Air Pollution Status and Its Control in China

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Abstract - The air pollution status in China is comprehensively introduced. The main factors, the pressure and the control measures of air pollution in china are also interpreted carefully and some proposals are tabled in the article.

I. Atmospheric Environment Outlook

China covers 9.6 million square kilometers land and occupies three weather zones including temperate, sub-tropical and tropical. Most of china locates in north temperate and sub-tropical and its climatic region mainly belongs to eastern monsoon region. The characteristic feature of China's geomorphology is high in the west and low in the east, and is complicated and diversified. The population density is high in the east and low in the west. The economic developments are also unbalanced and are fast in the east and comparably slow in the west. Affected by the natural situation and economic development factors, the air qualities of different districts are also different.

Till 2001, the discharging amount of main air pollutants is still on a high level and the urban air quality is in a comparably heavy polluted condition. According to urban air quality data collected in 341 cities, only 114 cities, or 33.4% of the monitored cities, met or exceeded GradeIIof the National Standards for Environmental Air Quality. And 10 cities in them, such as Haikou, met Grade I . And 114 cities met Grade III, which accounts for 33.4% of the monitored cities. The other 113 cities did not meet GradeIII, which accounts for 33.2%. Compared with 2000, the urban air quality is basically unchanged.

Suspended particle substance is also one of the main air pollutants, which affects the air quality largely. Cities that the annual average concentration of total suspended particles (TSP) exceeded GradeIIof the National Standards for Environmental Air Quality, account for 64.1%. And there were 101 cities, which the annual average concentration of TSP exceeded GradeIII. It is up to 29.2% of the monitored cities. The cities with high TSP concentration mainly distribute in some provinces and districts, which include Xinjiang Province, Qinghai Province, Gansu Province, Shangxi Province, Inner Mongolia Autonomous Region, Shanxi Province, Ningxia Autonomous Region, and Hebei Province.

The percentage of city that the annual average concentration of sulfur dioxide did not meet GradeIIof the National Standards for Environmental Air Quality, accounted for 19.4%. And the unqualified city percentage for Grade III was 9.7%, which decreased 2 percent than last year. The most serious sulfur dioxide polluted cities are mainly located in Shanxi Province, Hebei Province, Guizhou Province, Chongqing Province and part of Gansu Province, Shangxi Province, Sichuan Province, Hunan Province, Guanxi Autonomous Region and Inner Mongolia Autonomous Region.

In 2001, the annual average concentration of nitrogen oxides of the monitored 341 cities all met Grade II of the National Standards for Environmental Air Quality. The nitrogen oxides concentration of the metropolis such as, Guangzhou, Beijing, Shanghai and so on, was comparably higher.

The country has clearly defined acid rain and sulfur dioxide control areas, and among the statistical 341 cities, there are 64 cities belonging to sulfur dioxide control area and 118 cities belonging to acid rain control area. The cities belonging to sulfur dioxide control area and acid rain control area that the concentration of sulfur dioxide met GradeIIof the National Standards for Environmental Air Quality, accounted for 48.4% and 79.7% respectively. Compared with 2000, qualified city percentage of sulfur dioxide emission in sulfur dioxide control area slightly increased and the percentage of city that worse than Grade III, decreased 4.3%.

In 47 key cities, 19 cities met GradeIIof the National Standards for Environmental Air Quality. Among them, Haikou met Grade I of the National Standards for Environmental Air Quality. There are 14 cities that air quality met GradeIII and 14 cities that air quality exceeded GradeIII.

In 2001, the cities that annual average PH value of precipitate lowered than 5.6, are mainly located in the south of China, the east of China and the west-south district of the center of China. In the north of China, the cities that annual average PH value of precipitate lowered than 5.6, included only Tumen city of Jilin Province, Weinan city and Lueyang city of Shanxi Province, and Tianjin.

There were 101 cities, which PH value of precipitate ranged from 4.21 to 8.04 and annual average PH value of precipitate lowered than 5.6(including 5.6) accounting for 36.9% in 274 monitored cities. The number of city that acid rain has occurred is 161 accounting for 58.8%. Compared with the last year, the number has slightly decreased.

