo monitoring of marine environment has been intensified and a national network for monitoring marine environment has been established. A national survey on marine ecology has been carried out, directed at typical issues on marine ecology. Ten red tide monitoring districts have been set up in the coastal marine aquicultural zones and the discovery rate of red tide has been raised. In order to protect the diversity of marine organism, national-level and local-level marine natural protection areas have been established. In order to improve public awareness about the protection of marine environment and deepen the public understanding of the marine environment, marine disasters and marine ecosystem, competent authorities of the State Oceanic Administration have issued the Bulletin on Marine Environment in China for the preceding year in the first season of each year, comprising the Bulletin on the Quality of Marine

Environment in China, the Bulletin on Marine Disasters in China and a three-year Bulletin on the Sea Level in China.

(2) Adaptive measures planed to be adopted

The construction of coastal facilities for the protection against sea level rise would be strengthened. In order to adapt to the increasing trend of sea level rise due to global warming, standards designed for sea dikes would be raised from the present standard for meeting maximum sea level occurrence in 20 years, 50 years or much longer. The existing coastal facilities would be heightened and reinforced. In constructing environmental protection facilities and drainage works in the coastal cities, impacts of sea level rise should be put into consideration.

The technical level for the renovation and reconstruction of the coastal ecosystem would be raised. The whole-set technique for forestation with seeds of mangrove, techniques of introducing high-quality tree seeds and their cold-resistance in the northward migrations and the technique of transformation of secondary-forest would be researched and applied. Methods for determining and assessing the effects of protection for mangrove would be formulated. The index for marine environment suitable for planting mangrove would be set up. Experiments and researches would be conducted for transplanting corals, and the structure, function and restoration mechanism for the diversity of the coral reef ecosystem would be studied.

The construction of coastal monitoring system would be strengthened. Various high-tech monitoring approaches, especially satellite remote sensing and geographical information system would be used to strengthen the monitoring of the change of sea level in the coastal areas, the change in the ecosystem of sea-side wetland, mangrove and coral reef and various influencing factors, so as to bring about a long-term, continuous and stable monitoring system. Inter-sector technical cooperations and exchanges of datasets would be carried on and the network sharing of monitored information would be promoted.

3.8 Uncertainties and priorities for further study

Up to now, assessments on the impact of climate change in China still contain considerable uncertainties. This is because: methods for projecting future climate change are not perfect enough and social-economic scenarios are not certain; it is difficult to identify the impact of climatic factors from that of other factors; the method used for assessing the impact is not yet perfect, and most models for assessment are static models and have not been given sufficient parameter rating and validation.

In order to reduce the uncertainties in the assessment, it is necessary to improve the projection of the GCMs, develop the RCMs suitable to China, vigorously develop impact assessment models established by Chinese scientists, and carry out a sufficient validation and improvement for foreign models.

Present impact assessments in China are mainly concentrated on agriculture, water resources, terrestrial ecosystems and coastal zones. Aside from continuing efforts in strengthening, improving and expanding the assessment of impacts of climate change on those fields, study should be conducted on the fields of human health, tourism, energy, national key projects and building facilities. There is a vast area in China with various landscapes, so the impacts of climate would be different across regions. There is a particular need to conduct a thorough study on the impact of climate change on different regions, so as to find out concrete adaptive measures suitable to the circumstances of different regions.

It is shown from the reality that the impacts of extreme weather/climate events on all sectors are very strong, but relevant study in this regard is very limited. Therefore, study on the occurrence of extreme weather/climate events and their impacts should be strengthened.

Chapter 4 Policies and Measures Related to Climate Change Mitigation

In accordance with the provisions of the Convention and the Kyoto Protocol, China, as a developing country, is under no obligation to quantified reduction or limitation of greenhouse gas emission. However, over the past 20 years and more, in the spirit of being responsible for the global environment and meeting the need of promoting sustainable development strategy, China has made positive contributions to relieving the increase of greenhouse gas emission and protecting global climate by adjusting its economic structure, improving its energy efficiency, developing and using hydropower and other renewable energy and strongly implementing afforestation policies and measures.

4.1 Comprehensive policies and measures

4.1.1 Sustainable development strategy

Sine 1992, the Chinese Government has taken a series of actions and measures in a responsible manner and effectively pushes forward the process of China's sustainable development.

— *Ten-Point Strategy for China's Environment and Development* drawn up in August 1992, clearly shown that the sustainable development is the inevitable option for China's present and future.

— China's sustainable development strategy, *China Agenda 21 --China's Population, Environment and Development in the 21st century ,* was formulated and issued in 1994.

— In March 1996, the *Ninth Five-Year Plan and 2010 Long-Term Program for National Economic and Social Development of the People's Republic of China* was approved at the 4th session of the 8th National People's Congress, setting sustainable development as the important guideline and strategic objective of China's social and economic development for the first time.

— *The Outline of the Tenth Five-Year Plan for National Economic and Social Development of the People's Republic of China* (2001 to 2005) issued in March 2001, fully demonstrated the strategic thinking and requirements of sustainable development, put forward specific objectives of sustainable development in various areas and at different phases, and formulated and implemented specific key plans for ecological construction and environmental protection.

— In 2003, following the 2002 World Summit on Sustainable Development, the Chinese Government formulated t*he Program of Action for Sustainable Development in China in the Early 21st Century*. In the same year, the *Decision on Some Issues of Improving Socialist Market Economic System*, by the Central Committee of the Communist Party of China, set the people-first principle, the scientific outlook on overall, coordinated and sustainable development and the promotion of all-round economic, social and human development as the most important guidelines and principles for furthering the reform of economic structure.

Due to painstaking efforts of the last ten years or more, sustainable development strategy has manifested in various areas of China's economic and social development, has greatly promoted sustained and coordinated development between economy, population, resources and environment. While China's economy has witnessed sustained rapid and healthy development and continuous improvement of its people's living standards, conservation and management of natural resources has been strengthened, its control over environmental pollution and ecological construction stepped up, and environment quality in some cities and regions has improved remarkably.

Box 4-1 Program of Action for Sustainable Development in China in the early 21st Century
After the U.N. Conference on Environment and Development in 1992, the Chinese Government took the lead in drawing up China Agenda 21 -- China's Population, Environment and Development in the 21st Century, as a blueprint document for guiding China's national economic and social development, which launched the process of sustainable development in the country. In order to promote further implementation of a sustainable development strategy, the Chinese Government formulated **Program of Action for Sustainable Development in China in the early 21st Century** in 2003, and made clear the objectives, basic principles, key areas and safeguard measures for implementing a sustainable development strategy. The key areas include optimizing the energy structure, improving energy efficiency and strengthening sustainable use of such resources as forests, grasslands, minerals and climate.

4.1.2 Relevant legislation

Over the last decade and more, China has persistently implemented its sustainable development strategy, formulated a number of laws for protecting resources and environment, and revised and improved many other laws so that a legal system conducive to the promotion of sustainable development has started to take shape (Table 4-1).

Table 4-1 Some of China's laws related to climate change

Date of issuance	Name of Law	Date of the Latest Revision
Oct. 28,2002	Law of the People's Republic of China (PRC) on Environmental Impact Assessment	
June. 29,2002	Law of PRC on Promoting Clean Production	
June. 29,2002	Production Safety Law of PRC	
Aug. 31,2002	Law of PRC on Desert Prevention and Transformation	
Oct. 31,1999	Meteorology Law of PRC	
Nov. 1,1997	Law on Energy Conservation of PRC	
Nov. 1,1997	Architectural Law of PRC	
Aug. 29,1997	Flood Control Law of PRC	
Oct. 29,1996		
Aug. 29,1996	Township Enterprises Law of PRC	
Dec. 28,1995	Law of PRC on the Coal Industry	
Oct. 30,1995	Electric Power Law of PRC	
July. 2, 1993	Law of PRC on the Prevention and Control of Environmental Pollution by Solid Waste	Dec.12, 2002
June. 29,1991	Agriculture Law of PRC	
Nov. 8,1988	Law of PRC on Water and Soil Conservation	
Jan. 21,1988	Wildlife Protection Law of PRC	Aug.28, 2002
Sept. 5,1987	Water Law of PRC	Apr.4, 2000
June. 25,1986	Law of PRC on the Prevention and Control of Atmospheric Pollution	Aug. 29, 1998
March. 19,1986	Land Administration Law of PRC	Aug. 29,1996
Jan. 20,1986	Mineral Resources Law of PRC	Oct. 31,2000
June. 18,1985	Fisheries Law of PRC	Dec. 28,2002
May. 11,1984	Grassland Law of PRC	May. 15,1996
Aug. 23,1982	Law of PRC on Prevention and Control of Water Pollution	Dec.25, 1999
Sept. 13,1979	Maritime Protection Law of PRC	Dec.26, 1989
Feb. 23,1979	Environmental Protection Law of PRC	Apr. 29,1998
Sept. 20,1954	Forest Law of PRC	March14, 2004
	The Constitution of PRC	

The Energy Conservation Law of the People's Republic of China (refers to Energy Conservation Law hereafter) which came into force in Jan.1, 1998 makes clear the tasks for China's energy-saving and its position in China's strategy of social-economic sustainable development. The law also designates authorities responsible for energy conservation, sets up an energy conservation management system and required performances of energy users, and establishes safeguard systems for energy conservation technologies. The issuance and enforcement of Energy Conservation Law has brought China's energy conservation gradually onto a legal path.

4.1.3 Industrial policies

Since the late 1980s, the Chinese Government has adopted proactive steps to promote the transformation of economic growth means and readjustment of economic structure. Reducing resource and energy consumption, making better use of resources and energy, promoting clean production, and preventing industrial pollution are treated as important components of China's industrial policies.

In March 1989, the State Council issued the "Decision on Key Issues on Industrial Policies at Present", which called for macroeconomic adaptation and control, accelerating the development of tertiary industry and restructuring secondary industry. It also defined the industries which the government would support and restrict, and encourage the industries and products that would achieve good economic return but consume low resources and energy.

In April 1994, the State Council issued the "Outline of China's Industrial Policies for the 1990s", calling for the promotion of the development of applied technologies, accelerating the application and popularization of scientific and technological achievements, enhancing product quality and technological performance, and reducing energy and material consumption as well as cutting down production cost. It also calls for formulation and implementation of research and development plans, by sectors, for key technologies that would play major roles in the development of industrial sectors. Furthermore, the Outline proposes to publish, in the form of laws or regulations at regular period, a list of backward production equipments and techniques that must be phased out. Moreover, it requires the setting and implementation of a standard on economy of scale for investment projects on fixed assets. The Outline further underlines the implementation of a policy of attaching equal importance to development and conservation, aiming at promoting coordinated development of energy, economy and environment.

In June 1995, the State Planning Commission, State Economic and Trade Commission and Ministry of Foreign Trade and Economic Cooperation jointly issued the Guiding Catalogue for FDI Industry , which was revised in 1997 and 2002 respectively. In 1997, the State Planning Commission issued the Catalogue (List or Inventory) of Key Industries, Products and Technologies for promotion and revised it in 2000. After the revision of the List or Catalogue, 28 key areas are under promotion support by the government, which includes 526 varieties of products, technologies, infrastructure and services. Table 4-2 shows some of the technologies and projects that can achieve GHG emission reduction.

Table 4-2 Some technologies and projects helpful to the greenhouse gas emission and encouraged by Chinese government

Field	Technologies and Projects encouraged by State
Agriculture	Dry farming agriculture, water saving and ecological agricultural construction, undertakings for cultivating herbage, energy-saving stove, biogas cooked

Forestry and Ecological Environment	Conservation projects of natural resources such as natural forests Tree-planting and Grass-growing projects Prevention and control of forest disasters Extremely-difficult-location afforestation technology applied to areas with vulnerable ecological environment Ecological demonstration projects Fast-growing and high-yielding forest projects Shelter-forest projects Projects of reforesting cultivated lands and recovering forest resources Comprehensive improvement projects on ecological environment and small river basins Projects for recovering vegetation in mining areas Comprehensive development and utilization of resources in forest zones
Coal	Building of high-efficiency and medium-size coal preparation plants Producing environment friendly briquette for industry and domestic use Coal water slurry Technologies Coal liquification and gasification Coal-bed gas exploration, development and utilization Development and utilization of low-heat-value fuels and accompanying resources in coal-mines Clean coal technology
Electricity	Hydropower generation Combined heat and power production Power-generation by solar energy, geothermal energy, ocean energy, biomass energy and wind energy Integrated gasification combined cycle (IGCC) Power generation by clean coal Power generation by coal gangue and low-quality coal Transformation and construction of urban and rural power grid
Iron and Steel	Efficient ore dressing and comprehensive utilization of minerals resource Generation of acid pellet Power generation by top pressure differential equipment Technologies of regulation on water content of the coal fed to coke oven, mixed coal used for coking, rammed coal coking and coke dry quenching Blast furnace ejection with rich-oxygen coal injection Direct reduction Smelting reduction Recovery and comprehensive utilization of furnace gas and converter gas High-tech of continuous casting Hot charge and hot conveyance technology for continuous casting base
Chemical Industry	Constructing large-scale equipments for producing nitrogenous fertilizer and transforming of existing enterprises of producing nitrogenous fertilizer for saving energy and increasing production Adopting new energy-saving and environment-protecting technology, building

	and transforming the existing production of inorganic chemical industries Control of "three wastes" and comprehensive utilization of resources in chemical production
Petrol-Chemical	Comprehensive utilization of refinery gas and chemical by-products Control and comprehensive utilization of "three wastes"
Building Materials	Over-4000-ton-per-day cement production by way of new dry process cement clinkers Producing building materials through waste
Mechanical Engineering	Manufacturing of supercritical thermal-power generating sets Manufacturing of fluidized bed boiler with capacity above 100MW Manufacturing of air-conditioning units over 600MW Manufacturing of gas-steam combined cycle equipment with a capacity of over 36MW. Manufacturing of large-sized wind-power-generation units Manufacturing of nuclear-power sets and key supplementary machines Development of FGD technology and equipments New technology of straw-resolving and utilizing as well as manufacturing of its key equipments Development of urban garbage disposal technology and equipment manufacturing Development of sewage treatment technology and equipment on a large-scale Manufacturing of equipment for separating sulfur and niter from flue gas Manufacturing of complete units of coal gangue power-generation equipment Stockpile and shipping of fly ash and manufacturing of complete sets of brick-making equipment Manufacturing of plastic recycle facility Manufacturing of energy-saving, low-pollution heating facility
Nuclear Energy	Construction of MW-level pressurized-water-reactor nuclear power plant Low-temperature thermonuclear reactor, fast breeder reactor, thermonuclear reactor, high-temperature gas cooled reactor
Oil and Natural Gas	Comprehensive utilization of accompanying resources in oil and gas fields Technology of improving recovery factor in oil field
Urban Infrastructure	Building urban subway, light rail (over 70% of their equipment is domestically made) and other public transport facilities Treatment and comprehensive utilization of urban and township garbage and other solid wastes to make them reduced, resourced and be harmless Urban and township gas projects Urban and township central heating projects Projects of transforming urban vehicles to gas-fueled vehicles

Environmental Protection and Resource Comprehensive Utilization	Projects to control and improve the ecology and environment Comprehensive utilization of wastes and scraps Technologies and projects to protect biodiversity Substitution of ozone-depleting substance Recycling agricultural plastic sheets and harmlessly-resolving technology

In order to optimize the industrial structure and reduce resource waste and environmental pollution, the State Council has issued a series industrial policy documents to control the development of high-pollution and high-energy-consumption industries (Table 4-3). A group of high-energy-consumption and high-material-consumption enterprises with backward technologies and high pollution were shut down.

Table 4-3 Industrial policy documents issued by the State Council of China

Year	Name of Document	Relevant Industrial Policy
1990	Decision on Further Improvement of Environment Protection Work	Ordering "resource and energy wasting, and environment-polluting enterprises, especially rural enterprises such as small-scale paper-making, chemical, coke-producing, printing and dyeing and sulfur-producing mills to solve their problems within fixed periods or take steps to close down their enterprises, suspend production, connect themselves to others and convert to other industries."
1996	Decision on A Number of Problems Related To Environmental Protection	Calling on local governments above county level to outlaw before Sept. 30, 1996 paper-making mills with production capacity below 500 tons, tanneries with annual production below 30 thousand oxhide-equivalents, dye-producing mills with annual production below 5000 tons, and backward coke and sulfur producing enterprises; and to close down the enterprises producing arsenic, mercury, lead, zinc, oil, pesticides, bleaching dyeing as well as electroplating in a backward way, and enterprises making asbestos products and radioactive products.
1999	Disseminating Suggestions on Winding-up and Reorganizing Small Refineries and Standardizing Circulation Order of Cruel Oil And Refined Oil	Calling for a ban of illegally excavated oil and backward oil-refining, sorting out and reorganizing small refining enterprises, improving the distribution and control of crude oil, enforcing centralized wholesale of refined oil and standardizing retail market of refined oil

1999	Disseminating Suggestions on Suspending Operation of small Thermo-Power Generating Sets	Suspending the operation of steam condensing units below 25MW by the end of 1999, and the operation of standard medium- and low-pressure coal-fired power sets by the end of 2000
1999	Disseminating Suggestions on Winding-Up and Reorganizing Small –scale Glass and Cement Plants	(I) Shut down small-sized plate glass plants, discard vertical drawing plate glass production line with drawing machines no more than four, shut down or discard ordinary shaft kiln production and the mechanical kiln with diameter less than 2.2 meters (inclusive) (II) Close down, by the end of 1999, small-scale glass and cement plants exceeding the limit of gas emission in acid-rain and sulfur dioxide pollution control areas, as well as in municipalities directly under the Central Government, provincial capitals, cities in special economic zones and coastal areas and key cities of tourist attractions.
2000	Disseminating Notice Concerning Suggestions on Reorganizing Small-scale Steel Mills	Calling for the wind-up and reorganization primary coking, primary sintering, small-scale blast furnace below $50m^3$, small-scale converter below 10 ton, small-scale electric oven and small-scale rolling plant with annual production below 100kt.

4.1.4 Economic incentive policies

Since the 1980s, the Chinese Government has formulated and implemented a series of financial, credit and tax incentive policies conducive to sustainable development (see Table 4-4). The following are preferential tax, loan and subsidy policies that the government has mainly adopted in terms of energy-saving and comprehensive utilization of resources:

— Energy-saving projects (reforming energy-saving technology and purchasing energy-saving equipment) enjoy such preferences as loan interest discount, differentiated interest rate, exemption of value added tax for imports, reduction of enterprise income tax and accelerated depreciation.

— Preferential tax is applied to the comprehensive utilization of resources such as the reuse of coal gangue, fly ash, stone coal and oil shale for power generation, cement production and new wall material production.

— Tax reduction or exemptions are applied to the power generation from municipal garbage, wind power generation and other rural renewable energy projects.

Table 4-4 China's economic incentive policies for sustainable development

Date	Issuing	Name	Contents

	Organization		
Feb.1985	State Council	Temporary Regulations on Some Policies Related to Promoting Technological Advance in State-Owned Enterprises	Reduction and exemption of import tax applied to imported equipments and instruments for technology renovation and import, low interest or discount loans provided by banks for technology development, extension to 7 years of repayment of loans for energy conservation
Apr.1985	State Planning Commission, Ministry of Finance, Construction Bank	Additional Notice on Exemption of Principal-interest Related to the Transformation from Allocation of Funds to Loans with Regard to Small-scale Energy Conservation Capital Construction Projects	All investment for capital construction within central government budget must be turned from allocation of funds to loans. Small energy-conservation infrastructure projects enjoy exemption or reduction of principal and interest
Aug.1985	State Economic Commission	Notice on Discount on Energy Conservation Loan of 300 Million Yuan	Preferential loans are applied to energy-conservation-oriented technology renovation projects; in principle, half of the interests of special loans for this kind of project are subsidized by government finance and the other half is borne by enterprises. Discounts should be covered by central and local finance separately in accordance with the institutional affiliation of the enterprises
Jan.1986	Ministry of Finance, Ministry of Labor and Personnel, State Economic Commission	Implementing Measures to Award Raw Material and Fuel Conservation in State-Owned Industrial and Communication and Transportation Enterprises	Making clear the award requirements, areas and grounds, award rate for various raw materials and fuels, and calculation and distribution of the award. The award can be put into the cost of production and exempted from award tax.