For the 107 cities that are in the acid rain control area, PH value of precipitate ranged from 4.21 to 7.21. There are 78 cities that annual average of PH value of precipitate lowered than 5.6(including 5.6), accounting for 72.9%. The number of city that acid rain has occurred was 98 accounting for 91.6%.

In 2001, the total amount of sulfur dioxide in waste gas reached 19478000 tons that 15666000 tons was from industry and 3812000 tons was from domestic use. The total amount of smoke in waste gas reached 10591000 tons that 8412000 tons was from industry and 2179000 tons was from domestic use. And the total amount of dust in waste gas reached 9906000 tons.

TABLE I
The Main Pollutants in Waste Gas (10000tons)

Year	SO_2	Smoke	Dust
2001	1947.8	1059.1	990.6
2000	1995.0	116504	1092.0
Change (%)	-2.4	-9.1	-9.3

Generally speaking, coal smoke pollution is the main air pollution style in China. But recently, coal smoke and vehicle exhaust style appeared in some big and medium-scale cities.

Table II shows the air pollution situation at the beginning of 1990's, and Table III shows National Standards for Environmental Air Quality.

TABLE II
Air Pollution Situation ($\mu g/m^3$)

	Year	1990	1991	1993	1994	1995	1996
TSP	Northern city	475	429	407	407	392	387
	Southern city	268	225	251	250	242	230
	National	387	80-1433	108-815	89-849	55-732	79-618(309)
SO_2	Northern city		92	100	89		83
	Southern city		88	96	83		76
	National		4-351	8-451	2-472		2-418(79)
NO_X	Northern city	47		59	55		53
	Southern city	38		40	39		41
	National	42		10-147	44-120		5-152(47)

It is regulated in the American Environmental Protection Agency Standards that average concentration of $PM_{2.5}$ per day should lower than 0.065 mg/m^3 and annual average concentration of $PM_{2.5}$ should lower than 0.015 mg/m^3. In China National Standards for Environmental Air Quality, GB3096-1996, it is ratified that average concentration of PM_{10} per day of Grade II is 0.15 mg/m^3 and the annual average concentration of it is 0.06 mg/m^3. It can be concluded that the concentrations of PM_{10} and $PM_{2.5}$ in China are higher than that in America.

The air pollution condition of PM_{10} and $PM_{2.5}$ in Nanjing was tested and researched. See Table IV.

TABLE III
Air Quality Standards ($\mu g/m^3$)

Pollutants	Average time	National standard			WHO standard
		Grade I	Grade II	Grade III	
SO_2	Year	20	60	100	40-60
TSP	Day	150	300	500	150-230
	Year	60	120	150	60-90
PM_{10}	Day	75	150	250	70
	Year	20	60	100	
$CO_2 mg/m^3$	Day	4	4	6	10
NO_X	Day	50	100	150	150
O_3	8 hours				100-200
Pb	Year	0.7			0.5-1

TABLE IV
Testing Results of PM_{10} and $PM_{2.5}$ in Nanjing

Function area	PM_{10} mg/m^3			$PM_{2.5}$ mg/m^3		
	Number	Range	Average	Number	Range	Average
Main communi-cation	5	0.344-0.944	0.617	5	0.203-0.586	0.400
Domestic	5	0.116-0.212	0.176	5	0.085-0.166	0.131
Business and restaurant	5	0.171-0.395	0.255	5	0.110-0.313	0.190
Chemical industry	5	0.090-0.357	0.169	5	0.070-0.251	0.126
Sight seeing	5	0.068-0.356	0.183	5	0.044-0.238	0.134
Total	25	0.068-0.944	0.280	25	0.044-0.586	0.196

II. National Air Pollution Factors

Air pollution in China, was caused primarily by coal burning. Sulfur dioxide and soot were the major pollutants. Acid rain was still a problem.

China is a country with coal as its main energy source. The raw coal still accounts for 75 per cent of the total energy consumption, although various kinds of energy such as oil, natural gas, hydropower and nuclear power have been developed in recent decades. In the structure of coal consumption, the domestic use of coal in China occupies a higher proportion than in most developed countries, amounting to about 30 or 40 times of those in Japan and US. Moreover, coal contains high rate of sulfur and ashes.

Table Vshows the energy production and consumption structure in China from 1980s to 1990s.

Coal burning produces large amount of precipitated dust, TSP, SO_2, NO_x and CO_2. It is predicted that 70% TSP, 90% SO_2, 60% NO_x, and 85% CO_2 produced by mineral combustion, come from coal burning.

TABLE VI shows the situation of energy consumption, smoke and SO_2 emissions in China.

The basic reason for air pollution seriously in China is the backward condition in exploiting, processing and utilizing the coal. There is a lot of problem in the use of coal, such as the poor energy utilization ratio. All of that bring about not only energy loss but also environmental pollution. TABLE VII shows the comparison of energy consumption of unit GDP between China and developed countries.

The energy utilization ratio in various departments between developed countries and China is shown in TABLE VII. The energy consumption of unit GNP in China is high in the world. Great energy consumption in enterprises leads to poor economic benefits and serious environmental pollution. A lot of reasons such as using a wrong kind of coal, backward way of energy utilizing and burning for the low energy utilization ratio, furthermore, being short of desulphurization installs, low dust removing ratio, dust

escaping and poisonous gases discharging etc. are the reasons for the state of air pollution in China.

TABLE V
Energy Production and Consumption Structure in China

Year	Energy production amount (10000tons of coal equivalent)	Percentage (%)			
		Coal	Oil	Natural gas	Electricity
1981	63227	70.2	22.9	2.7	4.2
1982	66778	71.3	21.8	2.4	4.5
1983	71270	71.6	21.3	2.3	4.8
1984	77855	72.4	21.0	2.1	4.5
1985	85546	72.8	20.9	2.0	4.3
1986	88124	72.4	21.2	2.1	4.3
1987	91266	72.6	21.0	2.0	4.4
1988	95801	73.1	20.4	2.0	4.5
1990	103922	74.2	19.0	2.0	4.8
1993	111059	74.0	18.7	2.0	5.3
1995	128728	75.5	16.7	1.8	6.0
1998	124250	71.9	18.5	2.5	7.1
Year	Energy consumption amount (10000tons of coal equivalent)	Percentage (%)			
		Coal	Oil	Natural gas	Electricity
1981	59447	72.7	20.0	2.8	4.5
1982	62 67	73.7	18.9	2.5	4.9
1983	66040	74.2	18.1	2.4	5.3
1984	70904	75.3	17.4	2.4	4.9
1985	76682	75.8	17.1	2.2	4.9
1986	80850	75.8	17.2	2.3	4.7
1987	86632	76.2	17.0	2.1	4.7
1988	92000	76.1	17.1	2.1	4.7
1990	98703	76.2	16.6	2.1	5.1
1993	115993	74.7	18.2	1.9	5.2
1995	135447	75.0	17.3	1.8	5.9
1998	136000	71.6	19.8	2.1	6.5

TABLE VI
Energy Consumption and Pollutant Discharge Amount (in million tons)

Year	1990	1992	1993	1994	1995	1997	1998	2000
Energy consum-ption	987.0	1091.7	1159.3	1227.4	1311.8	1420.0	1360.0	
Coal consum-ption	1055.2	1072.6	1110.6	1187.3	1290.3	1461.2	1363.8	
Smoke discharg-e	13.24	14.14	14.16	14.14	14.78	15.65	14.52	11.62
SO_2 discharg-e	14.94	16.85	17.95	18.25	23.70	23.46	20.90	19.95

According to some material, under the same conditions of burning same kind of coal and discharging same amount of sulfur dioxide, environmental harmfulness of kitchen ranges is 10 times higher than that of high chimneys. That is the major reason for the serious air pollution in the heating period in urban living area. Before 1980s, fuel gas was only used in large scale cities. Till 2000, central heating area was 11070 million m^2 and fuel gas popularized ratio was 84.1%.