Mar.1986	Ministry of Finance	Notice on Tax Related to Energy Conservation Management	Repayment of loans for energy conservation projects approved by the State is allowed before tax payment. New energy conservation products approved can be exempted from product and value added tax. Imported energy conservation equipments are exempted from product tax or value added tax. Energy conservation award is exempted from award tax.
June.1986	State Council	Notice on Revising Award Rules For Rationalization Proposals and Technological Progress	Proposals and technological progress about quality promoting, variety improving, energy and raw material conservation are rewarded according to their economic value.
Mar.1991	State Planning Commission	Notice on Readjusting, Distribution of Energy (Material)-Saving Capital Construction Projects and Investment Quota	Providing allocation principles for integration of heat and power supply, central heating, recovery of emitted flammable gas for urban use, production of methane for urban civilian use, briquette projects, mixed coal used for steam, energy conservation instruments and meters, coal conservation, new wall material and energy-conservation residences, and energy- and material-conservation demonstration projects and their dissemination. Setting norms for investment quota on various energy- and material-conservation projects.
April 1991	State Council	Interim Regulations on Regulatory Tax on Investment Direction for Fixed Assets of the PRC	Zero tax rate is set for projects related to pollution control, environmental protection and energy conservation, as well as for energy-conservation residences in the North.
Dec.1994	State Economic and Trade Commission	Suggestions on Accelerating Up Energy-Conservation Transformation of Fans and Water Pumps	Special loans arranged by the State since 1995 for energy-conservation renovation of fans and water pumps

Nov.1997	State Planning Commission	Notice on Issues Concerning Capital Construction Loan of Energy-Conservation Projects	Providing that the area for energy-conservation projects be broadened, the capital volume of fixed asset investment in energy-conservation projects be reduced and volume of loans from bank be increased

4.2 Energy sector

4.2.1 Reform of energy industry structure

Following the continuing of China's economic structural reform since the 1980s, great changes have taken place in the management system of China's energy industry. As the government was gradually loosening up the administrative management over enterprises and energy-producing enterprises moving into market, China's energy industry is becoming increasingly commercialized and energy pricing system more rational, which has adjusted energy's demand and supply relationship and improved the efficiency of energy utilization.

Since 1983, the situation where coal mines are owned by the state with investment coming from the government has changed gradually. Since 1994, investment in coal-mining has become commercialized. In 1987, the government terminated price control on coal mines owned by village and township, opened part of the coal market and implemented double-track coal prices. In 1993, the mandatory coal price of state-owned coal mines began to be abandoned. Up to July 1994, with the exception of coal used for electric power generation, coal production, transportation and distribution were fully based on the market. Since 2002, the price of coal used for electric power generation has become commercialized.

In 1998, China National Petroleum Corporation and China Petroleum and Chemical Corporation were founded, which are independent legal entities "responsible for their own operation, profits and losses, development and obligation". The prices of crude oil and refinery products have basically been linked with the international market.

In 1985, the State Council issued Temporary Regulations for Encouraging Power Plants Investment and Implementing Multi-Electricity Prices. Since then, multi-channels of power plant investments and multi ownerships of power plants have been established. In the power sector, detachment of enterprises from the government have been implemented, state-owned power enterprises have been reorganized, and reform targets have been set as follows: breaking monopoly, introducing competition, raising efficiency, reducing cost, reforming pricing system, optimizing resourcing distribution, promoting power development, accelerating power network connection, and establishing an open and fair competitive power market with enterprises detached from the government and under the governmental supervision.

4.2.2 Energy planning

Energy development has always been an important part of China's national economy and social development plan. In 2001, the State Planning Commission drew up "Special Plan of Energy Development for the 10th Five-Year under National Economy and Social Development Plan", giving emphasis on optimizing the primary energy structure, increasing the proportion of natural gas and hydropower, and reducing coal consumption in the end use sector. The Plan insists requires on rational utilization of resources, gives priority to energy efficiency improvement, industrial restructuring, technological progress, and use of market instruments. The plan also stresses that clean energy and clean coal technology must be developed to prevent and reduce environmental pollution and ecological damage, with the aim of promoting coordinated development of energy, economy and environment.

Table 4-5 China's energy planning and programming

Energy Field	Issuing authority	Date	Key Points
Energy Industry	The State Planning Commission	1982-1996	Objectives for energy industry development and environmental pollution reduction were set up in the 6th, 7th, 8th and 9th Five-Year Plans respectively
		2001	"Special Plan of Energy Development for 10th Five-Year-Plan period" puts forward "on the precondition of ensuring energy security, priority will be given to optimizing energy structure, improving energy efficiency, protecting ecological environment, and speeding up the development of western China."

Energy Conservation and Energy substitution	State Planning Commission	1989	"Special program of technological retrofit for the 8th Five-Year-Plan period", involving energy conservation, raw material consumption reduction, improvement of product quality and developing high-quality products.
	State Economic and Trade Commission	2000	"Energy Conservation and Comprehensive Utilization of Resources Plan for 10th Five-Year-Plan period", requests for promoting the whole society to save energy and raw material, make comprehensive use of resources, and promote the transformation of economic development mode conducive to sustainable development
	State Economic and Trade Commission	2000	Oil Conservation and Fuel Oil Substitution Plan for the 10th Five-Year-Plan period
New and renewable Energy	State Economic and Trade Commission	2000	Key Points of New and Renewable Energy Industry Development Plan for 2000-2015, calls for the speeding up of the development of new and renewable energy and related industries in accordance with a socialism-based market economy.
		2000	"New and Renewable Energy Industry Development Plan for the 10th Five-Year-Plan period", which points out that development of new and renewable energy is one of the important strategic steps for optimizing the energy structure, improving the environment, and promoting sustainable development. Therefore, it is necessary to accelerate industrial development of new and renewable energy.

4.2.3 Electric power sector

Since 1995 to 2000, development policies beneficial to reducing emission of greenhouse gas were implemented in China's power sector, i.e., giving priorities to the development of hydropower, optimizing thermal power, properly developing nuclear power, strengthening electric network development, and developing new and renewable energy generation in accordance with local conditions.

Development of hydropower shall be given priorities. Between 1995 and 2000, installed power generating capacity in China increased from 217 GW to 319 GW, with an average annual growth rate of 8.0%, of which installed hydropower generating capacity increased from 52.2 GW in 1995 to 79.35 GW in 2000, with an average annual growth rate of 8.7%. By the end of 2000, large and medium-sized hydropower projects under construction amounted to 31.679 GW. Since China's hydropower resources are mainly located in the west, in order to speed up the development of hydropower in this region, the State Council issued "Implementing Guidelines of Policies and Measures Relating to Western Region Development" in 2001. The document stipulates: hydropower projects should be given priorities and preferential treatment in land use. Unused state-owned land flooded by hydropower development is exempted from land compensation fee, and loan payback period for hydropower should be prolonged. The payback period for hydropower projects with investment over 300 million Yuan and in line with "transmission power from west to east" program can be prolonged to 25 years.

Nuclear power shall be developed properly. In 1994, Qinshan Nuclear Power Station, the first nuclear power plant in China, was put into commercial operation. By 2000, the nuclear power generating capacity in operation accounted for 2.1 GW, with a further 6.6 GW under construction.

Wind power shall be promoted. In the 1980s, China began to build demonstrative on-grid wind power generating farms by using imported generation units. Since the 1990s, the Chinese Government has implemented a series of preferential policies to encourage the development of wind power generation, including: the grid is requested to allow wind power farms to be connected to power grid nearby and to take all electricity generated by wind farms with a price covering all costs, loan repayment and rational profits; research and development of wind power technology and equipment are encouraged; special loans for wind power generation projects and large-sized wind power generation unit localization are allocated; custom duties are lowered or exempted for imported wind generating units with unit size over 300 kilowatts; and half of the value added tax for wind power generation should be returned back.

By the end of 2000, China had built 26 on-grid wind power farms. The installed capacity of wind power has increased from 30MW in 1994 to 375MW. Between 1999 and 2000 alone, on-grid wind generating capacity was increased by 150MW.

Box 4-2 Riding Wind Program
In 1996, the State Planning Commission initiated the "Riding Wind Program", which aims at improving the domestic capability on wind generating equipment manufacturing and making it a new industry by introducing advanced foreign technologies through multi-channels. In April 2000, No.1 Chinese Tractor Group Corp. manufactured the first 660KW wind turbine unit, with a localization rate of around 40%. By the end of 2000, 12 sets of domestic manufactured 600KW wind generation units have been put into operation in China.

Figure 4.1 Wind farm in Inner Mongolian Autonomous Region

Efficiency improvement for coal fired thermal power generation. In 2000, coal-fired thermal power generation accounted for 80% of total national power generation in China, and coal will remain the major fuel for power-generation in the coming few years. Raising the efficiency of coal-fired power generation is of great importance for reducing greenhouse gas emission in China. To this end, China has adopted the following major steps: shut down small coal-fired generating units and replace them with big and high-efficiency units. In the early 1990s, the Chinese Government called for the replacement of small thermal generating unit sets with advanced big ones or the transformation small coal-fired generating sets into co-generation sets. Since 1995, several regulations have been enacted for restricting the construction of small coal-fired generating units and for shutting down those existed. According to uncompleted estimations, from 1996 to 2000, about 13.1 GW small coal-fired generating unit sets were replaced by big unit sets, and from 1996 to 2000, around 10 GW small coal-fired generating sets with unit size below 50MW were forced to shut down.

Newly-built thermal power plants are equipped with large-sized and high-efficiency generating sets. In the 1990s, China made a clear policy stipulating that 300 and 600 MW thermal unit sets should be the main options for the development of thermal power generation, and that unit coal consumption of 300 and 600 MW units should not exceed 330 gce/kWh. From 1995 to 2000, the share of thermal units with capacity of 300 MW and above increased from 22.5% to 34.4% of national thermal capacity. In the mean time, steam parameter of thermal units kept rising. In 2000, unit sets with sub-critical pressure and super-critical pressure accounted for 40.7% (of which super-critical sets accounted for 2.78%), sets with high-pressure and super high-pressure accounted for 43.07% and sets with low-pressure parameters account for 16.23%.

Technological retrofit for large- and medium-size thermal generating units. Since 1989, China has started to retrofit domestically-manufactured 200 MW and 300 MW thermal generating units. By 2001, about 20% of 200 MW unit sets have been retrofitted, resulting in an average fuel rate reduction of around 14.29 gce/kWh.

Development of co-generation. Between 1995 and 2000, installed co-generation capacity increased from 16.538 GW to 28.676 GW in China, with an annual growth rate of 11.6%. Policies and measures encouraging co-generation can be found in Table 4-6.

Table 4-6 Policy and regulations for developing cogeneration

Issue time	Issuing Organization	Names and Contents
Feb.1986	State Council	"Strengthening the Management of Urban Central-Heating Supply", making it clear for heating-supply enterprises to be granted reduction or exemption from regulatory tax, and adopting reasonable price for heat supply
Aug.1989	State Planning Commission	"Some Measures on Encouraging Small-Sized Co-generation and Strictly Restrict the Construction of Small-Sized Thermal Generation Units", setting ten policy measures for developing small-scale co-generation and six policy measures to strictly control the construction of small-sized thermal generating units
Feb. 1998	State Planning Commission, State Economic and Trade Commission, Ministry of Construction and Ministry of Power	"Some Measures on Developing Co-generation", stipulating that electricity output of cogeneration units should match with heat output
Aug.2000	State Planning Commission, State Economic and Trade Commission, Ministry of Construction and State Environmental Protection Administration	"Regulation on Developing Cogeneration", setting the principle for developing cogeneration: integrated planning with step by step implementation, proper-scale development and electricity output matching with heat output. For newly-built and expanded co-generation units that can meet with the above principle, the grid authority should allow such units to be connected to grid and be exempted outfit fees. The regulation encourages the development of such technologies as cogeneration, tri-generation (electricity, heat and cooling or electricity, heat and coal gas), and combined cycle gas turbine for cogeneration, and supports the development of combined cycle co-generation, and encourages to gradual deployment of small-scale cogeneration where applicable.

Promotion of clean coal generation technologies. China currently has a 15 MW experimental PFBC-CC equipment, and is preparing to build a 100 MW PFBC-CC demonstration station and a 300~400 MW IGCC demonstration station. The manufacturing technologies for 300 MW CFBC generating unit have been introduced into China and localization of manufacturing equipment has started. In order to accelerate the development of clean coal generation technologies, the State Planning Commission issued a preferential policy for clean coal generation technology and demonstration projects in July 2002, including custom duty and value added tax reduction or exemption for imported equipments for demonstration projects. In the construction of demonstration projects, preferential loans are given to clean coal combustion technologies as priority so as to reduce the cost of relevant projects. The cost of imported technologies is apportioned into the cost of equipments manufactured afterwards to reduce the cost burden of demonstration projects. The State could give supplementary financial support to research institutes and manufacturing enterprises engaging in assimilating imported technologies. The price of electricity generated by clean coal technology is set by reference to the price of coal-fired units which were built in the same period and with environmental protection devices within the grid.

Reducing transmission and distribution losses. Against the situation where power grids are generally equipped with outdated devices and transmission and distribution losses are comparatively high, China has increased the capital investment for updating and constructing urban and rural grids significantly in recent years. In 1998, China launched a program to update rural and urban grids. By the end of 2000, 78.3 billion Yuan were invested for upgrading urban grids, covering 1.92 million kilometer new lines, 87.99 MVA transformer and 30.3 million household electric meters. In the same period, 110.7 billion Yuan were invested for the upgrade of rural grid, covering grids in 1,070 counties and the replacement of 35.48 MVA low-efficiency transformers.

Promotion of demand side management (DSM). Since early the 1990s when DSM was introduced into China, great efforts have been made to promote it, and a number of experimental and demonstration projects have been carried out. In December 2000, the State Economic and Trade Commission and State Planning Commission jointly issued the "Management Method for Electricity Saving", incorporating DSM in the form of regulation. In 2002, the State Economic and Trade Commission issued Directive for Promoting DSM, clarifying the responsibilities of the government, power enterprises, energy service intermediaries and electricity users for the implementation DSM.

Box 4-3 DSM project in Suoli Coal Mine, Huaibei, Anhui Province
Suoli Coal Mine is a medium-size mine with annual coal output of 2 million tons. The mine introduced DSM in 2000, and adopted following measures: 1) holistic reform to shorten transmission distance of 380V lines in the mining areas, to allocate transformers rationally and to discharge load as near as possible. Low-voltage line loss is expected to be cut by 2% after the completion; 2) compensate reactive power for 660V electricity supply system underground and raise power from 0.85 to 0.97; 3) replace low-efficiency transformers and the power saving potential is about 350 kVA after replacement; 4) reform elevator control system for main well, increasing coal-hoisting capacity of 400kt and saving electricity over 1.5 GW each year; 5) reshape the blades of ventilators and ventiducts in three ventilation shafts to reduced air resistance, resulting in an annual electricity saving of 1.5 GW for each ventilator; 6) apply frequency-modulating and speed-regulating technology to water pumps and motors over 55 KW. By the above-mentioned measures, gross electricity consumption per ton coal output decreased from 24.31 KWh in 1999 to 22.10 KWh in 2000, saving electricity by 9.09%.

4.2.4 Oil and natural gas production

Oil and natural gas exploitation and utilization is highlighted in China. The proportion of oil and natural gas in China's primary energy production rose from 19.5% in 1994 to 25.2% in 2000. The share of oil and natural gas consumption in total primary energy consumption rose from 19.3% in 1994 to 27.1% in 2000. The increase in proportion of oil and natural gas consumption is lowering the intensity of greenhouse gas emission from energy consumption.

Box 4-4 Project of Transporting Natural Gas from West to East
The project is a huge infrastructure construction project for transporting natural gas produced in Talimu Basin, Xinjiang Autonomous Region and other gas fields in the west to Shanghai and the Yangtze River Delta. The western section of the project covers 2330 kilometers, beginning from Lunnan, Xinjiang Autonomous Region and ending at Jingbian Shaanxi Province, and the eastern section covers about 1500 kilometers, from Jingbian to Shanghai. Construction of the project started in 2002. The eastern section began to supply gas for commercial use in Shanghai in Jan. 2004, and now daily gas supply amount is around 2.6 million cubic meters. It is expected that the whole project will be put into commercial operation in Jan.1, 2005, with an annual transportation amount of 12 billion m^3 natural gas at initial period.

Energy-saving and environment protection technologies shall be developed and disseminated. A lot of researches on energy conservation and environmental protection related to oil and natural gas production and process have been conducted in China's oil and natural gas sector, and substantial progresses have been made in the areas of energy-saving technologies for oil and natural gas production, recovery of associated gas in oil and natural gas fields, and utilization of flare gas in refinery plants. Recovery of light hydrocarbon has popularized in oil production throughout China. During the 9^{th} Five-Year Plan period, refinery and petrochemical enterprises launched the flare-eliminating plan, and over 1 million tons of combustible gases were recovered each year, accounting for more than 85% of total combustible gases originally emitted. At present, torchlight in oil fields have been mostly eliminated on average, and 1.3 million tons of light hydrocarbon can be recovered every year, effectively reducing the emission of methane.

4.2.5 New and renewable energy

In line with the poverty-alleviation plan and the rural energy development target, the Chinese Government has implemented a series of policies and measures to support new and renewable energy development. It is stipulated in the "Energy Conservation Law of the People's Republic of China" that "governments at different levels must enhance the construction of rural energy, develop and make use of new and renewable energy including biogas, solar energy, wind power, hydropower, geothermal, etc, in accordance with principles of fitting to local conditions, multi-category, comprehensive utilization and effectiveness."

Figure 4.2 Fuel saving stove promoted in China's rural areas

Between 1986 and 2000, China carried out a program for building elementary electrification counties based on small hydropower. The Ministry of Water Resources provided a loan of 300 million Yuan with discounted interest to support small hydropower projects. By 2000, over 1500 counties located in 30 provinces (autonomous regions and municipalities) have developed rural hydropower projects and built more than 40,000 rural hydropower stations, with installed generating capacity of 24.80 GW and annual electricity output of 80 TWh.

Since the 1970s, China has began to develop small wind power generation. After the 1980s, micro wind power generators with capacities between 50W and 200W were batch-produced in succession and by the 1990s, technologies for manufacturing mini-wind-power-generation units for household had become matured. By the end of 2000, over 190,000 wind-power-generators were installed across China, of which over 120,000 were used in pasture areas in Inner Mongolia, Xinjiang and Qinghai as well as coastal areas without grid power, providing electricity for lighting and TV-watching for families of fishermen and herdsmen.

In 1990, China began to implement "comprehensive development of rural energy in counties". Besides wind power and small hydropower stations, fuel saving stoves, biogas, solar energy and geothermal technologies have been promoted in a wide range of rural areas. By integrating rural energy construction with farmers' general living condition, agricultural production, income increased and ecological environment protection, significant economic, ecological and social benefits are achieved. By the end of 2000, there were nearly 8.5 million rural households using biogas fuel, over 1100 large and medium-sized demonstrative biogas projects with annual biogas output of 600 million m3 in cattle and poultry raising farms, 189 million households using fuel-saving stoves, 19.40 million energy-saving heated brick beds, 11 million square meters of solar water heaters, 9.77 million square meters of solar houses, 330,000 solar stoves and nearly 400 straw gasification stations across the country.

Figure 4.3 Solar water-heating system for building in Kunming city, Yunnan Province

In order to support and encourage the development of new and renewable energy, the Chinese Government has drawn up clear industrial development polices mainly as follows: In Dec. 1986, State Economic Commission issued the "Opinion on Enhancing Rural Energy Construction" which calls for the making of long-term plans for rural energy, formulation of technological and economic policies on rural energy, making great efforts to tackle key technology problems, managing and enhancing rural energy conservation, building and developing rural energy industry, and establishing technological service system for rural energy.

In Jan. 1995, the State Planning Commission, State Scientific Commission and State Economic and Trade Commission issued the "Programme on Developing New and Renewable Energy" which calls for commercialized production and selling of people's coal saving stove based on the improvement of saving firewood and transforming stoves; perfecting industrial and service system of firewood-saving stoves; accelerating the update and replacement of rural biomass utilization technology; developing efficient direct combustion technology, solid shaping, gasification and liquidation technologies; establishing and perfecting industrial service system; improving designing norms, standards and the supply of complete-set (large and medium-sized) equipment for biogas projects; speeding up the development of small hydro resources; increasing the development and utilization of solar energy, and popularizing energy-saving solar-energy buildings, solar water heaters and photovoltaic systems.

In March 1996, the 9th Five-Year Plan and 2010 Long-Term Target Programme on National Economy and Social Development of the People's Republic of China was approved at the 4th session of the 8th People's National Congress. It puts forward "Popularize firewood and coal saving cooking stove and coal saving for household consumption; Establish industrial and complete service system; adopt measures suitable for local conditions, and develop small hydro power, wind energy, solar energy, geothermal energy and biomass to a great extent."

Since 1999, the provincial governments of Shandong, Hebei, Heilongjiang, Anhui and Gansu have formulated Management Regulations on Rural Energy Construction or Management Regulations on the Development and Utilization of New Energy, which designate specific rural energy administration of the people's governments above the village (township) and county level to be responsible for the development and utilization of such new and renewable energy used for rural life, and production in their administrative zones as biomass energy (biogas, straw and firewood), solar energy, wind power, geothermal and micro-water energy, as well as the popularization and application of rural energy-conservation technology, while their subordinates are responsible for daily management. The local governments and departments must adopt measures suitable for local conditions, complement various energy sources, make comprehensive use of energies, pursue sound effects, give equal importance to development and conservation, and allocate special funds to support construction of demonstration projects. They must organize the dissemination of biogas technology and its comprehensive utilization, solar heating and solar power generation technology, geothermal technology for farming and breeding, wind power, mini-hydropower technology, bio-gasification/solidification/carbonization technology, and other energy conservation technologies for rural production and household purpose.