With the quick development of economics in China, the vehicles quantity also increased. Coupled with it, the vehicle exhaust pollution also became more and more serious.

TABLE VII
The Comparison of Energy Consumption of Unit GDP Between China and Developed Countries (t/1000Dollars)

Country	China	Japan	France	USA	German y	Italy	England	Canada	Swiss
Energy consu-mption of unit GNP	2.26	0.214	0.257	0.486	0.271	0.200	0.314	0.543	0.157
Ratio	1.0	10.6	8.8	4.6	8.3	11.3	7.2	4.2	14.4

TABLE VIII
The comparison of Energy Utilization in Various Departments Between Developed Country and China in 1995

Energy consumption of Industry productions (kg/t)	China	Developed country	Ratio (%)
Steel	976	629	155.2
Refined oil	21.91	19.46	112.6
Synthetic ammonia	1268	930	136.3
Cement	175	113.2	154.6

TABLE IX
Urban Infrastructure Construction Situation

Urban infrastructure construction index	1995	1996	1997	1998	2000
Fuel gas popularized ratio (%)	70.0	73.2	75.7	78.9	84.1
Central heating area (million m^2)	646.5	734.4	807.5	861.9	1107.0

TABLE X
Vehicles Production Ability of China (in 10 thousands)

Year	1965	1970	1980	1985	1990	1995	1997	2000
Quantity	4.05	8.72	22.23	43.72	51.40	145.27	158.25	207.00

China is one of countries that soil erosion is serious. The arable land per capita in China was 0.11 hectares and was only 43% of the world average. One-fifth of arable lands was polluted and 40% of the arable lands in arid and semi-arid areas was seriously degraded.

Forest resources are 0.11 hectares per capita in China, which is only 17.2% of the world average, and ranks 119th in the world. The forest stumpage is 8.6 m^3 per capita in China, which are only 12.0% of the world average. China is one of the countries with the lowest per capita existing forest stumpage.

Sand storm phenomenon, which strong wind blew dust and sand in the ground into the air, has increased in recent years. Part of sand and dust aerosol in China is resulted from process of wind erosion and wind blowing in desert and arid regions, change of land-use, desertification and urbanization owing to human activities. Additional, changes of climate and features of the earth's surface resulting from natural or artificial factors can change the frequency and intensity of sand and dust storm. Every spring a great quantity of sand and dust aerosol came into the air with sand and dust storm. Then in some background of atmospheric circulation, it can be transported to densely populated areas thousands of kilometers away. Therefore threatened and influenced natural environment that human based on. Moreover, sand and dust aerosol particles with the size of several microns can affect people's respiratory system and imperil people's health. The air qualities of Chinese northern cities are mostly influenced by sand and dust.

III. Atmospheric Environment Pressure

Recent years, Chinese government has increased urban infrastructure construction, and continued to improve the quality of the infrastructure and enhance services. The living standard of resident was improved further. However, there are still many problems with urban environmental quality in China. Rapid urbanization, high population densities and the increasing number of motorized vehicles are all factors that are placing great pressures on the urban environment.

The environmental problems of energy consumption will be more prominent. In the 21st century, the energy demand will continuously increase and the energy policy of using fossil fuel is difficult to change completely. A lot of SO_2, NO_x and CO_2 emissions from energy consumption will result in the constant expansion of pollution area of SO_2 and acid rain. The air pollution in the cities will be more serious and bring about great pressure on the environment.