Both the "Specific Planning of Energy Development Priority for the 10th Five-Year" and the "10th Five-Year Plan for Power Industry" stipulate, in clear terms, the development of new and renewable energy as the long-term strategy for China's sustainable energy development.

In November 2001, the State Planning Commission and Ministry of Science and Technology issued "Guidelines on Key Areas for Prioritized High-Tec Industrialization", which stipulates that advanced energy technologies should include the development of new and renewable energy industry, and calls for the development and deployment of clean renewable energies such as biomass energy, wind power, solar energy, hydrogen energy and geothermal in line with local conditions.

Taking into consideration of different technologies of new and renewable energy, the relevant national authorities, together with financial, banking and tax departments, have developed the following preferential policies related to finance, investment, credit, taxation and price respectively, for new and renewable energy development, mainly as follows:

— Subsidies for research and operational expenses. The state subsidized the research and development of renewable energy technology, by allocating around 60 million Yuan for science and technology research on renewable technologies during the 9th Five-Year Plan period. Central and local financial departments subsidized operational expenses to management bodies at different levels for the development, dissemination and deployment of new and renewable energy technologies.

— Financial subsidies. Central and local governments provide capital and/or material as direct subsidies for the construction of household biogas system, firewood-conservation stoves, small hydro power stations, small-sized wind turbines and photovoltaic systems.

— Discount loans and specific discount loans for rural energy. In 1986, the State Planning Commission, Agricultural Bank and Ministry of Agriculture issued a document named as Loans for Supporting Development of Rural Energy, which stipulates the provision for discounted loans for projects for rural energy projects such as biogas production, solar energy, firewood-conservation stove and geothermal energy, with additional subsidies provided by the central financial department paying low interest. In 1987, the State Council set a special discounted loan to support renewable energy industrialization and commercialization. Such a loan supports the following series of activities : the establishment of capability to manufacture 10,000 small wind turbines annually; the import of non-silicon photovoltaic production line; the assistance to preparations for building 91 wind farms and demonstration activities; the construction of over 100 medium-sized biogas projects and production of accessory equipment; assistance for more than 60 factories to make firewood and coal saving stoves and for more than 100 plants to manufacture solar-energy water heaters with production capacity close to 1 million square kilometers, and assistance to industrialization projects of other renewable energy technologies like geothermal energy and biomass gasification or briquetting.

--Preferential taxation and pricing. In Jan. 1999, the State Development Planning Commission and Ministry of Science and Technology promulgated a document named "Issues Related to Further Supporting the Development of Renewable Energy", which calls for active support to renewable energy power generation projects, and a provision of 2% discounted loans for such projects, encourages grid authorities to buy electricity generated from renewable energy with a price to make renewable energy producer have reasonable profit. The document also sets low import tax rate for importing wind power generation and photovoltaic equipment, and sets low income tax rate for some of the renewable energy projects, or even exemption from income tax during the initial operational period. The document further requires that the profits from small hydro power production would be exempted from income tax, and state-owned small hydro power stations can keep their profits.

Box 4-5 China's Brightness Program
In Sept. 1996, at the "World Summit on Solar Energy" held in Zimbabwe, the Proposal of "Brightness Program" was put forward to call for the introduction of renewable electricity to regions without electricity supply across the world. The Chinese government responded in a positive manner, and the State Planning Commission made an action plan of China's Brightness Program. This Brightness Program will develop photovoltaic panels in some remote counties of Tibet and other regions without electricity supply. By constructing wind and solar power generation facilities, it is planned that, electricity will be provided for 8 million people by 2005, and for 23 million people by 2010, with a goal of increasing the power-generation capacity per capital to 100W in these areas, equal to one-third of the national average.

4.2.6 Development and utilization of coal bed methane

In the "Decision on Current Key Points in Industrial Policy" issued by the State Council in 1989, development of coal-bed methane is described as a "key industry and product to be supported by capital construction". In 1994, the Ministry of Coal Industry proposed to develop coal-bed methane as the second coal resource and set forth in the "Outline of Planning on Comprehensive Utilization, Diversified Operation and Tertiary Industry in Coal Industry for 1994 to 2000 "that the utilization of coal-bed methane is the priority for development in comprehensive coal utilization. The Law of PRC on Coal Industry enforced since December 1996 stipulates that the state encourages coal-mining enterprises in comprehensive development and utilization of coal-bed methane.

In 1996, the State Economic and Trade Commission, Ministry of Finance and the State Taxation Administration issued the "Suggestions on Further Developing Comprehensive Utilization of Resources", which stipulates that enterprises making use of their discarded materials (including methane from the mine) produced from the production process are exempted from income tax for 5 years. For those power plants which make comprehensive use of fuels like low-heat value fuel for power generation, meet the conditions of connecting to the grid by regulation and have an unit capacity over 500 KW, power departments should allow them to be connected to the grid and their connected power units to be exempted from small-thermal-power-unit on-grid fees.

In June 2002, the State Economic and Trade Commission and other relevant departments drew up the “Policy on National Industrial Technologies”, and stated in “developing directions for key enterprises” that advanced coal utilization technology and the technology for developing and utilizing coal-bed methane should be promoted in a positive manner”. In 2002, the State Council issued the “Tentative Regulation on Exempting Imported Material for Operation Projects of Coal-bed Methane Exploration and Development from Import Tax”, stipulated that equipment and material imported for projects of coal-bed methane exploration and development approved by the state are exempted from custom duty and import link tax, while equipment and materials imported for projects of underground methane pumping in mine and power generation from coal-bed methane within the framework of comprehensive resource utilization can also be exempted from these duties.

By the end of 2000, China had 184 coal mines equipped with underground pumping systems and ground transportation and distribution systems, with methane pumping capacity reaching 920Mm^3 per year and utilization capacity 500 Mm^3. Over 60 ground-drilling methane utilization projects have been built, including over 200 surface wells for coal-bed methane.

Box 4-6 Town gas energy-saving project in Yangquan city , Shanxi Province
This project was jointly constructed based on state allocated funds and funds raised by the Yangquan government and its mining administration. It makes use of a coal-bed methane gas pumped by Yangquan Mining Administration to supply cooking fuels to the residents of the city and the households of the administration. The project started construction in 1985 and went into operation in Sept. 1991. Up to 1996, coal-bed methane supply totaled 58.80 Mm^3 and was used by 70,000 households and 150 municipal and commercial users. This project has not only reduced the emission of methane, but also prevented the emission of carbon dioxide from coal combustion.

4.3 Energy conservation

Over the years, the Chinese Government has always pursued the policy of promoting energy development and conservation with latter as the priority. Since the 1980s, the State Council and government departments in charge at different levels have made and enforced a series of energy conservation rules and regulations (Table 4-7), which effectively promoted energy conservation and efficiency-improvement work. From 1980 to 2000, energy intensity of China’s GDP witnessed an annual drop of 5.32%. (Chart 4.4)

Table 4-7 Rules and regulations on energy-saving management issued in China

Issue time	Issuing body	Titles and Contents
1982	State Council	Regulation on Further Promoting Electricity Saving, requested quota control, monthly examination and prioritized power supply for power consumed in production. Enforcing planned power consumption and reward for power saving and preferential fund for

		updating equipment. Quota for maximum power consumption of 9 electricity intensive products is set. Power-supply will be limited or shut down if quota is exceeded.
Jan.1986	State Council	Tentative Rules on Energy Saving Management, includes 60 provisions covering energy management system, basic work of managing energy conservation, management of energy supply, energy consumed by industries and energy consumed for urban and rural purposes, technological progress, reward and punishment, publicity and education.
Aug. 1986	State Economic Commission, State Planning Commission	Circular on Further Strengthening Management of Oil Consumption and Conservation, stipulates the control of oil-consuming machines, strict control of oil combustion, discard of primitive oil refining furnace and dissemination of oil saving measures.
Jan.1987	State Economic Commission	According to the Tentative Regulation on Upgrading (Grade-Classification) Enterprise Energy Saving Management, upgrading energy saving management should be launched in China's enterprises. Specific regulations are made on conditions for upgrading, approval procedures and rewards. Enterprises are classified as national special class, first grade and second grade enterprises in terms of energy saving as well as provincial classes, with standards to be made by their respective industries.
Feb.1987	State Council	State Council's Directorate on the Reduction of Oil Consumption of Various Boilers and Industrial Kilns and Furnaces, and State Council's Directorate on Saving Coal Consumed by Industrial Boilers.
July. 1987	State Environmental Protection Commission, State Planning Commission, State Economic Commission and Ministry of Finance	Tentative Measures for Developing Household Briquette, calls for the development of coal for household use, implementing preferential price for fine-quality coal according to the principle of "Keeping the capital even". Subsidy policy should be implemented. Production and business management should be strengthened. Fund should be provided through various channels and importance should be attached to tackling scientific and technological problems and publicity education.
Mar. 1991	State Planning Commission	Regulation on Upgrading (Grade-Classification) Enterprise Energy-Saving Management, stipulates upgrading (grade-classification) range, conditions, and approval procedures and rewards, enclosed with specifications on application forms and targets for

		advanced energy consumption that should be worked out by respective industries.
Apr.1991	State Planning Commission	Suggestions on Further Improving Energy-Saving Work, stipulates a system of examine and publication on energy consumption indicators. Departments in charge of energy conservation must participate in making infrastructure construction and technological reform plans. Maintain energy conservation reward system and increase the input on energy conservation.
Nov.1992	State Planning Commission, Production Office of State Council and Ministry of Construction	Tentative Regulation on Including Energy Saving Chapter to Feasibility Studies on Infrastructure Construction and Technological Renovation Projects, stipulates that energy saving chapter must be added to feasibility study report of infrastructure construction and technological renovation projects, and that this chapter must be examined by authorized departments and various industries should develop regulations for energy saving designing
Mar. 1999	State Economic and Trade Commission	Energy Saving Regulation on Key Energy Consuming Enterprises, stipulates that key energy consuming enterprises refer to the entities with annual comprehensive energy consumption exceeding 10,000 tons and entities with energy consumption of 5000-10,000 tce, appointed by provincial economic and trade commissions. State Economic and Trade Commission and its provincial sub-commissions are in charge of supervising key energy consuming enterprises in their jurisdiction areas. These entities should establish sound energy-saving management systems and employ qualified managing personnel in this field.
July. 1996	State Economic and Trade Commission	Programme on Resource Saving and Resource Comprehensive Utilization During the 9th Five-Year Plan Period, calls for improvements in resource utilization efficiency and energy saving in order to reduce emission of pollutants, and increase in the quality and results of economic growth and environment.

Dec.2000	State Economic and Trade Commission	Management Regulation on saving Electricity, calls for power consumption management, reduction of direct and indirect electricity losses, improvement of energy efficiency and environmental protection by adopting technologically feasible and economically rational electricity-saving measures. Support and encourage the research and introduction of power saving science and technology, improve power-saving awareness and education, popularize scientific knowledge on power saving and increase power saving awareness of the entire nation. Issue regular domestic advanced power-consumption targets of main power consuming products and enforce maximum quota of per unit power consumption for major power consuming products.

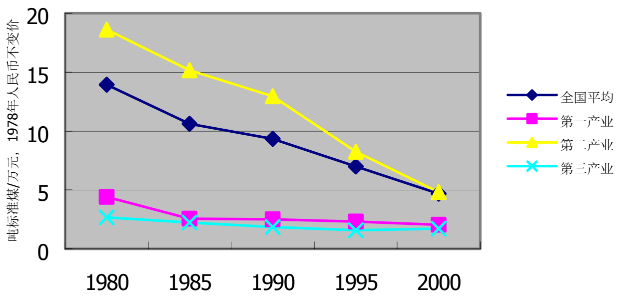


Figure 4.4 Trend of China's energy consumption intensity of GDP

4.3.1 Energy conservation planning

In Feb. 1980, the State Council transmitted its instructions on "Report on Improving Energy Conservation Work" submitted by the State Economic Commission and State Planning Commission, and pointed out that the Four Modernizations calls for sound solution of energy problems and effective energy conservation. Since the 6^{th} Five-Year Plan, the Chinese Government has integrated the development energy conservation program into national economic and social development plans. By 2000, the government had made energy conservation programs for the 6^{th} to 10^{th} Five-Year Plan periods respectively and annual energy saving plans, and set phased development objectives, key projects and main policies for its energy conservation work.

4.3.2 Energy-conservation management system

From the 1980s to the end of 1990s, China established a fairly complete energy-conservation management system at central government, local and industrial as well as enterprise level.

With regard to the central level in 1985, the State Council established an office meeting system for energy conservation work, whose main task is to study and examine energy conservation principles, policies, laws and regulations, plans and reform measures, as well as the deployment and coordination of energy conservation work. Daily responsibilities are shared among the State

Planning Commission, State Economic Commission and State Science and Technology Commission.

With regard to the local and industrial level, major leaders of provinces, autonomous regions and municipalities directly under the Central Government, as well as main energy-consuming industries are responsible for the energy conservation work while corresponding management organizations are in charge of routine energy conservation work.

With regard to the enterprise level, major leaders of key energy-consuming enterprises with annual energy-consumption capacity exceeding 10,000tce are responsible for energy-saving work directly. Special management bodies are established to formulate and implement energy-saving technology measures for their own enterprises, and enforce the energy conservation management in production processes.

In 1988, the State Energy Conservation Company was set up under the State Energy Corporation, and in 1994, it was reorganized as China Energy Conservation Investment Company. As a state-funded and policy-oriented investment organ, this company is responsible for implementing China's energy conservation technology policies, construction of important energy conservation projects, and special tasks and other energy conservation management work assigned by the state.

Besides, according to the "Tentative Rules on Work of Energy Conservation Technology Service Centre and Tentative Regulations on Energy Conservation Monitoring and Management" issued by departments under the State Council, energy conservation technology service centers have been set up in different regions and departments. China Energy Conservation Monitoring and Management Centre was established by the state, and local energy conservation monitoring centers were set up by different provinces, cities and industries.

In March 1994, the State Economic and Trade Commission issued and distributed the "Suggestions on Improving Resource-Conservation and Comprehensive Utilization", which differentiates key energy-consuming units from general ones, separates energy consumption indicators of main products into different ranks and improve the examination of energy consumption indicators, as well as started trial implementation of energy auditing for enterprise and energy-saving product certification.

4.3.3 Policy for energy-conservation technology

Since the 1980s, focusing on efficiency improvement of electricity and heat utilization, the Chinese Government has issued a series of specific policies for energy conservation technology (Table 4-8).

Starting from the 1990s, China has periodically published the catalogs of recommended and discarded products in groups. So far, catalogues of 18 groups of catalogs concerning 1068 recommended energy conservation products and 17 groups of catalogs covering 610 discarded products have been published.

Table 4-8 Documents on energy-conservation technologies and products issued by relative Chinese government departments

Time of Issuance	Issuing Authority	Titles and Contents
July 1986	State Economic Commission, Ministry of Finance, Ministry of Machinery, and Bank of commerce and Industry	Tentative Regulations on Encouraging Dissemination of Energy Conservation Mechanical and Electrical Products and Suspending Producers of Outdated and Backward Products, stipulates that the production of outdated mechanical and electrical products announced by the central government must be suspended. And that design departments must not go on designing such products, and such products are not transferable for further use. Priorities are given to enterprises producing energy-conservation products on allocation of technological retrofitting projects and the support of discounted loans. These enterprises enjoy priorities on the reduction of and exemption from regulatory tax. Their depreciation is classified and they can enjoy reduction of and exemption from product tax within a certain period.
April 1987	State Economic Commission, State Planning Commission	Notice on Dissemination of Current 33 energy conservation technological measures introduced in the recent period.
Mar. 1988	State Planning Commission	Calling for introduction of 48 energy conservation, material-saving and comprehensive resource utilization technologies.
Feb. 1996	State Economic and Trade Commission and Ministry of Machinery	Catalogue of Energy Conserving Fans and Pumps in China.
May 1996	State Planning Commission, State Economic Commission, State Science and Technology Commission	The Outline Policy on China's Energy Conservation Technology, integrating long-term development of energy conservation technology with its short-term development, while giving priority to energy-conservation technology and technological equipment introduced from now on to the year 2000. Mid- and long-term energy-conservation technologies should be regarded as technological reserves, which include realizing optimized allocation and rational utilization of energy resources, accelerating the update and transformation of energy-consuming equipment such as industrial kilns, furnaces and boilers; improving the heat-supplying efficiency, making use of waste heat and energy of industrial kilns and furnaces; recovering flammable gas released in the

		course of industrial production, developing new energy and energy-substitution technology; developing and disseminating new energy-conservation materials,; improving energy quantification, monitoring, supervision and scientific management, establishing comprehensive transportation system that conserves energy, attaching importance to building energy conservation, and improving management of residential energy use in urban and rural areas. Twelve parts totaling 330 articles are included in the Outline policy for main energy intensive sectors.
Sept. 1996	State Economic and Trade Commission, State Planning Commission, State Scientific Commission	106 key scientific and technological results recommended for the period of the 9th Five-Year-Plan.
1999-2002	State Economic and Trade Commission	Catalogue of Eliminated Backward Production Capacity, Technology and Products (3 batches in total)

4.3.4 Energy conservation publicity

China attaches importance to raising public awareness on energy conservation, and has launched extensive activities to publicize energy conservation in various forms. Since 1979, China held *Energy Conservation Promotion Month* every year, and changed it into *Energy Conservation Promotion Week* from 1991 which has been implemented till now. By holding energy conservation promotion activities in various forms, it aims to help enterprises to save energy, reduce energy consumption and increase efficiency, as well as to improve people's awareness on energy conservation, resource and environment. *Energy conservation Promotion Month* and *Energy conservation Promotion Week* have made sound impacts on energy saving in the entire nation.

4.3.5 Standards, labels and certifications

In July, 1987, the State Economic and Trade Commission and State Standardization Administration disseminated the Minutes of the Working Meeting on China's Energy Standardization, which stated that energy standard is the basis for energy conservation work, and proposed the target to formulate 498 standards on 288 items. By the end of 1999, China had formulated and revised 26 basic energy standards, 57 energy management standards, 48 energy methodology method standards, 33 energy product standards and 53 standards and rules on the energy efficient design.

In 1998, the State Economic and Trade Commission launched the certification of energy conservation products, set up a fairly complete system of the minimum energy efficiency standards including energy efficiency standard for household appliance and laboratory testing methods, and issued attestation certificates to products passing the standards and permitted these products to use China's energy conservation label.

In Feb. 1999, the State Bureau of Quality and Technical Supervision issued the “Management of Certification of China’s Energy Conservation Products”. By the end of 2003, China had established over 20 organizations to test and examine energy efficient products, and issued energy conservation certificates to more than 2000 products from over 150 enterprises, covering the areas of household appliances, electricity, lightening, etc..

In 2001, the State Economic and Trade Commission decided to establish and enforce a labeling system of energy efficiency, make and improve the efficiency and energy consumption standards (labeling) of main electrical and mechanical products, including energy efficiency standards for such major energy-consuming industrial equipments as industrial boilers, motors, fans, water pumps and transformers, as well as household appliances, lighting tools, buildings and automobiles.

4.4 Industry

4.4.1 Building materials

China’s building material industry is one of the major energy-consuming industries in the national economy. Over the years, China has adopted a series of measures (Table 4-9) such as improving energy management, readjusting industrial structure, eliminating and transforming backward mode of production, making better use of industrial wastes and stepping up technological transformation for energy saving, so that unit energy consumption of building-material products witnessed a general drop (Table 4-10). Therefore, though the production of most building-material products in China has increased to a great extent, their energy consumption only increased at a lower rate.

Table 4-9 Policies and measures concerning building-material industry

Measures	Contents
Improving energy management	In 1991, the former State Building Material Administration issued “Building Material Energy Conservation Management”, calling for building material enterprises to bring energy conservation into enterprise management, so that management is held accountable for enterprise energy statistics, exceeding of energy-quota and transformation of energy conservation technologies.
Setting graded quota management of energy	In 1990, the State Standardization Administration set graded quota of energy consumption and statistical and calculation method for 22 major building material products such as cement, cement products, plate glass, sanitary building ceramics, sintered bricks and tiles, which are applied to quota management of energy for building material producing enterprises.

Discarding backward technological equipment	In 1999, the State Economic and Trade Commission issued "Catalogue to be Eliminated Backward Production Capacity and Products" (the first and second batch), banning in clear terms and eliminating at fixed periods primary vertical kilns, small mechanized vertical kilns of which diameter is less than 2.2 meters, small sized plate glass production line, Vertical drawing furnace with four drawing machines, Primary ceramic kilns, primary brick kilns, and lime kilns. There are about 3000 enterprises of primary vertical kilns and small mechanized vertical kilns with less than 2.2 meters diameter and over 200 enterprises with small-sized plate glass production line and vertical drawing furnace with four drawing machines were suspended and closed down in China. The production capacity of small and backward cement and glass plants suspended and closed down are about 100 million tons and small sized glass 30 million boxes respectively.
Investment and industrial policies	In June, 1996, the State Building Material Administration issued "Guidelines for Investment in China's Building Material Industry", which proposed gradual development of advanced large-scale energy conservation production of building material industry, suspension and elimination of backward small-sized and local production technologies, so as to increase the proportion of modernized energy conservation technologies gradually and new factories would produce advanced energy conservation products from the very beginning.
Tax policies	In 1993, the State Taxation Administration promulgated the Notice on Exempting Some Wall Materials from Value Added Tax (VAT). In the same year, Ministry of Finance and the State Taxation Administration jointly issued the Notice on Exempting Some Products that Utilize Resources Comprehensively from VAT. The two documents raw building materials mixed with no less than 30 per cent of coal gangue, stone-like coal, fly ash, and industrial slag are exempted from VAT. They also stipulate that clay hollow bricks, non-clay hollow bricks, grey slag bricks, waste slag bricks, air entraining brick products, slag lay bricks, vapor pressured silicon-calcium board, platinum board and some other new building materials are temporarily exempted from VAT.
Energy conservation technological zenovation	Fourteen energy conservation measures have been applied to vertical cement kilns. For example, comprehensive energy-conservation technology innovations have been used in vertical kilns, and power-generation equipments by residual heat has been installed in middle-hollow kilns. Some technical innovations have been made to rotary kilns, such as transforming wet kilns into dry or semi-dry process manufacturing, and comprehensive energy-conservation technology innovation for rotary kilns was introduced. Some energy-conservation technology improvements have been applied to heat insulation and combustor and warm-up boilers have been installed. Some technological transformations have been introduced to porcelain kilns in order to improve heat preservation and recycle waste heat emitted from roller kilns and kiln furnaces. Also, some energy-saving technologies, such as

	technologies on kiln furnaces heat preservation, recycling of residual heat and inner combustion bricks have been adopted. Besides, relevant technologies on semi-mechanized innovation of vertical kiln furnaces have also been applied to lime kilns.

Table 4-10 Comprehensive energy consumption per unit product of some major building Table material products [1990-2000]

Products	Unit	1990	1994	2000
Rotary kiln cement	kgce / t	201.0	193.4	188.0
Vertical kiln cement	kgce / t	161.4	160.8	158.0
Plate glass	kgce / box	34.8	28.0	27.0
Building ceramics	kgce / m^2	12.8	8.8	7.5
Sanitary ceramics	kgce / piece	20.2	16.4	14.7
Bricks	kgce / 10^4 pieces	1363.2	983.4	960.0
Tiles	kgce / 10^4 pieces	1261.6	1131.2	1105.0
Lime	kgce / t	184.0	182.8	180.0

4.4.2 Iron and Steel

The Iron and steel industry has not only been a basic industry of the national economy, but also one of the main energy consuming sectors. Since the 1980s, the former Ministry of Metallurgical Industry has adopted the policy that "Equal emphases should be placed on the development and economical utilization of energy. In the near term, the latter should be given a top priority". The State Council also issued a series of energy-saving polices which include energy-saving regulations, policies and standards for the iron and steel industry. （See Table 4-11）

Table 4-11 Relevant policies and measures of iron and steel industry

Measures and means	Detailed contents
Improve energy management	In 1980, a set of energy balance and consumption index system was established in the iron and steel industry, such as the establishment of an energy balance system among large- and medium-sized steel enterprises, to gradually improve energy management of steel enterprises to the path of scientific and high-quality management. Since 1991, an energy conservation plan has been laid down and since then such indexes as comprehensive energy use per ton steel and their annual energy-saving have been under examination and verification. Since 1992, Ministry of Metallurgical Industry began to issue energy-saving plan to some key steel manufacturers, metallurgical material, mine, and mechanic repair enterprises as well as various levels of departments (bureaus and companies) of the metallurgical sector and strengthen the inspection on energy consumption and conservation indicators.
Relevant industrial	In 1991, the Ministry of Metallurgical Industry (MMI) issued the

policies	"Specific Regulation on Some Proposals to Further Strengthen Energy conservation", the "Further Strengthen Energy Conservation" was adopted by the State Planning Commission. In 1992, MMI promulgated the Regulation on Encouraging Enterprises to Achieve More Progress in Saving Energy, and the Implementation Details of the Temporary Prescription on Energy Conservation, adopted by the State Council. In 1996, MMI drafted the Ninth Five-Year Program for Energy Conservation
Eliminate backward industrial equipment and strengthen structural readjustment	Some relevant industrial technological policies have been adopted to eliminate backward equipments and technologies such as mould casting, cogging, steel making through melted iron, open-hearth furnaces, primitive coking, small blast furnaces and small electric furnace. A series of energy-saving technology improvement measures have been taken, ranging from single-process energy conservation and conservation management applied in the 1980s, to measures on the improvement and management of production structure in the 1990s, such as optimization of technological process, strengthening the construction of large-scale equipment, and development of continuous casting and coal spraying through blast furnaces, as well as reducing the manufacture of steel through melting iron.
Draft and design relevant energy-saving and standards	The Regulation on the Design of Energy Saving Technologies for Steel Enterprises; the Regulation on Saving Energy Resources in Coking process; the Regulation on Saving Energy Resources in Sintering process; the Regulation on the Energy Conservation in Iron Smelting Process; the Regulation on Energy Conservation in Steel Smelting Process of Open-Hearth Furnaces; the Regulation on the Energy Saving in Steel Smelting in Electric Ovens; the Regulation on the Energy Conservation in Steel Smelting in Rotatory Furnace; the Regulation on Energy Saving in the Process of Steel Smelting in Cupola Furnaces; the Regulation on Energy Saving Steel Smelting in Converters; the Regulation on the Energy Saving in the Process of Blooming; the Trial Regulation on Energy Saving of Steel Rolling Process; Some Regulations on Fuel Saving in Steel-Rolling Heating Furnaces; the Trial Regulation on Energy Saving of the Metalwork Furnaces; the Regulation on Energy Saving in Producing Refractory Materials; the Trial Regulation on Energy Saving in Iron Alloy Production; the Trial Regulation on Energy Saving in the Charcoal Production; Some Trial Regulations on Energy Saving in the Iron Ore Dressing Process; the Regulation on Energy Saving of Metallurgical and Mechanical Enterprises; the Trial Regulation on Power Energy Saving of Steel Enterprises; the Temporary Regulation on the Energy Balance Calculated Methodology and Energy Consumption Indicators of Steel Enterprises; the Prescription on the Regulation on the Calculating

	Methods of Energy Balance and Energy Consumption Indicators of Metallurgical Material Enterprises; the Trial Methods on the Energy Balance and Energy Consumption Indicators of Metallurgical Machine Repair Enterprises.
Incentive policies on Investment and others	In the 1980s, the State established a special fund for Basic Energy Saving Construction as well as a special fund for renovation in energy-saving technologies. In the 1990s, the country lowered the interest rate on loans for the basic energy-saving infrastructure construction projects by 30 per cent compared to commercial loans. An Award for Energy Saving Enterprises was established. The State has also actively promoted clean production among enterprises, giving preference to investments for projects on reducing energy consumption and conservation, environmental protection, and comprehensive utilization of resources.

Over the past ten years, China's iron and steel industry has made substantial progress in technology improvement and structural optimization, making a remarkable achievement in saving energy resources, reducing cost and improving quality. Within a decade (1990-2000), the country's steel output in 2000 doubled compared to that of 1990, while total energy consumption only increased by 34%. Chart 4.5 shows the status of energy consumption in China's steel production and continuous casting ratio of steel-making from 1991 to 2000.

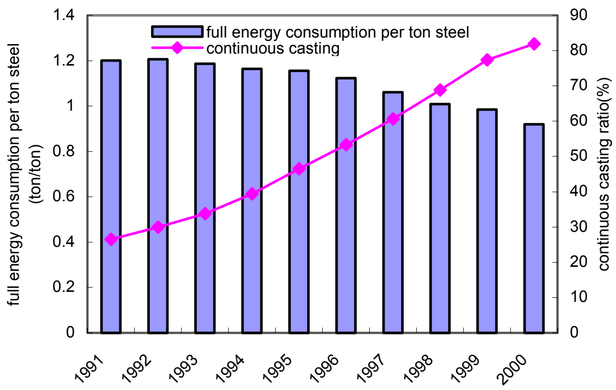


Figure 4.5 Continuous casting ratio of steel-making in iron and steel industry and changes of energy consumption per ton steel (1991～2000)

4.4.3 Chemical industry

China's chemical industry has achieved important progress in improving basic energy saving, constructing energy-saving regulations and management systems, as well as developing energy-saving technologies.

From 1990 to 2000, energy consumption for every 10,000 Yuan worth of output in the chemical industry decreased from 6.68 tce to 4.04 tce, with a 5.15 per cent of decrease rate per annum. The high-consuming sectors in particular have achieved more marked progresses. For example, energy consumption in fertilizer manufacturing industrys was decreased from 15.38 tce for every 10,000 yuan of output in 1990 to that of 8.36 tce in 2000, with an average annual decrease rate of 6.28 per cent. For the changes in energy consumption for every unit of output in various sub-sectors of the chemical industry, see Table 4-12 for details.

Table 4-12 Changes of unit energy consumption of the main chemical industrial sub-sectors (1990-2000)

（Unit：tce/10000 yuan）

Sub-sector	1990	1994	2000
Chemical industry	6.68	5.29	4.04
Chemical mining industry	4.51	5.50	3.66
Basic chemical raw materials	6.73	6.89	5.95
Caustic soda		6.26	6.01
Chemical fertilizer	15.38	11.58	8.36
Nitrogen fertilizer	18.47	14.40	10.52
Small-scale Nitrogen fertilizer	19.39	14.83	10.8
Phosphate fertilizer	5.20	4.19	3.2
Organic chemical products	3.22	3.20	2.61
Synthesized materials	3.84	2.47	2.48
Special chemical products	3.84	2.47	2.06

Since the 1980s, Ministry of Chemical Industry and other departments have issued and adopted a series of management and technical regulations and standards (Table 4-13), which have played an important role in optimizing energy management and conservation.

Table 4-13 Relevant regulations and standards of the chemical industry

Time of issuance	Title and Contents
1986	A Detailed Rule for the Implementation of the Temporary Regulation on Energy Conservation Management in the Chemical Sector
1986	The Technical Regulation on the Design of Energy Conservation of Caustic Soda; the Technical Regulation on the Design of Energy Conservation of Soda Ash; the Technical Regulation on the Design of Energy Conservation of Synthetic Ammonia; the Technical Regulation on the Design of Energy Conservation of Calcium Carbide; the Temporary Regulation on Energy Saving Technologies of Oil Refining Equipment; the Technical Regulation on the Industrial Design of the Mucilage Glue and Fiber Factories (A trial edition).
1987～1988	The Regulation on the Industrial Designing Technologies of Terylene and Filament Factories; the Regulation on the Industrial Designing Technologies of Terylene and Short Fiber Factories (A trial edition); and the Guideline on the Designing for Rational Use of Energy Resources by Petrochemical Plants.
1987	Temporary Regulation on the Upgrade of Energy Saving Management of Chemical Enterprises. Based on the trial from 1988 to 1989, the

	temporary regulation was revised in 1990 into the Regulation on the Upgrade or Grading of Energy Saving Management of Chemical Enterprises; three batches of examination indexes on the upgrading of energy saving management by chemical enterprises were issued from 1989 to 1991
1987	The Key Direction on Technological Retrofitting of Energy Conservation in Chemical Industry. Management Measures on Technological Retrofitting Projects of Energy Conservation in Chemical Industry during the Period of Seventh Five-Year Plan.
1988～1990	Three industrial standards were laid down: The Principle on Energy Balance of Chemical Enterprises. The Graded Technological Standards on the Operation of Boilers and Heat Preservation of Heat Pipelines of Chemical Enterprises; General Rule on the Quantitative Calculation of Energy Consumption and Energy Conservation of Chemical Enterprises.
1991	Guidelines on the Competition Activities of Energy Conservation Conducted among Chemical Enterprises. The Management Guideline on Special Loans for Energy Conservation of Chemical Enterprises

Since the 1980s, anthorities in the chemical sector have introduced and applied tens of new techniques, technologies, materials and equipments introduced and applied in large, medium and small-sized synthetic ammonia manufacturing enterprises. For example, among large-sized synthetic ammonia manufacturing enterprises, recycling of residual heat emitted from furnace smoke and gas, new-type of catalysts that can lower down the feeding water-carbon ratio, new-type of baking mouths, lower-consumption decarbonization crafts, and synthetic energy-saving towers have been adopted widely. Among medium-sized synthetic ammonia enterprises, technology of optimizing intermittent gasification at atmospheric regular layers, technology on atmospheric high-grade oxygen continuation at regular layers, entirely-low-alteration crafts, new-type double-tower renewable decarbonization crafts, and technology on membrane separation as well as technology on absorbing and recycling hydrogen through voltage transformation have been introduced. As to small-sized synthetic ammonia enterprises, they have introduced low-temperature transformation crafts, reformation of gas-producing furnaces, inner parts for new-type synthetic towers, self-producing vapor technology for synthetic ammonia production, as well as closed-circuit recycle of cooling water . As for key energy-consuming products such as caustic soda, fine soda and calcium carbide, chemical industrial departments have applied and disseminated tens of domestic-developed energy-saving technologies. These technologies include voltage regulation-transformation-rectification of caustic soda; combined heat and power generation and multi-level utilization of vapor in calcined soda enterprises; boiler systems with direct combustion of gases from closed calcium carbide furnaces, boiler systems using residual heat of smoke gases from half-closed furnace, as well as the technology of limekiln fueled by furnace-gases in calcium carbide manufacturing enterprises.

4.5 Energy conservation in buildings

China has a vast area of territory with a great climate diversification. Compared with other areas of the same latitude around the world, China has lower temperature records in the winter and higher in the summer. Such climate characteristics have made China consume more energy resources in running heating equipments in winter and air-conditioners in summer than the same-latitude countries. By the end of 2000, China's actual building area of houses in cities was 7.66 billion M^2 and 31 billion M^2 in the countryside. China has a large number of new buildings constructed every year. In 2000, newly-built housing area amount to 1.82 billion M^2. In the same year, the housing area with central heating supply was 1.11 billion M^2, and other houses were mainly heated through scattered small-sized boilers. Coal accounted for more than 90 percent of energy consumption for heat supplies and natural gas and electric power only accounted for a very small portion. Air conditioners are on a rapid increase in residential dwellings and public buildings.

4.5.1 Energy-saving policies and regulations for buildings

China has started the promotion of energy conservation in buildings since the 1980s. In November 1992, the State Council issued a notice on accelerating the renovation of wall materials and disseminating energy-saving building technologies. The notice stipulated that, in accordance with relevant regulations, zero tax rate for regulatory tax should be imposed upon fixed asset investments on energy-saving residential houses and new-type wall materials in north China. In 1995, the Ministry of Construction promulgated the Policy on Building Energy-Saving Technologies, in which concrete policies on technologies for building layouts, surrounding facilities and heat-supply air-conditioners were drafted. The Energy Conservation Law stipulates that the layout and construction of buildings should, in accordance with relevant laws and regulations, adopt energy-saving building structures, materials, equipment and products, to improve their functions of heat preservation and thermal insulation, and to reduce energy consumption in heating, refrigeration and lighting. In February 2000, the Ministry of Construction issued a regulation on management of energy conservation in residential buildings. The regulation requires that the organizations in charge of building, designing and construction shall implement compulsory standards on building energy conservation and accept supervision and examination from the administrative departments responsible for construction projects and the supervisory bodies overseeing the construction quality. In addition, some cities have already carried out experimental reforms on metering for heat supply in buildings.

4.5.2 Energy-saving standards for buildings

In 1986, the former Ministry of Urban and Rural Construction and Environmental Protection issued the Designing Standards on Energy-Saving for Residential Buildings. The document stipulates that heating energy consumption of newly-built residential buildings should be reduced by 30 per cent from the local standard commonly applied between 1980 to 1981. In 1995, the Ministry of Construction revised the document, putting forward the target that residential building heating energy consumption in northern part of China should be cut by 50 per cent from the previous standard.

To promote energy conservation in buildings, the Ministry of Construction has successively promulgated the following documents: Grading of Insulation of Outside Windows of Buildings and its Testing Methods; Design Standards for Lighting in Residential Buildings; Design Standards for Thermal Engineering in Residential Buildings; Design Standards for Energy Conservation in Thermal Engineering and Air Ventilation in Tourist Hotel Buildings; the Technical Directives on Energy Conservation Renovation of Existing Residential Buildings in Areas Hot in Summer and Cold in Winter , etc.

To implement nationwide designing standards for energy saving in buildings, a lot of provinces, cities and regions have successively formulated local standards and detailed implementation rules. For example, Beijing and Tianjin have both adopted detailed implementation rule for the Design Standard on Energy Conservation in Residential Buildings. Hebei Province has adopted a temporary technical regulation on energy conservation for the residential building heating. Inner Mongolia Autonomous Region and Shannxi Province have adopted a detailed implementation rule of the Design Standard on Residential Buildings Energy Conservation. The city of Wuhan, capital of Hubei Province, has drafted a technical provision on residential buildings energy conservation design etc.

4.5.3 Energy-saving products and projects for buildings

Since the late 1990s, the technology of outer wall heat insulation has achieved a substantial progress in China. Plastic windows, aluminum windows, middle-hollow glass windows and other types of windows have been widely used in the country. Obvious progress on temperature control and heating supply measurement was achieved. At the same time, solar energy technology application in buildings has also achieved tangible progress. All these have initially formed a building energy saving products system with complete types, comprehensive and advanced methods, as well as practical purposes.

Since 1992, the Ministry of Construction has successively carried out trials building energy-saving in Beijing, Hebei, Liaoning, Gansu, Ningxia Autonomous Region and other three provinces and areas. Until 2000, tens of cities in southern and northern China had been approved to construct exemplary districts of energy-saving buildings. By the end of the year 2000, a total of 180 million square meters of energy-saving building area had been constructed in China, and about 95 per cent of them are in the northern region that need heating supply in winter. Among the 180 million square meters, around 70 million square meters have a energy-saving ratio of 50%, and the others have a ratio of 30%. Beijing has had a total of 68 million square meters of energy-saving residential area, of which 26 million square meters have a energy-saving ratio of 50%. In Tianjin, these two figures are 28 million and 90 million respectively.

4.5.4 China’s Green Lighting project

To develop and spread high-efficiency electric lighting products to satisfy people’s increasing demands for lighting quality and environment, saving electricity use for lighting and reducing environmental pollution, the State Economic and Trade Commission, together with several ministries and commissions, such as the States Development Planning Commission and Ministry of Construction, launched and adopted a Green Lighting Project in China in October 1996.

The project laid down some incentive policies that can contribute to economical use of electricity for lighting, improved relevant policies and regulation systems, and established a product testing system and a quality guarantee system. In this project, some supporting policies were provided to enterprises which produce high-efficiency electric lighting products to reduce their production costs, to improve their product quality and function, and to raise their market competitiveness. Also, the campaign, through medias such as radios, televisions, newspapers, magazines and others, , lectures and seminars, has widely disseminated and popularized relevant knowledge about economical usage of electricity for lighting, and strengthened the public's awareness in this regard.

From 1996 to 1998, a total of 267 million pieces of high-efficiency electric lighting products were used in China, saving as much as 17.2 TWh electricity. According to a sample survey conducted in some of China's cities in 1998, the utilization ratio of high-efficiency electric lighting products was 82% among government departments, and 49.7% among state institutions and enterprises. In hotels, business plazas, office buildings, institutions and schools in the large and middle cities, energy-saving lamps have been widely used for illumination. In particular, the popularity ratio of high-efficiency electric lighting appliances has reached 90% in large-sized commercial buildings.

4.6 Communications and transportation

Since the 1980s, China has adopted active investment and industrial development policies, and promoted the development of the communications and transport industry greatly. The policies are as follows:

——To strengthen the investment in the construction of communication and transport facilities. The construction of highways, ports, railways and urban public transport systems has been stepped up, the level and quality of communications and transport supplies have been improved, the network of urban roads and public transport lines have been continuously optimized, and transport efficiency has been tangibly improved.

——To step up commercialization reforms of the communications and transport industry. Road, water and air transport departments have been separated from the government and carried out a market-oriented operation, so forming a mechanism of distributing transport resources through market rules.

——To push forward the technological renovation of communications and transport equipment and the accelerated application of new technologies. In the field of railway transport, a lot of steam-powered engines with serious environmental pollutions have been eliminated through developing electric power or internal combustion powered engines. In the field of highway transport, some measures have been taken to improve operating efficiency of vehicles, to step up the speed of eliminating high-energy-consuming and old vehicles, and to promote technological improvement of vehicles. In the field of water transport, some concrete measures have been adopted to encourage the development of ships to a large-scale direction, vigorously develop containerized traffic, improve transport efficiency, and apply a strict retirements regulation on outdated ships.

With the technology development of communications and transport equipment and improvement in their management, unit energy consumption has been remarkably reduced in China's communications and transport sectors (Table 4-14 for details).