TABLE XI
Prediction of Oil and Natural Gas Requirement Amount of China

	Year	2005	2010	2015	2020	2050
Oil (10^8ton)	Requirement	2.5	3.0	3.5	4.0	5.0
	Productivity	1.65	1.70	1.75	1.80	1.0
	Shortage	0.85	1.30	1.75	2.20	4.0
Natural gas (10^8m^3)	Requirement	525	1000	1500	2000	3000
	Productivity	400	700	850	1000	2000
	Shortage	125	300	650	1000	1000

TABLE XII
Population Prediction of China (in 10 thousands)

Year	2000	2005	2010	2020	2030	2050
Popul -ation	127220	133240	139000	147000	152000	150000

Rapid urbanization will increase the environmental pressure on cities. To accelerate the urbanization progress and increase the urbanization level will be one important strategy of social and economic development in the tenth five-year plan. It is predicted that the urbanization in 2005 and 2010 will be up to 39% and 45% of the total population respectively. With the increase of urban population, the urban air pollution will face to double pressures of coal-smoke pollution and tail gas of vehicles, especially in metropolis.

In recent years transport has emerged as one of the most urgent environmental issues. Like energy, all forms of transport impact on the environment. The availability of the car for general popular use has created the possibility that air pollution in some large and medium-sized cities was a mix of coal burning gases and vehicle exhausts.

With the growth of urban population, the amount of municipal solid waste increased every year. Now one person produces average 1.16 kg/d of municipal solid waste. And it is predicted that the amount of municipal solid waste will be not less than 2×10^8 tons per year. The problem of garbage being dumped in the outskirts of cities became a more serious problem. In recent years, it has been admitted that power generation using garbage incineration is a kind of important technology that decrease the quantity of the garbage and turn it into resource. One ton garbage will produce 6000 - 10000 m^3 smoke when it is incinerated, so garbage incineration will be another pressure on atmospheric environment.

IV. Air Pollution Control

In order to change the present air pollution situation, the Chinese government has made the environmental objective for the future 15 years. It is planned that the state of degraded ecological environment will have to be fundamentally changed and the quality of urban and rural environment will have to be significantly improved by the year 2010. The overall policy's targets of China atmospheric environment construction is that industrial emissions of dust, SO_2, NO_x and CO_2 shall be maintained at the same levels as in 1995, and the capacity of treating SO_2 emissions should be increased significantly and the trend of atmospheric environment deterioration should be reversed. The concrete measures include:

Effort will be made to adjust the energy consumption structure and utilize green energy, such as wind, solar and so on. The ratio of coal in the energy consumption will be decreased and the ratio of fossil energy, natural gas, waterpower and nuclei energy will be increased. It will

basically change the smoke and SO_2 pollution situation. Desulfurized technology and device should be applied and the coal with high sulfur content should be limited to be mined and applied.

The poor energy utilization situation should be changed by heightening the technical level of enterprises and possibly introducing all kinds of advanced technology and device in the world. Close and forbid medium and small-scale enterprise, which has characters such as high-energy consumption ratio, low source utilization ratio.

Popularize the use of fuel gas and central heating. The fuel gas utilization ratio reaches 92% and the central heating ratio of national key cities (northern city) surpassed 30% till year 2005.

The total amount of discharged pollutants shall be controlled. The total amount of discharged SO_2 shall be less than 18 million tons and that of dust and smoke shall be less than 20 million tons till 2005.

Adopting discharge limitation policy controls the vehicle exhaust. part of small petrol car shall be implemented by Europe standard II and Europe standard III will be adopted till 2005.

To mitigate the sand storm, efforts had been made to stop non-agricultural construction on arable lands. In addition, local targets for total arable land area have been established to ensure stability in land use patterns.

V. Conclusions

1 The current air pollution in CHINA is still very serious, and it is primarily because of coal burning. At present, the air pollution style of part of metropolis turns from coal smoke pollution to coal smoke and vehicle exhaust mixture pollution.

2 The main air pollution factors in China are dust, SO_2 and NO_x that are the products of coal burning. The vehicle exhaust pollution is continually strengthened. Land desertification and sand storm increase the air pollution degree.

3 Backward economics and out-dated technologies are the basic reasons for the serious air pollution situation in China, and the unique way to change it is to promulgate the renovation of technologies and development of economics.

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