Table 4-14 Changes of per unit energy consumption of China's main communications and transportation sectors [1990 -2000]

Major communications and transportation departments	1990	1994	2000
Railway transport（tce/million ton kilometers）	16	12.3	10.4
Highway transport (passenger transport)			
Gasoline-driven vehicle (litre/100 vehicle kilometer)	29.8	26.4	22.3
Diesel-driven vehicle (litre/100 vehicle kilometer)	24.1	22.9	18.3
Highway transport（freight transport）			
Gasoline-driven vehicle (litre/100 vehicle kilometer)	37	34.4	28.4
Diesel-driven vehicle (litre/100 vehicle kilometer)	35.9	32.3	28.1

4.6.1 Policies, rules and regulations

To improve the efficiency of the communications and transport system, some relevant departments under the Chinese Government have adopted a series of policies and measures (Table 4-15).

Table 4-15 Relevant policies, rules and regulations adopted by the authorities of communications and transportation to improve the energy efficiency and energy saving

Issuing Organizations	Regulations and policy measures
The State Council	The Policy on Automobile Manufacturing Industry, promulgated in 1994, to encourage automobile manufacturers to enhance technological levels, use energy-saving and low-pollution technologies and products; The Notice on Stopping Manufacturing and Selling Automobiles Fuelled by Leaded Gasoline, issued by the Administrative Office of the State Council. The document stipulates that as of January 1, 2000, all gasoline producers in China should produce lead free gasoline with gasoline grade at 90 or above, and from July 1, 2000, they should stop selling and using leaded gasoline. The Suggestion on Application of Smooth Traffic Project to China's Urban Road and Transport Management, disseminated by the Ministry of Public Security and Ministry of Construction in 2000.

Ministry of Railways	Temporary Detailed Rule on Railway Energy Saving Management, issued in 1986; Detailed Rules on the Implementation of the Law of Energy Conservation among Railway System, issued in 1998; all 14 railway bureaus adopted energy-saving management measures. Policy on Railway Energy-Saving Technologies, promulgated in 1999.
Ministry of Communication	The Regulation on Publication of Energy-Saving Products among the Fields of Automobiles and Ships, issued in 1992; Management Measures on Popularization and Application of Energy-Saving Products (Technologies) used by Automobiles and Ships, issued in 1995; Detailed Rules among the Transport Industry on the Implementation of the Energy Conservation Law, issued in 2000.
Local governments	In the field of urban transport, major large-sized cities have basically replaced carburetor motorcars with electric sprayer-installed ones; some large-sized cities have popularized the principle of "public transport first'', designating special lanes for public buses and improving transport efficiency. In Shanghai, Beijing and some other metropolitans, advanced intelligent transport management system has been applied, which greatly improved transport management ability and efficiency of urban transport network.

4.6.2 Standards and technology regulations

From 1986 to 2002, the State Economic Commission, the State Economic and Trade Commission and other government departments issued a series of standards and technological stipulations successively on the discarding of old vehicles. In 1986, the State Economic Commission issued a temporary prescription on stepping up the discarding and renovation of old and torn vehicles, in which standards and recycling methods were laid down. In 1997, the State Economic and Trade Commission and other departments jointly promulgated a standard on the discarding of vehicles, compulsorily prescribing the accumulated mileages for the discarding of different types of vehicles. The document was revised in 2000. The State Economic and Trade Commission and other departments respectively issued a standard on the discarding of agricultural transport vehicles and a temporary regulation on the standard of discarding motorcars in 2001 and 2002.

From 1986 to 2000, the Ministry of Railways and Ministry of Communications respectively issued the Stipulation on Energy-Saving Technologies for the Design of Railway Projects, the Stipulation on the Energy Saving for the Design of Railway Projects, the Stipulation on Energy Saving Technologies for the Design of Water Transport Projects, and the Regulation on Examining Energy Utilization of Port Ships. In 2000, the Ministry of Communications revised and issued again the Standard on the Energy Conservation for the Design of Water Transport Projects, and the Assessment of Unit Energy Consumption of Basic Port Construction Projects (or Technological Reconstruction) in 2003.

In 1999, the State Bureau of Quality and Technical Supervision issued the Stipulation on Limiting the Discharge of Pollutant by Automobiles and Testing Methods, Standards on the Discharge of Pollutants by Light Automobiles, the Stipulation on Limiting the Discharge of Pollutants by

Automobiles with Pressure-fueled Motors and Testing Methods, and the Stipulation on Limiting the Discharge of Visible Pollutant by Automobiles with Pressure-fueled Motors and Testing Methods, etc.

4.6.3 Technology development, dissemination and application

Since the 1990s, under the guidance of the State Science and Technology Commission and the Ministry of Mechanics, scientific research institutions and academic bodies, such as the China Research Center of Automobile Technology, have conducted the technological researches and development of alternative fuels for vehicles. The researches mainly focused on gas-fueled vehicle technologies, hybrid vehicle technologies, fuel-cell vehicle technologies, and electric vehicle technologies. Among them, certain progress has been made on gas-fueled vehicle technologies which were applied to buses and taxies, on trial in a number of large-size cities.

In April 1999, a dozen Departments, such as the Ministry of Science and Technology, the State Environmental Protection Administration, the State Planning Commission, etc. jointly launched a campaign entitled "Atmosphere Purification Project—Clean Vehicle Action". During the Tenth-Five-Year Plan period, 16 provinces and cities, such as Beijing, Shanghai, Tianjin, Chongqing, Sichuan Province, Hainan Province, Harbin, Changchun, Yingchuan, Xi'an, Urumuqi, Jinan, Qingdao, Guangzhou, Lanfang and Puyang, became the first major provinces and cities to promote clean vehicles . By the end of 2003, the number of gas-fueled vehicles in the 16 provinces and cities reached 193,000 and 594 gas stations were built.

Box 4-7 City transport—a case study in Beijing

The city of Beijing has improved its traffic and transport efficiency through accelerating the development of its urban railway transport system. From 2000, Beijing started to construct nine railway transport lines, among which, No. 4 Line, No.5 Line, No. 10 Line, Olympics Branch Line and Yizhuang Line are subway lines, Batong Line is a Light-Rail line, Liangxiang Line, Shunyi Line and Changping Line are suburb railway lines. By 2008, the total mileage of railway transport in Beijing would reach 300 kilometers.

As far as road transport is concerned, Beijing has designated special lanes for public buses in order to improve the efficiency of public transport system and indirectly reduce the use of private automobiles.

In the field of alternative fuels, Beijing has launched a comprehensive project to control environment pollution caused by vehicles. During the period from 1998 to 1999, Beijing completed refitting 1,640 buses with liquefied petroleum gas and natural gas and refitting more than 6,000 taxies with liquefied petroleum gas. By the end of 2001, more than 36,000 vehicles in Beijing changed to use clean fuels, among which 1,630 buses were fueled by natural gas (Chart 4.6). Beijing is a city with the largest number of buses using natural gas in the world.

With regard to the emissions of vehicles, Beijing adopted No I Emission Standard of Europe (EURO I) from 1999, and applied green environment protection label to vehicles. From 2003, Beijing adopted No II Standard of Europe (EURO II)for light vehicles.

Figure 4.6 Natural gas-fuelled public buses in Beijing

4.7 Agriculture

Policies and measures to mitigate GHG emissions in the agriculture sector focus on two areas: to reduce the emission of methane and nitrogen oxide in rice planting, fertilizer utilization and livestock breeding; and to increase the storage of carbon dioxide by grassland.

4.7.1 Utilization of chemical fertilizers

The Law of Environmental Protection of the People's Republic of China stipulates that governments at all levels should strengthen environmental protection in agriculture sector, and fertilizer, pesticide and plant growth hormones should be used rationally. The Law of Agriculture of the People's Republic of China also stipulates that entities running agricultural activities should take responsibility to land maintenance, rational utilization of fertilizers and pesticides, and improvement of land viability, and to prevent land pollution, damage or degeneration.

More than ten provinces and autonomous regions, including Jilin, Heilongjiang, Liaoning, Shanxi, etc. issued regulations on agricultural environmental protection respectively, which require rational utilization of fertilizers, pesticide, agricultural plastic film and other agricultural chemicals, and the prevention from and/or reduction of the pollution to soil and agricultural products. Hebei, Shandong and some other provinces have formulated measures for managing non-pollution agricultural products, which also require the dissemination of balanced fertilizer application.

4.7.2 Treatment of Animal wastes

In April 1996, the Ministry of Agriculture issued a notification calling for the acceleration and intensification of the construction of energy-environment protection projects during the Ninth-Five-Year Plan period. This notification requires that, for newly built livestock and domestic fowl breeding farms, entities must carry out, according to the decision on further strengthening of environmental protection issued by the State Council, planning, designing and construction of treatment facility for dejection and sewage simultaneously with farm construction, and that treatment investment should be no less than 10 per cent of the total investment. The notification also requires that during the Ninth-Five-Year period, for existing domestic fowl and livestock breeding farms with more than 100 fenced cattle, 1000 fenced pigs or 10,000 fenced fowls and without waste treatment facilities, the waste treatment facilities should be built gradually phase by phase.

The regulations on agricultural environmental protection issued by local authorities also stipulate that entities and individuals breeding livestock and domestic fowls and processing agricultural and livestock products should dispose of dejection, wastewater and other waste materials in a sound and harmless manner.

4.7.3 Development and protection of grasslands and pastures

The Law of Grasslands of the People's Republic of China stipulates that local governments at each level should be responsible for conducting surveys on grassland resources, making development programs for grazing industry, strengthening the protection, construction and rational use of grasslands and pastures, and improving animal-breeding capability of the grasslands and pastures within their administrative regions. It also stipulates that measures should be taken to protect pasture vegetation, forbid farming and devastating, use grasslands rationally and prevent excessive grazing. This law further stipulates that measures should be taken to strengthen the management and rational utilization of artificial pastures, to prevent them from deterioration.

The regulations on agricultural environmental protection issued by local authorities stipulate that efforts should be made to protect grasslands, pastures and artificial grazing lands. It also requires rational utilization of grasslands to prevent grassland degradation, desertification and soil erosion by over-grazing, and it forbids felling and chopping of sand-fixing plants and taking of soil to avoid destroying the vegetation on grasslands.

Figure 4.7 People converting farmland into grassland in the Western Region of China

China has begun to build household-based contract system for running grasslands since the 1980s. Such system defines the responsibility, right and interests of grassland construction and protection and provides great incentives to herdsmen for developing husbandry while protecting and constructing grasslands. Some achievements have been made in the aspect of high-quality herbage breeding and dissemination. The cultivation belts for different types of high-quality herbages suitable for tropical, subtropical and temperate zones have been exploited and processing technologies have been developed. So far, annual sowing area of herbage in China has reached 40,000 hectares and aerial seeding area of herbage has reached 1.5 million hectares, in which the area of vegetation coverage exceeds 80 percent. Artificial grasslands and managed and improved grasslands have cumulated over 16 million hectares, and the area of fenced pastures has increased to 10 million hectares. On average, 4.5 million hectares of pastures were prevented from damage causes by rats and pests each year, and in total about 90 million hectares of grasslands were prevented from damage causes by rats and pests. In different ecological areas, 11 different types of natural pasture preservation zones have been established. Measures for preventing and controlling pasture pests have been changing from chemicals to biological means.

4.7.4 Construction of China's eco-agricultural counties

In 1993, the Ministry of Agriculture, together with the State Planning Commission and other five commissions or ministries, carried out a demonstration program to build eco-agricultural county nationwide. Five years later, remarkable achievements in 51 counties selected for demonstration have been made. In all the 51 counties, economy grew significantly, the structure of agriculture, forestry, husbandry, and fishery became more rational, 73.4 percent of soil erosion areas and 60.5 percent of desertification areas have been managed and improved. The coverage of forests and grasses increased by 3.7 percentage. 49% of straw residues was returned to fields. 73.4 percent of waste gas and 57.4 percent of waste water was treated respectively, and 31.9 percent of solid waste was recovered and utilized. In southern areas an eco-agricultural model combining "pigs-breeding, biogas generating and –fruits-planting" has been developed, while in the north, a model combining pigs-breeding, biogas generating, household fuel and greenhouse planting" (**four in one)?** has been developed(fig. 4.8).

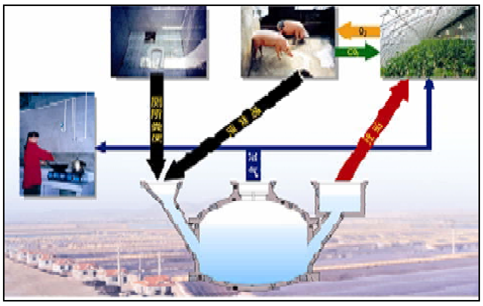


Figure 4.8 The "four in one" eco-agricultural model in Northern China

In 2000, the above mentioned seven ministries and commissions launched the second phase of eco-agricultural county program, another 50 counties were selected for further demonstration. At the same time, the Ministry of Agriculture also promoted eco-agricultural constructions in counties located in special natural type areas. The Taihu Lake basin and the Three Gorges Reservoir area were selected to demonstrate reduced use of fertilizers and pesticide in order to prevent non-point pollution from agriculture.

4.8 Forestry

The area of China's forests have been increasing since the 1980s (Table 4-16). According to the fifth national inventory of forest resources, conducted during the period from 1994 to 1998, total area in China's forestry sector amounts to 263.29 million hectares, among which 158.94 million hectares are forests, accounting for 16.6% of the country's total area.

Table 4-16 Changes of land areas in forestry sector

(unit：million hectare)

	1989～1993 [(1)]	1994～1998 [(2)]
Forests	133.70	158.94
Economic stands	16.10	20.22
Bamboo stands	3.90	4.00
Open forests	18.03	7.20
Brush wood	29.71	34.45
Temporary unstocked lands	7.14	4.62

Note；(1) Ministry of Forestry (1994)； minimum crown cover:0.3；(2) the State Forestry Administration (2000)；minimum crown cover:0.2.

4.8.1 Regulations, systems and standards

Since 1980, China has successively issued and revised a series of administrative regulations related to forestry, such as the Regulation on the Implementation of the Law of Forest, Stipulation on Grain for Green, the Regulation on the Protection of Wild Plants, the Regulation on Natural Preserves, the Regulation on Forest Fire Control, and the Regulation on the Control of Forest Diseases and Pests, etc.

To guarantee planting quality, relevant government departments have issued the Measures on Supervision and Management of Forestry Projects.

In 1995, the State Commission for Restructuring and Ministry of Forestry jointly issued the Outline on the Reform of Forestry Economic System. The Outline states that a subsidy system for ecological benefits of forests shall be established to levy forest ecological subsidy fees on the units gradually which have gained direct benefits from adjacent forests. The Ministry of Finance, the State Development and Planning Commission and the Ministry of Forestry were yet to draft concrete fee-collecting methods. In 2001, the State Forestry Administration and Ministry of Finance jointly issued the Reply on a Trial Construction of Subsidy for Forest Ecological Benefits in 2001 and since then, trial works in this regard has been formally launched.

In December 1981, the fourth session of the Fifth National People's Congress passed a resolution on the launching of a nationwide campaign for voluntary planting, and the State Council issued methods on the implementation of such resolution in February 1982. Since then, a voluntary planting system has been established nationwide. By 2001, about 35 billion of trees had been planted by 7 billion person-times across the country.

Since 1990, China has gradually set up a forest pricing system, a forestry foundation system, an afforestation loan system, and a forest certification system. Relevant government departments have reviewed past technical standards for planting and have made some revisions and improvements. Also, 26 technical standards relevant have been developed.

China has conducted some reforms on the tenure of wasteland, and adopted an encouragement policy of "the one who treats, the one who can benefit". Multiple wasteland use models have been set up, such as contracting, joint stock, renting and auction systems. Within a 50-year tenure or a longer one, the rights of using wastelands and barren hills will not be changed and the users' exploitation rights are allowed for transfer. The Law of Land Contract clearly stipulates that the contracting period of forestry land is 30 to 70 years, and for special forestry lands, contracting deadlines can be prolonged after being approved by the responsible administrative departments under the State Council.

4.8.2 Projects of ecological forest system

Since 1978, China has successively initiated the construction of shelter-forests in the *Three-Norths* (north, northwest and northeast China) as well as in some key areas along the middle and upper reaches of the Yangtze River, and launched projects such as natural forest conservation (Table 4-17). By 2000, there are 46.667 million hectares of plantation, and 30.19 million hectares of wasteland have been under land closure for natural growth of trees.

Table 4-17 China's ecological forest projects

Name of the project	Starting time	Extension Scope	Results of Implementation
Three-North Shelter-belt Forest Project	1978	13 provinces, autonomous regions and municipalities	By 2000, the accumulated planted area had reached 22.037 million hectares
Plain Greening	1986	26 provinces,	By 2000, 32.56 million hectares of

Project		autonomous regions and municipalities	croplands and forests had been under protection and 850 counties had reached the standard for plain greening
Planting in Taihang Mountain	1987	4 provinces, autonomous regions and municipalities	By 2000, total planted area had amounted to 2.952 million hectares
Coastal Shelter-belt Forest Project	1988	11 provinces, autonomous regions and municipalities	By 2000, total planted area had accounted for 3.24 million hectares
The Yangtze River Watershed Shelter-Forests	1989	17 provinces, autonomous regions and municipalities	By 2000, total planted area had accounted for 6.855 million hectares
The ZhujiangRiver Watershed Shelter-Forests	1996	6 provinces, autonomous regions and municipalities	By 2000, total planted area had accounted for 0.864 million hectares
Natural Forest Conservation Project	1998	17 provinces, autonomous regions and municipalities	Commercial logging of natural forests has been fully stopped, and by 2002 1.466 million hectares had been afforested by direct planting, 1.653 million hectares by air seeding, and 4.781 million hectares by hill closure. A total of 94.96.7 million hectares of forests have been under effective management and protection.
Sandstorm Sources Controlling in Beijing and Tianjin	2000	Five provinces, autonomous regions and municipalities	By the end of 2002, 2.28 million hectares of sand sources have been under control, among which 1.423 million hectares have been planted.
Construction of the Bases for Fast-Growing and High-Yield Timber Forests in Key Areas	2002		In 2002, the country provided construction funds for 10 afforestation projects, with an planting area of 0.293 million hectares.
Wild Animals and Plants Conservation and Nature Reserve Project	2002		By the end of 2002, the number of nature reserves in the forestry sector had amounted to 1405, with a total area of more than 100 million hectares

4.8.3 The Grain for Green Project

The Law of Land Management of the People's Republic of China stipulates that agricultural exploitation of forests, grasslands, lakes and river beaches is prohibited. According to overall land use planning, effective measures should be taken to convert arable lands to forestlands or pastures (Grain for Green) gradually. The Law of Water and Soil Conservation of the People's Republic of China stipulates that reclaiming and growing crops on steep slope above 25 degrees is forbidden. The governments of provinces, autonomous regions and municipalities can allow the reclamation and crop growth on slope below 25 degrees according to local conditions under their jurisdiction. The areas reclaimed against the stipulations of the law should be gradually restored to forest and grasslands in accordance with local conditions to restore vegetation, or should be constructed to terraced fields.

In August 1998, the State Council issued a notice to protect forest resources and prohibit deforestation and misappropriate occupation of forestlands. The notice requires that local regions should reforest destroyed forestlands within a certain time limit according to the principle that the one who approves deforestation should undertake the responsibility for reforestation. In the same year, the Communist Party of China (CPC) Central Committee and the State Council issued the Proposals on Post-Disaster Reconstruction, Management of Rivers and Lakes, and Construction of Water Conservation Projects. The document regards the principle of "tree planting and the grain for green" as the top priority among post-disaster reconstruction measures. In 1999, the provinces of Sichuan, Shaanxi, and Gansu started trial work on the grain for green according to the policy measure of "grain for green, mountain closure for natural growth of trees, taking foods as relief means, and individual contracting". In 2000, similar trial work was formally unfolded in 17 provinces, autonomous regions and municipalities. The government also adopted some policies to provide subsidies for the project, which mainly include:

——Grain and living allowance: The standards on allowance are as follows: In the Yangtze River Watershed and southern part of China, every mou of arable land converted to forestland will get an allowance of 150 kilograms unprocessed grain every year. In the Yellow River valley and northern part of China, 100 kilograms of unhusked grain will be subsidized. Also, 20 Yuan of living allowance will be given every year for every mou of arable land to be restored. The deadline for such allowances are two years for arable land to be converted to grassland, five years for arable land to be converted to economic forests, and eight years for arable land to be converted to forests.

——Seedling and planting allowance: The allowance for seedling and planting is 50 Yuan or more for every mou.

——Tax preference: Agricultural tax on all cultivated lands to be converted to forests or grassland will be reduced from the planned beginning if their received grain allowance is less than their previous output. When grain allowance stops, all agricultural taxes levied on them should be exempted. All those plans to convert arable lands to grasslands and forests will enjoy relevant tax preferential policies, and the incomes gained from special local products grown in the converted forest or grasslands will be exempted from specialty taxes according to relevant state regulations.

——Payment transfer: For counties implementing the plan of “grain for green”, the central government will provide a certain amount of allowance to balance their reduced agricultural revenues in the manner of payment transfer.

By the end of 2000, the country had completed restoring a total area of 1.32 million hectares of arable lands to forests in 17 provinces, autonomous regions, municipalities and the Xinjiang Production and Construction Corps, among which 786,000 hectares of arable lands and 534,000 hectares of desolate hills and wastelands had been planted respectively.

4.9 Municipal waste treatment

The Chinese government attaches great importance to the issue of municipal waste treatment . By the end of 2002, China had constructed a total of 651 municipal waste treatment projects, among which 528 were for landfill, 78 for compost, and 45 for burning. According to statistics, landfill is the main method for municipal waste treatment, accounting for about 89. 3 percent of the total amount of household garbage treated so far (Table 4-18).

Table 4-18 China’s municipal waste treatment facilities [1994 - 2000]

Year	Number of cities	Urban population （million）	Removed garbage (million tons)	Waste treatment stations (including dejecta disposal factories)	Ratio of waste treatment (including dejecta disposal） （per cent）
1994	622	17,665.5	99.52	609	35.8
2000	663	20,952.5	118.19	660	61.39

4.9.1 Rules and regulations

Over the past 10 years, the Chinese government has promulgated a series of regulations, rules and standards for municipal waste treatment and pollution prevention during waste treatment processes（Table 4-19）.

Table 4-19 Relevant regulations and rules for municipal waste treatment

Time	Issued by	Name and content
September 1991	Ministry of Construction	Measures for Policy Implementation Relating to the Urban Environment and Sanitation
June 1992	State Council	Regulation on City Appearance and Environment and Sanitation Management
August 1993	Ministry of Construction	Measures on Household Waste Management in Cities
December 1997	Ministry of transportation, the Ministry of Construction, and the State Environmental Protection Administration	Regulation for Preventing the Yangtze River from Ships’ Waste and Riparian Waste Pollution
June 2002	The State Development Planning Commission, Ministry of Finance,	Notice on Establishing Payment System for Waste Discharge in Urban Areas and Promoting Waste Treatment Industry

	Ministry of Construction, and the State Environmental Protection Administration	
September 2002	The State Development Planning Commission, Ministry of Construction and the State Environmental Protection Administration	Notice on the Proposal for Promoting Industrialization of Municipal Sewage and Waste Treatment

4.9.2 Technical policies and industrial standards

To standardize municipal waste treatment and disposal, the Chinese government has successively promulgated a series of technical policies and standards (Table 4-20).

Table 4-20 Some technical policies and standards for municipal waste treatment

Time	Issued by	Title and content
1989	Ministry of Construction	Technical Standards for Civil Waste Landfill. It stipulates that small-sized landfill projects should use aeration to dispel landfill gas and large-sized ones should construct landfill gas collection and transmission pipelines, and flow-meter should be equipped to monitor gas collected. It also stipulates that methane content of the air within a landfill area should not be over 5 percent, and that methane which can not be collected and utilized should be burnt after being transmitted out of the ground surface.
1997	Ministry of Construction	The Standard on Civil Waste Landfill and Pollution Control. Provision 4.6 stipulates that landfill project design should include landfill gas collection, transmission and treatment system. Provision 4.8 stipulates that landfill gases should be collected and utilized if they are combustible.
2000	The State Environmental Protection Administration	The Standard on Burning of Civil Waste and Pollution Control
2000	Ministry of Construction, the State Environmental Protection Administration, and Ministry of Science and Technology	Technical Policies for Household Waste Treatment and Pollution Prevention in Urban Areas. Provision 3.2 proposed to give incentives to the utilization of heat generated by burning wastes and landfill gases, and the adoption of high-temperature process to transform organic wastes to compost and anaerobic digestion to recover combustible fuel. Provision 5.7 stipulates that all available measures should be taken to recover and utilize landfill gases, and gases which can not be recovered should be treated before discharge.
2001	Ministry of Construction	Technical Standards on Civil Waste Landfill in Urban Areas. It requires landfill projects available to recover and utilize landfill gases should construct landfill gas collection facilities, and monitor the contents and the volume of gas generated.

2002	Ministry of Construction	Notice on Enhancing Landfill Gas Management to Civil Waste Landfill. It urges provincial administration to carry out comprehensive examinations on landfill stations and waste disposal places, in accordance with the security production guidelines issued by the State Council and all national standards and specifications relevant to waste landfill.
2003	The State Administration of Quality Supervision, Inspection and Quarantine	Standards of Civil Garbage Classification in Urban Area established a standard system for civil waste classification and wrapper classification as well.

4.9.3 Payment system of waste discharge

To provide guarantee to effective waste treatment, the Chinese government has set up a payment system for waste discharge. In June 2002, the State Development and Planning Commission, Ministry of Finance, Ministry of Construction, and the State Environmental Protection Administration jointly issued the Notice on Payment System of Civil Waste Discharge in Urban Area and on Industrialization of Waste Treatment. The notice requires all fees levied should be used for waste collection, transport and treatment, and as a supplement to the investment and operation expanse of waste treatment facilities. In September of the same year, the State Development and Planning Commission, Ministry of Construction, and the State Environmental Protection Administration jointly issued a proposal on industrializing municipal sewage and waste treatment. The proposal requires cities with landfill stations levy waste discharge fees immediately and other cities should do so by the end of 2003.

4.9.4 Improvement of waste management

Pushed by the Chinese government, the reform of waste management system is accelerating, a competition mechanism is introduced, and a biding process has been used for the selection of qualified enterprises running civil waste treatment. The proposal for industrializing municipal sewage and waste treatment requires reform of the pricing system and management mechanism of sewage and garbage treatment, encourages various entities to invest in and run waste treatment, and gradually build up an investment, financing and operation management system in consistent with market mechanism. The proposal also encourages waste recovery facilities to be built as well as a cost compensation and incentive pricing system. It requires preferential electricity price to be provided waste treatment, to allocate land for waste treatment projects and to give the investors and operators of the projects land use rights within the contract period.

4.10 International cooperation

The Chinese government attaches great importance to international co-operation on climate change and has engaged wide exchanges and co-operations with many countries and international organizations in this field. These exchanges and co-operations played a role in setting examples for and promoting China's energy conservation and greenhouse gas emission reduction. From 1996 to 2000, the Chinese Government, along with the Japanese and Norwegian governments, implemented four projects of Activities Implemented Jointly (AIJ), namely, the model project for energy conservation in electric furnace used for ferro-alloy refining in Liaoyang, the model project for utilization of waste heat from incineration of refuse in Harbin, installation of coke dry quenching facility in Capital Iron and Steel Corporation, and CFBC/CHP pilot project in Henan Shangqiu Thermal Power Plant.

In the energy field, China and the United States signed an agreement on energy conservation and renewable energy co-operation, which has helped both countries exchange and co-operate in more than 10 projects in these two areas.

With the aid from the World Bank and the Global Environment Facility (GEF), the Chinese government has carried out projects such as "China End-Use Energy Efficiency Program", "Energy Conservation Promotion Project", "Capacity Building for the Rapid Commercialization of Renewable Energy in China ", etc. In the process of implementing these projects, new concepts, measures, and financing mechanisms of developed countries in energy conservation and renewable energy have been introduced into China. An energy conservation information center and an energy conservation service company were established, which is a good demonstration of the role of market mechanism in promoting energy conservation.

The implementation of the Agreement on Sino-European Energy Conservation Training, and the Agreement on Sino-Japanese Energy Conservation Training played an active role in personnel training for energy conservation. *The Technical Assistance on Capacity Building for China's Green Lighting* supported by the United Nations Development Program (UNDP) and *the project on the Removal of Barriers on Energy Conservation Lightening Products and Systems* co-supported by UNDP and GEF have greatly contributed to capacity building for China's Green Lighting in the fields of policy, standard and information. By the end of 2003, the project of Capacity Building for Clean Energy Technologies and Urban Air Pollution Reduction, starting in November 2002 and supported by UNDP, has organized seven training programs, four international study tours and four relevant technology and policy workshops. More than 700 persons participated in these activities and their comprehensive ability was thus improved substantially.

Box 4-8 Contracted Energy Management

The State Economic and Trade Commission, supported by World Bank loan and GEF grant, started *China Energy Conservation Promotion Project* in 1998. In the first phase of the project, three demonstrating energy conservation service companies were established in Beijing, Liaoning Province and Shandong Province respectively. By October 2003, these three companies had signed 283 energy conservation service contracts with different clients, investing about 600 million Yuan (RMB) and achieving an energy saving capacity of 730,000 tons of coal equivalent.

The second phase of the Project started in November 2003. A special loan guarantee mechanism was established for energy conservation service companies with a loan of 26 million US dollar from GEF and more than one hundred energy service entities received loan guarantee for their energy conservation project from this mechanism. The project planned to provide a loan guarantee of 3 billion Yuan for energy conservation projects in the following seven years, and support energy conservation projects with a total annual energy-saving capacity of more than 3 million tons of coal equivalent.

To promote fuel cell bus production and wide utilization in China, on March 27, 2003, the Chinese government financed a demonstration project on China Fuel Cell Bus Commercialization with the support of GEF and a UNDP grant. The project will purchase 12 fuel cell buses for Beijing and Shanghai within 5 years, in accordance with the geographical characteristics and resources of the two cities and through public-bidding worldwide. Relevant hydrogen-adding facilities will be built in these two cities and the projects will be put into trial operation. The trial operation is to obtain experience and knowledge relating to technological feasibility, reliability and models of failure of fuel cell buses, to improve the design, to reduce the cost and to promote fuel cell bus production and wide utilization so as to achieve the goal of GHG emission reduction and protection of the environment.

In the field of energy conservation in buildings, China started trial projects on energy conservation in buildings in 1980s in co-operation with Sweden. In the early 1990s, with support from Britain's Overseas Development Program and apparatus provided by the UK, China conducted researches on technologies in energy conservation in buildings, and set up some trial projects. In the late 1990s, with the support of the Canadian International Development Program, Chinese experts studied Canadian technologies in energy conservation in buildings, and implemented trial projects in the innovation in energy conservation in existing buildings in China. Later on, the Chinese government conducted wide co-operations with France, Denmark, Germany, the European Union (EU), the United States and the World Bank on energy conservation in buildings. Those co-operations played an active role in introducing energy conservation technologies from developed countries, organizing energy conservation technology symposiums, demonstrating heating system innovation and establishing energy conservation standards for buildings.

In the field of coal bed methane, the Ministry of Energy, in co-operation with UNDP and GEF, initiated the project on Capacity Building for Coal-Bed Methane Exploitation in China in 1992. Through different training programs, workshops and demonstrations of advanced technologies on coal-bed methane sampling, testing and drilling, the project improved China's capacity in the commercial development of coal-bed methane. In addition, the project also helped the Chinese government to formulate preferential policies in promoting coal-bed methane development and utilization.

In the field of forestry, the State Administration of Forestry implemented 269 international co-operation projects in more than 20 provinces, autonomous regions and municipalities over the past ten years. Having learned from the experience of the United States, Britain and other countries in this field, the bureau set up and improved forest-fire prevention centers, fire airplane and fire monitoring systems, strengthened biological measures to prevent and control forest diseases and pests, and introduced directional forest breeding method from Germany and Sweden. Through international co-operations, the Administration has introduced the concept, method and experiences of advanced foreign forestry management into China, such as participative pattern of afforestation, project accounting, entire-process project management and quality monitoring and assessment system for projects, which updated the forestry management modes and provided expert pools and technological support.

In the field of waste disposal, the Chinese government, with a grant from GEF, carried out a demonstration project entitled Promoting Landfill Gas Collection and Utilization in China in January 1997. The project conducted technology researches for landfill gas recovery and utilization in three demonstration cities, i.e., Anshan, Nanjing, and Ma'anshan. In Nanjing, recovered landfill methane was transformed into electricity and sold to the power grid, in Anshan, recovered landfill methane was purified and used as vehicle fuels, while in Ma'anshan, recovered landfill methane was used to burn toxic wastes from hospitals.

Chapter 5 Research and Systematic Observation

Climate system observation is the cornerstone of climate change scientific research. China has set up a basic climate observing and monitoring network in the past 50 years or more. As a member of the World Meteorological Organization, China has taken an active part in the program of Global Climate Observing System (GCOS), which includes more than 50 surface stations in China, accounting for about 6% of the total stations in this program's network. In recent years, China has made special efforts to intensify the monitoring of climate change and its impact in the terrestrial area.

Over a long period of time, the Chinese government attached great importance to the scientific research of climate change. In the mid 1980s, Chinese scientists participated in the deliberation and formulation of international research programs on global climate change. They engaged in most of the research activities in the World Climate Research Program and the International Geosphere-Biosphere Program, and took part in drafting successive assessment reports of the Intergovernmental Panel on Climate Change (IPCC). Besides, the Chinese government also assisted scientists to carry out extensive research concerning climate change, thus deepening their scientific understandings of the characteristics, causes and impacts of climate system evolution and related economic analysis.

5.1 Present status of the climate system observation

The existing observation network relating to climate system monitoring, which is managed and operated respectively by the meteorological, oceanic, water conservancy, environmental protection, agricultural and forestry departments as well as the Chinese Academy of Sciences, covers a great variety of fields such as atmosphere, ocean, hydrology, cryosphere, and terrestrial ecosystem.

5.1.1 Land-based observation

Atmospheric observation. With decades of efforts, China's meteorological department has by and large established a 3-dimentional meteorological observation network that includes networks of surface observation, upper air sounding, acid rain monitoring and agricultural meteorological observation. The types of land-based atmospheric observation stations under China Meteorological Administration and the major items monitored are shown in Table 5-1. The departments of agricultural, forestry and civil aviation as well as the Chinese Academy of Sciences have founded their own climate observation networks with a total of 2,813 stations.

Table 5-1 Types of the meteorological observation stations under China Meteorological Administration and the items of observation

Types of stations	Number	Times of Daily Observation	Items of Observation
Reference	143	24	Atmospheric pressure, temperature, humidity, wind

weather Station			direction and speed, precipitation, snow depth, snow pressure, sunshine duration, pan-evaporation, ground temperature, frozen soil, wire icing etc.
Basic weather Station	530	8 (4, 7)	Atmospheric pressure, temperature, humidity, wind direction and speed, precipitation, snow depth, snow pressure, sunshine duration, pan-evaporation, ground temperature, frozen soil, wire icing etc.
Ordinary weather Station	1736	3 (4)	Clouds, horizontal visibility, weather phenomenon, atmospheric pressure, temperature, humidity, wind direction and speed, precipitation, snow depth, sunshine duration, pan-evaporation, ground temperature, etc.
Upper-air sounding Station	120	2	Atmospheric pressure, temperature, humidity, wind direction and speed, etc.
Radiation Station	98		Total radiation, net radiation, etc.

China's Atmospheric Chemistry Observation Network comprises the global atmosphere baseline station, regional atmospheric baseline stations, acid rain monitoring stations and ozone monitoring stations. Located on the Qinghai-Tibet Plateau (Figure 5.1), the global atmosphere baseline station, the only global reference atmospheric station in Eurasia to provide baseline conditions for continental atmosphere, mainly monitors carbon dioxide, methane, black carbon aerosol, carbon monoxide, ozone in the atmosphere, etc. There are three regional atmosphere baseline stations located respectively at Longfengshan in Heilongjiang Province, Shangdianzi in Beijing Municipality and Lingan in Zhejiang Province (Figure 5.1), which monitor systematically atmospheric components in Northeast, North and East China, with the monitoring of atmospheric precipitation chemistry, cloudiness, and concentration of suspended particulate matter, etc., as their priority tasks. Besides, the Chinese Academy of Sciences has set up a field network of China's Atmospheric Baseline Observation comprising five baseline observation stations.

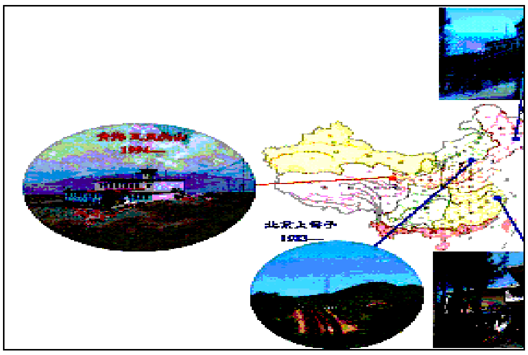


Figure 5.1 Distribution of some atmospheric baseline stations

Marine observation . China has basically formed a relatively integrated marine observation system (Table 5-2). It has one seashore ice-monitoring radar in charge of monitoring the situation of ice in the Liaodong Bay, including the area, thickness, density of ice and the direction and speed of floating ice, and two "China Haijian" aircrafts responsible for on-spot observation of oil-spill pollution, red tides, river delta, pollutants drainage outlets, etc. in China's coastal areas, in addition to the observation of sea ice in the Bohai Sea and northern Yellow Sea in winter.

Table 5-2 Types of China's marine observation stations and the items of observation

Type	Number	Items of Observation
Central Ocean Station	12	Tides, waves, sea surface temperature, salinity, sea ice, sea luminescence, etc.
Ocean Observation Station	62	Tides, waves, sea surface temperature, salinity, sea ice, sea luminescence, ocean weather elements, etc.
Voluntary Observation Vessel	200 plus	Temperature, salinity, ocean weather elements, etc.
Oceanographic Vessel	22	Temperature, salinity, ocean currents and other ocean elements
Ocean Buoy	3	Average wind velocity, gust velocity, wind direction, direction and velocity of currents, atmospheric pressure, sea temperature, effective wave height, maximum wave height, wave cycle
ARGO Buoy	10 in operation	Profiles of the temperature, salinity and sea depth
Tide Gauge Station	300 plus	Tides, sea level, etc.

Terrestrial observation. China has established a preliminary terrestrial observation network. The hydrologic observation network consists at present of 3,124 hydrologic stations, 1,093 water level stations, 14,242 precipitation stations, 515 pan-evaporation stations, 1,453 silt stations, 2,853 water quality stations and 1,054 groundwater observation wells. The China Ecosystem Research Network is composed of 36 ecological stations, 5 sub-centers and one comprehensive analysis center. At present, there are 36 field ecosystem experimental stations (Table 5-3) scattered in areas with representative biomes in China (Figure 5-2), engaging in long-term and standard *in situ* observation on ecologic environment.

Table 5-3 Types of the ecological stations in China's Ecosystem Research Network and the observation items

Types	Number	Items of Observation
Agricultural Station	14	Routine meteorological elements, moisture content, soil, biological elements, chemical composition of atmosphere, biodiversity, etc.
Forestry Station	8	
Grassland Station	2	
Wetland Station	1	
Lake Station	2	
Ocean Station	3	
Desert Station	6	

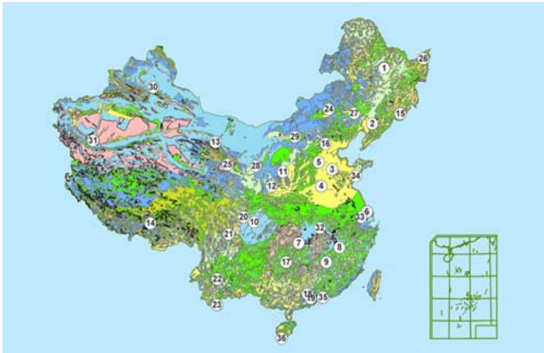


Figure 5.2 Distribution of the ecological stations in China's Ecosystem Research Network

China has also conducted observation and monitoring on extreme environments and disasters. For example, the Tianshan Mountain Glacier Observation and Experimental Station set up in 1959 has conducted comparative observations of glaciers' accumulation, melting, movement, ice temperature, ice thickness, energy balance and runoff in glacier and non-glacier areas, and made quite a number of photographic surveys to determine changes of the glaciers. The Qinghai-Tibet Plateau Integrated Observation and Research Station, devoted to comprehensive observation and research on plateau tundra and atmospheric physics, has basically established a network for monitoring natural and roadbed frozen soil along the Qinghai-Tibet and Qinghai-Kangxi highways, dynamic changes caused by warming of water in active layer of tundra along the Qinghai-Tibet highway and different layers of frozen soil at Wudaoliang and Fenghuoshan.

The Agro-Meteorological Observation Network, which comprises of 640 stations, conducted observation work on crops, soil, phenology, etc. It monitors crop growth length, crop growth condition (height and density of plants, etc.), plant productivity, yield composition, agro-meteorological disasters, and plant diseases and insect pests.

The environmental monitoring networks have a total of 2,223 stations. The National Environment Quality Monitoring Network is composed of 201 stations which monitor the surface water, atmosphere, acid rain, noise and radioactivity respectively. The surface-water monitoring network is composed of 135 stations, the atmospheric network 103 stations, the acid rain network 113 stations, the noise network 55 stations, and the radioactivity network 31 stations. The environment quality monitoring includes 12 routine monitoring items such as sulfur dioxide, nitrogen oxide, total suspended particulate matter, dust fall, sulphatization rate and acid rain.

5.1.2 Remote sensing observation

While developing land-based observation, China also promoted airplane and space observation, including meteorological satellites, land resource satellites and maritime satellites.

Since 1988, China has successively launched "FY-1" polar orbit satellites A, B, C and D as well as "FY- 2" geostationary meteorological satellites A and B (Table 5-4). They have provided monitoring services of weather/climate disasters and resources environment not only for China but also for the Asian region and the whole world.

Table 5-4 China's meteorological satellite series

	Orbit Type	Time of Launch	Status
FY-1 A	Polar orbit	1998	Retired
FY-1 B	Polar orbit	1990	Retired
FY-1 C	Polar orbit	1999	In service
FY-1 D	Polar orbit	2002	In service
FY-2 A	Geo-stationary	1997	In service
FY-2 B	Geo-stationary	2000	In service

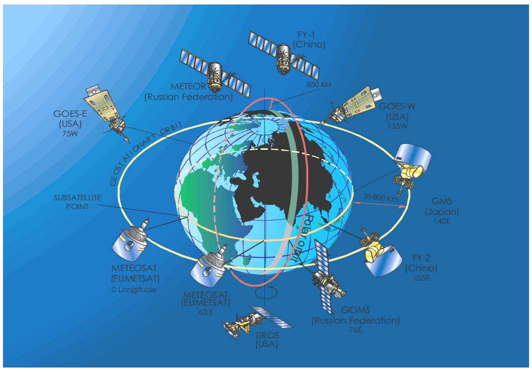


Figure 5.3 Roles of China's meteorological satellites in the global climate observation system

In 1983, under the support of the United Nations Development Program, China set up its first polar orbit and geostationary meteorological satellite data reception and processing system, which continuously receive and process high resolution image transmission data dispatched in real time by the American polar orbit meteorological satellites as well as broadened data from the Japanese geostationary meteorological satellites. In 1987, China developed by herself a system for receiving, processing and storing satellite data. At present, the polar orbit meteorological satellite data processing system has gained the ability to process satellite data from both FY-1 and the U.S. National Oceanic and Atmospheric Administration (NOAA) and provide 36 products such as vegetation indices, outgoing long-wave radiation, snow cover, atmospheric temperature, humidity, sea surface temperature, total content of ozone and various types of images; while the geostationary meteorological satellite data processing system is capable of processing satellite data from FY-2 and the Japanese geostationary meteorological satellites and provide 20 products such as outgoing long-wave radiation, cloud-estimated wind, precipitation, sea surface temperature, surface brightness temperature and various types of images.

5.1.3 Data management

China's climate system observation data are collected and managed respectively by more than a dozen departments and agencies such as the meteorological, oceanic, water conservancy and environmental protection departments as well as the Chinese Academy of Sciences. Data stored by Chinese meteorological authorities include national and global data from surface, air and vessel routine observation, data from China's solar radiation stations, the country's agro-meteorological observation stations, global and regional atmosphere baseline stations, ozone observation stations and acid rain observation stations, automatically recorded data, data from major scientific experiments and surveys as well as proxy data like tree rings. Among these data, real time meteorological data was stored in the format prescribed by the WMO while non-real-time surface and upper air meteorological data was kept in the format developed by China.

China's oceanic authorities keep information on different specialized fields of marine science and various information products, including the "Maritime Environment" Database (data on station-monitored temperature-salinity, waves and materials collected by the Nansen station), information on maritime environment and disasters and related products, and analytic information and related products on ocean tides and tidal currents.

The water conservation department of China have compiled and published hydrological data prior to 1949 and has started publishing yearly hydrological data on the country's various river systems since 1958. In 1990, work was initiated to set up the State Basic Hydrological Information Database.

The Chinese Academy of Sciences keeps in store all sorts of the information on ecological observation, which include ecological factors of long-term *in situ* observation such as meteorological elements, hydrological elements, soil parameters, biological productivity as well as quality of air, water, soil and biotic environment; information required for research on ecosystem processes such as water cycle and balance in the soil-vegetation-atmosphere system, cycle and balance of nutrients, energy flow process, production, transmission and transformation processes of trace gases, and deposition, accumulation and transmission processes of organic pollutants and heavy metal elements; and comprehensive spatial information on nationwide ecosystem including all kinds of climate elements within a resolution of 1 kilometer in space, large-resolution information on land use and vegetation cover, and information on carbon reserves in soil and vegetation.

China has also accumulated great quantity of valuable proxy data, including natural and documental records such as tree rings, historical documents, ice cores, lake sediments, pollen, corals and stalagmites. They are respectively kept in China Meteorological Administration, Chinese Academy of Sciences, Ministry of Land and Resources and the research and operation departments of some universities.

5.2 Problems in climate system observation and suggestions for improvement

5.2.1 Principal problems

Atmospheric observation: The observation stations are unevenly distributed with higher density in the eastern region; the standard of observation for some important items such as the radiation needs to be improved; and the means of upper-air sounding are limited and there is little upper-air sounding station in Qinghai-Tibet Plateau. There are inadequate stations and items for the observation of atmospheric composition, and the instruments and facilities, analysis tools and quality control methods are out dated.

Marine observation: There are few ocean observation stations, with distribution far from being reasonable, and there are no stations within the vicinity of several hundred kilometers in some sea areas; no station has been set up off the areas near the mouth of rivers, such as the Yellow River and Yangtze River; and observation is insufficient on sea water salinity, sea ice, marine life activities, partial pressure of carbon dioxide at the sea surface and ocean currents.

Terrestrial observation: China's terrestrial ecosystem observation network does not meet the needs of climate system observation; there are few items in relation to climate system observation in the environmental observation network, density and regional representativity of field ecological stations are low, and comprehensive observation ability needs to be improved and the equipment needs to be upgraded .

Remote sensing: There are insufficient satellite climate parameters and the time sequence is short; long-sequence data currently stored in the satellite database has yet to be processed to the climate related data in accordance with the requirements of standardization and systemization.

Data management: A lot of basic climate information and data remain to be collected; valuable long-period basic data already collected are still kept on papers and unable to be processed and accessed in computers; the data formats and quality standards are not unified, which makes it difficult to be studied and shared by scientists in the field of climate and other related disciplines; there are still lots of areas without proxy records of China's paleoclimate information, and the work to unify and standardize different types of proxy data remains to be started.

5.2.2 Suggestions for improvement

China needs further strengthening its observation and monitoring on climate system so as to meet the requirements of observation, research and international cooperation on climate change and variability. The main aspects are as follows:

1. To make full use of data and information related to climate system observation in current atmospheric, ocean and terrestrial observation networks to develop new climate parameters and information needed for research on climate and environmental changes.
2. To enhance China's ability in acquiring and managing data and information related to climate system observation in current atmospheric, ocean and terrestrial observation networks so that a unified and standard Chinese Climate System Observation Network through integration can be formulated.
3. To set up an efficient climate observation system with assessment and feedback mechanism on observation quality so that a standard data storage and processing

procedure for climate system observation can be formulated.

The priorities are:

1. To monitor near-surface parameters for land and ocean, radiation parameters, flux and exchange between atmosphere and sea surface and the upper-air sounding.
2. To monitor components related to atmospheric energy balance.
3. To monitor concentration and distribution of atmospheric compositions.
4. To monitor water and carbon cycle.
5. To launch a standard and continuous satellite observation.
6. To monitor soil, vegetation and land use as well as ice caps, ice sheets and frozen soil.
7. To collect, digitalize and conduct quality control of existing observation data and to make data integration and assimilation.
8. To reconstruct the series of proxy paleoclimatic data and to prolong climate data series.

5.3 Past and present research on climate change

5.3.1 Domestic research

China has organized and launched a series of key scientific research projects on climate change since the mid-1980s. The prominent ones include: national key scientific projects such as "Research on Project and Impact of, and Response to Global Climate Change", "Research on Global Climate Change and Environment Policies" and "Research on Responses and Supporting Technologies to Global Climate Change"; projects of the State Key Basic Research (alias the 973 Program) such as "Prediction Study on Trends of Change of China's Living Environment in the Coming 20-50 Years", "Research on Evolution Mechanisms and Prediction Theories for China's Major Climate and Weather Disasters" and "Projection Research on Changes of China's Living Environment and Drying Trend of northern China"; Key projects sponsored by the National Natural Sciences Foundation of China such as "Research on Change in China's Climate and Sea-Level and its Trend and Impact", "Modeling Study of response of China's Land Ecosystem to Global Change", "Research on Mechanism of the Interaction Between China's Agro-Ecosystem and Global Change" and "Key Processes of Fluxes in East China Sea"; projects of the Knowledge-Creation Program of the Chinese Academy of Sciences such as "Comprehensive Assessment on Evolution of Western China's Climate and Environment" and "Research on Carbon Balance of China's Terrestrial and Off-Shore Ecosystems"; "Scientific Assessment Report on China's Climate and Environmental Changes" jointly sponsored by the China Meteorological Administration, Ministry of Science and Technology and Chinese Academy of Sciences; and "National Assessment Report and the Relative Research on Climate Change" jointly sponsored by the Ministry of Science and Technology, China Meteorological Administration and Chinese Academy of Sciences.

5.3.2 International cooperation

China has, in partnership with some inter-governmental organizations, accomplished quite a number of international cooperation research projects on climate change. The main ones are:

“ Response Strategy on Global Climate Change in China” sponsored by the Asian Development Bank, completed in 1993; “China: Issues and Options in GHG Emissions Control” supported by the United Nations Development Program and Global Environment Facility, finished in 1994; “Asia’s Least-Cost GHG Abatement Strategy” financed by the Asian Development Bank, accomplished in 1998; and “ Targeted Research Related to Climate Change” financed by the Global Environment Facility. In the meantime, departments concerned in China have also carried out a series of bilateral cooperation with the United States, UK, Germany, Norway and Japan. For instance, the “China–Canada Cooperation on Climate Change” conducted by the National Development and Reform Commission in association with the Environment Canada, “China’s Climate Change County Study” carried out by the State Science and Technology Commission in cooperation with the U.S. Department of Energy, and “China-U.S. Experiment on Global Atmosphere-Sea Air Coupling Response at Tropical Oceans”, “China-Japan Joint Investigation and Research on Sub-Tropical Atmospheric Circulation”, and “China-Germany Joint Survey of Bohai Sea Marine Ecosystem”, which are organized and executed by the State Oceanic Administration.

Since 2000, China has engaged in the international cooperation on capacity building projects related to Clean Development Mechanism. These include: “Country Study on Methodology and Application of Clean Development Mechanism” financed by the World Bank, Switzerland, Germany and Italy; “Joint Project on Capacity Building for Clean Development Mechanism” financed by the United Nations Development Program, United Nations Fund, Norway and Italy; and “Research on Opportunities for Clean Development Mechanism in Energy Sector” financed by the Asian Development Bank.

5.4 Major achievements in climate change research

In the course of effectively implementing the above state key projects and international cooperative projects, China has made great achievements in scientific research on climate change, which have provided valuable scientific grounds for the State to formulate policies in response to global climate change, and to obtain international reputation in some aspects.

The main achievements in fundamental scientific research on climate change are: prominent results have been achieved in the monitoring and analysis of greenhouse gas emissions, especially paddy-field methane emissions, and the observation of carbon dioxide and ozone concentration above the Qinghai-Tibet Plateau; some research results with international profile have been obtained in some fields of paleoclimate, particularly the loess and paleoclimate reconstruction on thousand to 10-thousand year time scales; preliminary conclusions have been reached that many features of China’s climate change are identical to those of the world, as analyzed based on observational data for the past 100 years, providing basic information and data for departments and researchers concerned; China’s coupled global climate models, while still in the process of improvement, have already been used on a trial basis in climate forecasts, and regional climate models have already been or planned to be used for future climate projections; a lot of in-depth research has been made in the activities and variability of eastern Asian monsoon and its relationship with droughts and floods in China, and five major meteorological scientific experiments focusing on climate research were conducted in 1998 and attracted tremendous attentions from domestic and international society; and the scenarios of future regional climate change in China have been initially developed in accordance with the projections of foreign climate models.

Main results obtained in climate change impact and adaptation include: the important conclusion that Chinese agricultural sector is a weak sink of carbon has been reached; China's occasional weather model, daily-base weather generator, has been successfully developed and through its links to other models, regional agricultural impact model has been developed; a database supporting climate change impact assessment has been set up; a software of Knowledge Bank for Major Policies and Action Plans in Response to Global Climate Change by the agricultural, forestry and water conservancy sectors" has been compiled; and cost-benefit analysis has been made on policy responses to vulnerable areas most impacted by sea level rise.

A series of research have been conducted and preliminary results were achieved on socio-economic analysis and mitigation policies in relation to climate change: primary analysis has been carried out on the situations and future trends of China's greenhouse gas emission by sources and sinks; primary studies have been conducted on the potentials and costs of reducing carbon dioxide emission by energy, industrial and transportation sectors of China; comparison and analysis have been made on the impact of different emission quotas of greenhouse gases on China's obligation to control future greenhouse emission; and analysis has been carried out on the possible impact of the mitigation policies and measures taken by developed countries on China.

5.5 Problems and Directions of climate change researches

5.5.1 Gaps of China's climate change research

In spite of the fairly rapid progress made in climate change research, China still lags behind the developed countries.

1. Climate models and research methodologies need to be developed. At present, China's coupled global climate model and regional climate models are still in the process of development. In the research of the impact of and adaptation to climate change, early impact models are mostly qualitative and the assessments are of sensibility studies. Though the models based on quantitative analysis and linked with global climate scenarios have been widely used in recent years, they are mostly introduced from abroad and China still needs integrated assessment models on climate change.
2. Fundamental research lags behind and comprehensive research is inadequate. The understanding of the mechanism of climate change is incomplete and theoretic guidance is insufficient on the cost-benefit analyses of the impacts of and adaptation and mitigation options against climate change; there is a lack of methods for key issues such as economic analysis on non-market factors in the field of economics and decision-making principle under uncertain circumstances. Besides, while

internationally scientific research on climate change has largely been linked with studies on other fields such as ecology, environmental science, physics, chemistry, marine studies, geography, economics, sociology and the law, China is still in bad need of integrated and interdisciplinary research.

5.5.2 Major areas of China's climate change research in the coming 20 years

China's scientific research on climate change in the coming 20 years will mainly cover researches on atmosphere science, impact of and adaptation to climate change and national response strategy and policy to climate change.

(1) Priorities of atmosphere science research mainly include: research on global emission and sequestration of greenhouse gases and atmospheric concentration; research on China's climate change in the last 100 years in inter-annual to multi-decadal time scales; the development and improvement of China's climate system mode; projection and assessment of extreme climate events and climate abrupt changes; reconstruction and analysis of changes in China's paleoclimate; research on relations between global climate change and annual climate abnormalities; research on detection and attribution of anthropogenically-induced climate changes; and projection for the trends of natural and anthropogenically-induced climate changes in the coming several decades.

(2) Priorities of researches on the impact of and adaptation to climate change are: research on the impact of climate change on China's terrestrial ecosystem and adaptation measures; the impact of climate change on China's water resources and adaptation measures; the impact of climate change on China's agriculture and adaptation measures; the impact of climate change on China's other sensitive sectors and human health and adaptation measures; comprehensive assessment of impact of climate change on China's vulnerable areas and adaptation measures; and the impact of climate change on China's marine ecosystem and adaptation measures.

(3) Priorities in researches on national response strategy and policy to climate change are: research on relationship between global climate change and China's sustainable development strategies; research on China's medium- and long-term energy development strategy in response to global climate change; analysis on potentials and e economics of mitigating greenhouse gas emission and increasing carbon sinks through efficient management of China's agriculture, forestry and animal husbandry and land use; the impact of the three mechanisms in the Kyoto Protocol on China's future economic and social development and countermeasures; and the development and application of China's integrated assessment models for adaptation to climate change.

To deal with the above major scientific and technological issues, China is willing to cooperate further with the international community to promote the scientific research on climate change.

Chapter 6 Education, Training and Public Awareness

The Chinese government attaches great importance to the education, training and public awareness on environment and climate change. In the *Program of Action for Sustainable Development in China in the Early 21st Century* formulated by the Chinese government in 2002, it was put forward: to develop education at all levels and in various ways and enhance public awareness of sustainable development, and to reinforce human resource development to build up the public's scientific and educational capacities to participate in sustainable development. In recent years, China has speeded up training and education on climate-related issues, devoted considerable efforts to raise public awareness on climate change to promote sustainable development, and obtained initial results.

6.1 Education and public awareness raising

In order to carry out the work of training and education on environment effectively, the relevant departments of the Chinese government have successively issued two important documents, Outline for Actions of National Training and Education on Environment and Outline for National Training and Educational Work on Environment 2001–2005, as concrete guidance for nationwide training and education work on environment. In 2003, the departments concerned of the Chinese government published A Guide to the Implementation of Environmental Education in Primary and Secondary Schools, to strengthen the education on sustainable development in primary and secondary schools. Through many years of efforts, China has now established an initial system of education, including regular and non-regular education, covering the fields of sustainable development, environment protection, climate change and so on.

6.1.1 Regular education

Regular education in China includes elementary education and specialized education. Elementary education is targeted at students and children at and under middle-school level while specialized education covers students of vocational schools, professional high schools, colleges and universities.

China has already included environmental education in the Outline of All Subjects for Compulsory Education in Primary and Secondary Schools. In primary and secondary schools, two ways are adopted for environmental education in classes, i.e. subject permeation and specialized courses. According to statistics, teaching materials, books and coaching materials for environmental education in primary and secondary schools compiled by the departments in charge of environmental protection and education have come to over 50 versions with a publication of 2 million copies all over the country. Courses on environmental education have been set up in over 200 vocational schools and high professional schools in the whole country. The subject of environment protection has been set up in more than 200 institutes and universities for higher education, including over 200 undergraduate-degree offering units, 200 master-degree offering units and 77 doctoral-degrees offering units and post-doctoral posts. In addition, the State

Environment Protection Administration and the Ministry of Education have jointly pioneered the initiative activity of "Green School".

China is considering integrating content of climate change into the regular educational system gradually, making education on climate change as a part of the education on capacity and ethics. For instance, in order to promote awareness on renewable energy, "Renewable Energy", the teaching material for popularizing the knowledge, has been put into use to help students in primary and high schools to foster the concept and knowledge of sustainable development. This set of teaching material will be trial used in high and primary schools in the provinces of Shaanxi and Jiangsu as well as Tianjin, Beijing and Shanghai municipalities.

6.1.2 Non-regular education

China is also carrying out the education for adults on sustainable development, environmental protection and climate change by way of non-regular education.

In March 1996, "Sustainable Development" and "Revitalizing the Country through Science and Education" were adopted at the 4th session of the 8th National Peoples' Congress, as the two major medium- and long-term strategies to guide the national economy and social development. Afterwards, all kinds of education and training activities for sustainable development and climate change have been vigorously carried out, hence raising the public awareness for sustainable development greatly.

China has obtained an outstanding achievement in environmental education and training. Lectures on environmental protection and report sessions on environmental situation have been held in colleges for administration and management at all levels, and the contents of sustainable development and environmental protection have been integrated into the training material. The training for officials in the environmental protection sector has been greatly strengthened, with training classes held annually for local directors in charge of environmental protection.

China has compiled teaching material and trained all kinds of stakeholders by conducting training courses on climate change, which has enhanced the awareness of the public and policy-makers on climate change. For instance, the Administrative Center for China's Agenda 21 held a Training Course on Climate Change with participation by officials from the planning departments of 23 provinces, municipalities, autonomous regions and cities. With support from the China-Canada Cooperation on Climate Change, the Training and Education Center of the State Environment Protection Administration has compiled training material on climate change, and conducted trainings for leading officials of local administration, directors of local environmental protection bureaus, presidents and teachers of Green Schools and business managers as well as journalists. The China Remin University has, through the Sino-British Cooperation Project on Climate Change, compiled Training Material for Capacity Building for Provincial Decision-makers and conducted a series of training courses for provincial decision-makers.

6.2 Training and public awareness raising

The Chinese government attaches great importance to the work of training and education. Under the guidance of the national macro-policy, all the regions and institutions have taken the training and raising public awareness on sustainable development as an important part of their strategies or action plans for sustainable development. The whole society has witnessed increasingly active development in training on sustainable development, environmental protection and climate change with a higher public participation.

6.2.1 Survey on public awareness

Training on climate change can only be effective by understanding correctly the present status of public awareness on climate change. From this viewpoint, the departments concerned in China organized a nationwide survey with questionnaires to cover students in colleges and high schools, officials in governments, workers and farmers as well as community residents. The survey indicates that the Chinese public has, for the moment, just a little knowledge on the issue of climate change and limited understanding on the internal-relations between human-activities and climate change. They don't have a strong sense of climate protection in their daily life. The result of the survey has provided the Chinese government with basic information for carrying out training on climate change and increasing public awareness.

Table 6-1 Survey Results on sources of information related to climate change issues

Information sources	TV Program	Newspaper	Internet	Special Lecture	On-Road publicity	Fellows discussion	School education	Others
Proportion	88.2 %	79.9 %	37.4 %	29.8 %	20.7 %	18.6 %	14.8 %	11.4 %

6.2.2 Media publicity

China has made full use of the media including TV, broadcasting and newspapers for the publicity of environmental protection and climate change. For instance, during the past two years, the Central Radio Station of China has successively transmitted more than 100 periodic programs entitled *The Earth – Our Home*, which were broadly welcomed by the public. China Environment News has done a lot in the training of environmental protection and climate change mitigation. China Youth Daily pioneered a special green column, publishing periodically articles on climate change. The influential medias, such as CCTV, have developed and distributed many TV programs on climate change, including interviews with experts, TV films and TV public advertisements so as to help the public to understand climate change and realize the close relation between climate change and their daily life. During the Conferences of Parties of the UN Framework Convention on Climate Change, all major medias in China made tracing reports on the relevant issues of the conferences and climate change.

6.2.3 Website construction & publicity

China attaches great importance to the role of Internet in publicity of climate change. On 11 October 2002, the first official website on climate change – China Climate Change Info-Net (www.ccchina.gov.cn) was formally launched to the public with information covering: domestic and international actions and news, basic knowledge, laws and regulations, UNFCCC, reports and publications, greenhouse gas reduction technologies, National Communication, statistic data, international cooperation, etc. (Fig. 6.1). China Climate Change (www.ipcc.cma.gov.cn) focuses on introducing to the public with latest domestic and international information on research results and discoveries on climate change, relevant activities organized by the Inter-governmental Panel on Climate Change, information about China's participation in the activities of the Inter-governmental Panel on Climate Change and organized activities in China, knowledge on climate change impact and response policies as well as questions and answers to the hot-issues of the public and so on. The other relevant websites in China, such as China Energy (http://www.china5e.com), China Environment Online (www.chinaeol.net/zjqh) and the Website on the Counter-measures to Global Climate Change (http://www.ami.ac.cn/climatechanges2) as well as China Global Environment Facility (http://www.gefchina.org.cn) have also played a very active role in introducing climate change information, popularizing basic knowledge on climate change, publicizing relevant policies and research results of the Chinese government on climate change and promoting international cooperation and information exchange. China has also used the Internet to conduct experts' lectures and organize the experts to exchange online with the public on the questions of climate change.

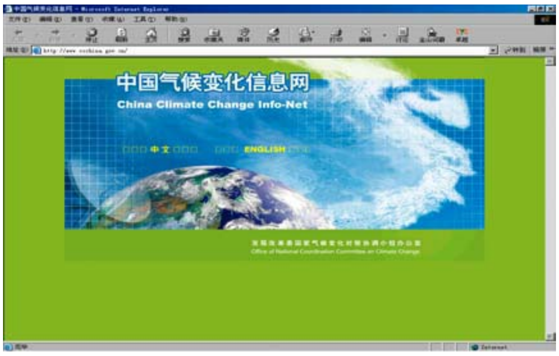


Figure 6.1 Homepage of China Climate Change Info-Net

6.2.4 Public lectures and reports

China has also conducted various kinds of public lectures and reports on climate change. For instance, the State Council held a special lecture on Climate Change given by climate change experts in 2002 for high-ranking leaders, including the Premier and Vice-premiers. The departments concerned also invited the representatives from the government who attended the climate change negotiations, and the experts in the field of climate change, to deliver lectures on climate change. During the international symposium on climate change, two lectures on elementary knowledge of climate change and one online expert lecture were held for officials, community residents, school students and so on.

6.2.5 Workshops and forums

Over the past 10 years, China has already conducted several conferences on climate change, hundreds of domestic and international workshops in connection with climate change and also organized many forums on climate change and environment. Of these activities, some were on a large scale and scope and at a high level, giving a great impetus on increasing the public awareness on climate change.

The Committee of Population, Resources and Environment of the National People's Political Consultative Conference (NPPCC) and China Meteorological Administration co-sponsored the Workshop on Climate Change and Ecological Environment in November 2003 (Fig. 6.2). The participants include officials from NPPCC, members of the Committee of Population, Natural Resources and Environment and other relevant committees of NPPCC, members of the Natural Resources and Environment Commission and other relevant commissions of the National People's Congress, members of National Coordination Committee on Climate Change and members of the provincial NPPCC, and experts, researchers as well as media journalists.

Figure 6.2 Workshop on Climate Change and Ecological Environment

Hosted by the National Coordination Committee on Climate Change and sponsored by the National Development and Reform Commission, Ministry of Science and Technology, Ministry of Education, National Natural Science Foundation of China, Chinese Association of Science and Technology, Chinese Academy of Sciences, China Meteorological Administration and World Meteorological Organization, the International Symposium on Climate Change was held successfully from March 31 to April 3, 2003 in Beijing. Hui Liangyu, Vice-premier of the State Council of China and Prof. Obasi, Secretary-general of the World Meteorological Organization presented and addressed at the symposium. A symposium with the subject of Climate Change -- Science and Sustainable Development was organized with the participation of over 500 representatives from 46 countries and relevant international organizations (see Fig. 6.3). At this symposium, the latest research results in the field of climate change were exchanged and the research results of Chinese scientists were presented to international participants. This symposium gained active responses and extensive supports, and was highly appreciated by domestic and international participants and organizations. The 14th World Meteorological Conference of the World Meteorological Organization adopted a document expressing high appreciation of the achievements of this symposium. The proceedings of the symposium were published by the World Meteorological Organization as its official publication.

Figure 6.3 International Symposium on Climate Change

6.2.6 Publications & other training material

In recent years, China has compiled and published many kinds of publications and training material on climate change. For instance, famous Chinese experts in the field of climate change composed and published an 18-volume serial publication titled Hot Topics on Global Climate Change, with topics on Economic Analysis of Climate Change Mitigation, Impact of Climate Change on Agro-ecology, Climate Change and Desertification and so on.

China has printed and distributed Newsletter on Climate Change, Research News and other publications. The brochure of China and Climate Change was compiled and distributed at the Conference of the Parties of the UN Framework Convention on Climate Change. China has also compiled and published the Booklet for Public Awareness on Global Climate Change (Fig. 6.4).

China has set up the Working Station for Receiving and Transferring Information on Climate Change, which helps gathering books, academic periodicals and relevant materials on climate change.

Figure 6.4 Booklet for Public Awareness on Global Climate Change

6.2.7 Other activities

China has integrated training on climate change into all such important events as the World Environment Day, the Earth Day, the Ozone Day and the Tree Planting Day and carried out various forms of training activities on climate change to expand the influence and strengthen the training.

By using popular facilities (museums, halls of science and technology and galleries for popularizing sciences), China has carried out training and education on climate change.

By integrating the residence house, daily life and climate change to conduct a surviving education, training activities on climate change in communities were organised.

By using documentary films and publicity pictures, a precaution education has been carried out in the whole country so as to build up the environment awareness in the whole society and the whole nation.

With Saving Energy in Line with the Laws for Sustainable Development as the thematic topic, an activity of energy-saving training week has been conducted in China. By way of large-scale exhibition and demonstration of typical enterprises, a series of activities were conducted for promoting energy-saving products in communities, schools and government organizations so as to increase the energy saving awareness of urban residents.

Activities also include organizing college students to take part in advertisement design competition on climate change for public welfare purposes (Fig. 6.5), and supporting Friend of Nature, the non-government organization in environment protection, with exhibition of climate changes on the “Antelope Cars” ---its mobile publicity vehicles, which carry out training and education on climate change in secondary and primary schools and townships and villages in mountainous and remote areas.

Figure 6.5 Works of advertisement design competitionon climate change for public welfare

6.2.8 International cooperation

The Chinese government has always stressed the importance of carrying out training and education on climate change through international cooperation. For example, since 2001 with the support of the Global Environment Facility and the United Nations Development Programme, China started the project of Capacity Building for the Preparation of China’s Initial National Communication, of which one of the specific topics is to strengthen public awareness on climate change and relevant activities. In 2002, China and Canada implemented the project “Capability Construction for Climate Change in China”, of which public awareness and training is one of the four sub-projects. In the Sino-British project on climate change, capability building and training of provincial decision-makers was chosen to be an important content. Under the support of the United Nations Development Programme, UN Foundation, Norway and Italy, the project “Capacity Building for Clean Development Mechanism in China” has also included a training component .

6.3 Outlook

China has made some useful attempts in both forms and contents of training, and has made initial achievements in the training, education and raising awareness on global climate change. However, the survey result concerning public awareness on climate change indicates that current awareness of the Chinese public has yet to be raised. This indicates that training and education in the field of climate change has to be further strengthened.

China will implement relevant requirements for education, training and public awareness raising of the United Nations Framework Convention on Climate Change earnestly. It will make its continuous efforts for training and education on climate change, including the preparation of long-term strategies and short-term action plans for raising public awareness on climate change, enabling more and more people to know the basic scientific facts and impacts of climate change, and to understand mitigation and adaptation policies to climate change, so that climate protection will become a conscientious behavior of the whole society, and therefore the capacity to response to climate change will be strengthened and good coordination between economic, social development and environment will be achieved, which will certainly contribute to the mitigation of and adaptation to the global climate change. At the same time, China hopes to continue to receive support from the international community in the fields of education, training and raising public awareness on climate change.

Box 6-1 Consideration on Long-term strategies and short-term action plans of raising public awareness on climate change

Raising the public awareness on climate change has to be based on China's national conditions so as to set up the training and awareness raising objectives suitable for current development situation of China. Raising public awareness on climate change should be jointly implemented under the guidance of the government and through the support from all walks of life. The general goals for raising public awareness on climate change in China are: based on present situation of social-economic development in China and the concrete national conditions, through popularizing and disseminating relevant knowledge on climate change, to raise public awareness of the whole society on climate change; to strengthen China's capability in responding to global climate change, with the aim to make due contributions to the mitigation of global climate change and sustainable development.

The realization of this goal is long-term and a difficult task. It needs to be carried out gradually on targeted groups at different levels in different sectors. First of all, the awareness of decision-makers and administrators in climate change has to be raised so as to enable them to take into consideration of the impact of and counter-measures to climate change in decision-making processes. Secondly, the awareness of the educational and technical workers and scientific researchers need to be increased. Through the daily activities of these persons, study and education on climate change can be strengthened. Thirdly, it is necessary to raise the awareness of the business managers and staffs, making enterprises to become aware of the pressures in mitigating climate change and the underlining relationship between the counter-measures and the development of enterprises. The fourth is to raise the awareness of the people from all walks of life so that the climate protection actions will become the conscientious behavior of general public.

Chapter 7 Needs for Funds, Technologies and Capacity Building

China is a developing country with a large population, diverse natural conditions，underdeveloped economy, and insufficient capacity in technology development. Therefore it faced a dual pressure in economic development and environmental protection. This is the basic situation in China. As one of the non-Annex I parties to the Convention, in order to honor the commitment effectively under the Convention, China needs funds, technologies and capacity building from developed country parties in line with obligations under the Convention to raise China's capacity in the mitigation of and adaptation to climate change and improve the level of relevant studies. Since needs assessment in China is an early stage, the needs for funds, technologies and capacity building mentioned in this chapter, remain a preliminary description, which is expected to develop further and improve later on.

7.1 Development of national greenhouse gases inventory

As specified in the Convention, development and publication of the national communication is one of the major commitments that a developing country has to implement. Article 4.3 of the Convention stipulates that developed countries should provide developing countries with new and additional funds to cover all expenses needed by developing countries to formulate the national communication.

As the sources and sinks of greenhouse gases are very complex, with great diversity in the level of technology and management in different sectors, great variations in different regions, as well as difficulties in information collection, statistical data needed in developing national GHGs inventories are insufficient. Thus China needs urgently funds, information and technologies to support the development national communication.

7.1.1 Training needs for the development of greenhouse gas inventory

The development of inventory of greenhouse gases in China is extensive and diverse in terms of contents, and is a long-term and sophisticated technical operation. It requires the specialists involved in the development of GHG inventory have not only a thorough understanding of relevant regulations of the COP to the Convention and methods for the development of the inventory set by IPCC, but also a clear idea about the characteristics of major sources and sinks in each field. Therefore, it requires adequate professional qualification and expertise from the specialists involved, and continuous and regular of their involvement.

Along with the continuous revision of the *IPCC Guideline on GHG Inventory* and gradual deepening of the development of the national communication, the level of requirement on the qualification of the specialists engaged in the development of the inventory of greenhouse gases is becoming higher and higher. It is necessary for developed countries to provide corresponding financial and technological supports to carry out training activities and international exchange to improve the technological level and capacity of Chinese specialists involved in development of the inventory of greenhouse gases.

7.1.2 Needs for improving the statistical system

There are certain differences between existing statistical indicator system in China and the one used by the international community. For instance, at sector level, energy statistics of the transportation and communication sector covers only the data of business departments, excluding vehicles owned by households and other sectors and has obviously underestimated the actual energy consumption in the entire transportation and communication in the society. At sub-sector level, the classification of industrial sectors is different from that of the International Standard Organization, causing difficulties in the comparison of data obtained at different sector levels with those used by the international community. With regard to fuel types, the classification of coals in the energy balance sheet of China consists of raw coal, clean coal and so on, which is obviously different from the classification of anthracite, bituminous coal, lignite and coking coal as defined by the IPCC .

In addition, existing statistical indicators are not adequate to meet the needs of the development of inventory of greenhouse gases. For example, over 70 percent of the population in China is living in rural areas. The main energy in rural areas is biomass energy. In the past, the departments concerned in China conducted several statistic surveys of non-commercial energy consumption. However, not only these statistic indicators failed to meet the needs for the compilation of the inventory of greenhouse gases, they also failed to be reflected in the state statistic system. After 1970s, China conducted five thorough nationwide censuses of forestry resources. Though it has succeeded in setting up a relatively improved monitoring system and technical standard, the data acquired is an average for several years in the past, not the one for a certain year, so there is a lack of continuous data series for the compilation of greenhouse gases inventory. Therefore, China hopes to obtain international technological and financial assistance to improve the capacity in collecting basic data for the development of greenhouse gases inventory to reduce the uncertainty in the development of national inventory of greenhouse gases.

7.1.3 Requirement for improving emission factors

In the course of compiling the 1994 national greenhouse gases inventory, it was noticed that a great difference exists between the emission factor data of greenhouse gas emission sources in China and the default data in the IPCC Inventory Guideline. For instance, the oxidation rate of coal burning, the carbon content of coal and its net calorific values, the methane emission factor from biomass burning, the methane emission factor from paddy-fields and carbon testing data from forest soils and so on. To obtain emission factor data that reflects the actual conditions in China still needs to do a lot of work, international technological and financial assistance.

7.2 Mitigation and adaptation

China has already taken a series of policies and measures for mitigation of and adaptation to global climate change. However, the actions taken by China are restricted by the economic development level and technological capacity. China's contribution to the mitigation of global climate change depends to a great extent on funding support, transfer of technologies and capacity building. If developed countries could implement all practical steps as required by the Convention to transfer environmentally sound and other relevant special technologies to China and support China to strengthen its capacity in the development and innovation of technology, China's capacity to deal with climate change challenges will strengthen.

7.2.1 Technology needs for mitigation of climate change

China is a country in which coal is used as its main energy source and it is now at a stage of rapid economic increase. However, the technological level of China is relatively behind. Many important economic sectors in China such as energy, industry, transportation, agriculture and forestry are all in the critical period of technological update. Therefore, developed countries which transfer their environmentally sound technologies to China by preferential treatment will not only be contributing to the improvement of environmental quality in China but also help China to reduce the emission of greenhouse gases. It will also play a very positive role in enhancing China's capacity in the mitigation of and adaptation to climate change in the future.

The Chinese government has mapped out a series of laws, regulations and preferential policies, in particular, preferential economic incentives to encourage the introduction of technologies, which has created a very good condition for the introduction, development and creation of environmentally sound technologies and equipments. In 1999, the State Planning Commission formulated the "Guidelines of Priority Development Areas for Hi-tech Industries at Present", which offers a detailed explanation to the technological areas and categories that China encouraged to develop priorities. Based on the guideline and other relevant documents, the major needs for environmentally sound technologies in China are shown in Table 7-1.

Table 7-1 Some Needs for Environmentally Sound Technologies in China

Environmental protection and comprehensive utilization of resources	Urban domestic waste disposal technology
	Technology for the industrialization of coke-dry-quenching equipment for big & medium coke plant
	Technology for the purification & recovery of coal gas from steel converter
	Technology for using surplus heat from smokes of open & semi-closed calcium carbide oven
	Technology for comprehensive use of petroleum associated resources
	Purified gas & mixed-fuel driven auto Technology
Energy resources	High-efficiency coal production technology
	Technology for exploring and utilizing coal-bed methane
	Oil hydrogenation technology

	High-efficiency, low-pollution coal-burning power generation technology
	Large-capacity supercritical thermal-power generation unit technology
	Large & medium hydropower generation unit technology
	Renewable energy technology
	Technology for the recovery and use of natural gas from oilfield rim areas
	Technology for control of volatile hydrocarbon from oil-gas field
Transportation and communications	Urban rail-based traffic technology
	Highway fieldwork, complete set equipment for road maintenance and new road material technology
	Intelligent transportation system technology
Materials	Oxygen-rich coal-spray blast furnace & long-life span technology
	High-efficiency successive casting system
	Ore-dressing-Bayer new technology and key technique for the production of oxidized aluminum
	High-efficiency energy-saving whole-set technology for ore dressing
	Technology for hydrogen recovery from refinery gas
	Comprehensive technology for the transformation and expansion of medium and small nitrogenous production equipment
	Technology for successive production of fluorochloro hydrocarbon substitute
Manufacturing	Big-horsepower wheeled tractor technology
	Oil & gas pipeline and manufacture technology
Building	New-type wall body material technology
	Technology for serial energy-saving products for building
Others	High-performance battery & material technology
	Other related technology

7.2.2 Technology needs for adaptation to climate change

China has a vast expanse of territory with a very long coastal line and a large number of islands. China strides over subtropical, temperate and frigid zones, having a great expanse of inlands, of which dry and semi-dry regions take up a very large area with a very serious problem of desertification. The ratio of forest coverage in China is very low. The ecological system in mountainous areas are very vulnerable and are located in an area with a relatively large variety of climate conditions in the world and with a high frequency of natural disaster. China is now in a process of rapid urbanization with a high density of population in cities and a low technology level, therefore, seeing a relatively serious air pollution problem. The above facts indicate that China is sensitive and vulnerable to the adverse impacts of climate change.

China's sensibility and vulnerability to climate change exist mainly in the areas of agriculture, natural ecology and forestry, water resources, sea level and coastal zones, desertification, natural disaster and some other areas, and the corresponding technology needs for adaptation to climate change are listed in Table 7-2.

Table 7-2 Some of technology needs for adaptation to climate change in China

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

7.2.3 Systematic observation and research on climate system

The Chinese government pays great attention to climate observation and research work with quite a big progress in all kinds of methods in climate observation, and has also achieved a lot in scientific research on climate change. China has also joined in the global observation system for climate change. However, due to limited financial resources and technology, China is still short of non-regular observation stations with backward instruments and facilities, insufficient personnel resources and weak ability in basic research work, and as a result is unable to play a role it should. The main technology needs required by China for climate system observation and research are specified in Table 7-3.

Table 7-3 Some of technology and equiment needs for climate systematic observation in China

Atmospheric observation	Density increase & improvement of network stations, including technologies and equipments for observation of earth surface parameter, boundary between land and atmosphere , water-heat flux exchange, radiation exchange, partitioned observation of atmospheric energy balance, etc.
	Technology and equipment support for observation & analysis for global and regional atmospheric background & composition
	Equipment & technological support for selected key meteorological stations for carrying on the observation in atmosphere chemical composition, flux, dry & humid sedimentation and 03 vertical section
	Technology & equipment support for density-increase construction of observation spots of typical and climate sensitive areas in west China
	Technology & equipment support for density-increase construction of observation spots in typical and climate sensitive areas in west China (including the exploration by robot plane)
Marine observation	Equipment & technology for oceanic near-land surface parameter, radiation parameter, land & oceanic atmosphere boundary related flux & exchange
Terrestrial eco-observation	Technology & equipment for monitoring on land water and carbon circulation
	Equipment & technology for monitoring & observation of typical ecosystem such as agricultural field, forest, grassland, wetland, lake, waste desert and urban areas
	Equipment & technology for observation of changes of soil, vegetation & land use.

Meteorological, marine and terrestrial resource satellites	Technology & equipment for high space-time revolving power, high spectrum revolving power & high-precision effective load
	Technology for satellite data acquirement & remote-sensing information collection & reviewing
Data management	Technology & equipment for quality control, collection, tidy-up, storage and distribution of climate information
Monitoring & detecting of Climate change	Technology & equipment for substitute data collection and technology & equipment for extreme weather/climatic events monitoring & pre-warning
Climate system mode	Application technology for the synchronization of quadra-dimensional variation data
	Climate forecasting modular technology covering multi-ring & strata (atmosphere-land-ocean) coupling, living-being circulation process & human activity influence process.
	Technology for integrated analysis and assessment modeling of climate change influence
Calculation capacity	High-performance calculation technology & equipment
Personnel training	New equipment operation, data analysis and personnel capacity building

7.3 Needs for capacity building

The "Marrakesh Accords" has put forward a relatively detailed framework for the capacity building of developing countries and has defined preliminarily the scope of requirement for capacity building of developing countries (Table 7.4).

Table 7-4 Main areas of capacity building

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

	Integrate climate change policy into national development strategy & plan

In the end of 2003, China already kicked off the project of "National Capacity Self-Assessment" with a climate component. The project will carry out the assessment of the needs for capacity building in China and the final assessment report is expected to be finished by the end of 2004.