3

State of the Environment in China

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INTRODUCRION

China's initiatives on environmental problems began with the First National Environmental Protection Congress held in 1973. In June of the previous year it had sent a delegation to the United Nations Conference on the Human Environment in Stockholm, where delegation members were shocked by the seriousness of pollution in the industrialized countries. It seems that China bettered its understanding of the need to alleviate these problems and sensed that something must be done for this purpose. After the 1973 congress and through the 1970s the country was preoccupied with political infighting, which thwarted progress in environmental policy. Ten years after the 1983 congress the Second National Environmental Protection Congress was held. From this time on, there was progress in organizing environmental administration, as well as in legislation and partial surveys of the country's situation while referring to the environmental laws and standards of the industrialized countries. Six years later, in April 1989, China held its Third National Environmental Protection Congress, where the government worked out a series of full-blown environmental measures, and brings us up to the present. In 1993 I more or less summarized the events up to this point (Continental China: "Environmental Studies Flourish, Environment Devastated," in Reeitsu Kojima and Nariaki Fujisaki, ed., *Development and Environment: The East Asian Experience,* Institute of Developing Economies, 1993).

In June 1992 the UN Conference on Environment and Development (UNCED) was held in Rio de Janeiro, Brazil, and China's Prime Minister Li Peng attended. This conference adopted five important documents: (1) the Rio Declaration on Environment and Development, (2) the Forest Principles, (3) Agenda 21, (4) the Framework Convention on Climate Change, and (5) the Convention on Biological Diversity. UNCED had a huge impact on the Chinese government, just as its First National Environmental Protection Congress did. In 1993 the government developed policy to accommodate these five major documents. This policy is embodied in two publications: China's Agenda for the 21st Century — A White Paper on Population, Environment, and Development in 21st Century China (China Environmental Science Publishing, 1994) and China's Environmental Protection Action Plan, 1991-2000 (China Environmental Science Publishing, 1994).

It was the Sixth Five-Year Plan (1981-1986) when China first partially included environmental policy in that plan, and for that purpose the government developed a number of long-term plans. Although they were discussion papers, the Third National Environmental Protection Congress in 1989 formulated an environmental plan and a plan up to the year 2000 for incorporation into the Seventh Five-Year Plan (1986-1990). Because the studies in environmental departments that made development of these plans possible had been in progress from the latter half of the 1980s to the early 1990s, the government was able in 1993 to develop the aforementioned two plans to accommodate the five 1992 UNCED documents.

This report will summarize the state of China's environment and the measures taken as of 1993 and 1994.

1. A Fundamental Perspective on Environmental Problems in China

When examining pollution problems in China, we should consider a few disadvantages it has in comparison with other countries. Let's take a look at them below.

1.1 Natural Conditions

First is topography. The large expanses of flat land make it hard for river pollutants to flow through the upper and mid-reaches of rivers. For example, the city of Chongqing, where pollution is severe, is 2,300 km from the mouth of the Chang Jiang, but its elevation ranges from a mere 165-250 meters.

Second, the north gets very little rainfall, which is only 600-700 mm even in Beijing. This is one-third or slightly more than Tokyo's rainfall.

Third, China is a continental nation, not an island country, so it has little ocean shoreline.

These natural conditions mean China's ecosystem has very little ability to cleanse itself of pollutants.

1.2 Economic Conditions

First, China's fast economic growth since the 1980s has been achieved by importing the wasteful economic system comprising mass production, mass consumption, and mass disposal, a system perfected by the United States in the 1950s.

Second, the industrial structure puts disproportionate emphasis on manufacturing industries, and heavy industries account for a very high proportion. Heavy industries emit far more wastes than light industries.

Third, as many as 25 million small and medium enterprises (SMEs) have been set up in rural areas, and the industrialization of rural area is farther advanced than in any other country. It costs these SMEs far more to manage their pollutants than it costs large companies.

Fourth, over 70% of the fuel used is coal, and that coal has a very high sulfur content, in many cases running as high as 3% and more.

1.3 Conditions of Social and Political Institutions

First, since the 1980s China has been working on transforming its controlled economy into a market economy, but the degree to which this has been achieved is still quite low in comparison with the capitalist industrialized countries. Capitalist countries have a system under which companies find it harder to operate if they are labeled as polluters, but such a system has yet not to be set up in China, and that is why people running businesses have not developed sufficient awareness about preventing pollution.

Second, China's political system has no arrangement under which people elect the heads of local governments. It is a dictatorship of the Communist Party. In capitalist developed countries the people choose their local government leaders in elections. There is a mechanism by which, as the people's environmental consciousness improves, the people will not elect leaders who are negative on the environment, but this sociopolitical mechanism does not work very well in China.

As the foregoing explanation shows, China suffers from more disadvantages than other countries in bettering its environment, and so environmental costs are that much higher.

2. The Degree of Environmental Degradation and Improvements

2.1 Wastewater

2.1.1 Industrial Wastewater

Table 1 shows all the available statistics on sewage in incorporated cities; parenthetical figures are the author's estimates.

I will use this table to discuss the major questions and the significance that can be discerned.

First, despite rapid economic growth, incorporated cities' wastewater emissions have not increased very much. Official 1980 figures are available, so calculating for the 14 years up to 1994 shows only a 1.1% increase. During those years iron manufacturing, which uses a comparatively large amount of industrial water, grew from 37,120,000 to 89,560,000 tons, a 6.5% yearly increase; plate glass grew at 11.3%, from 24,660,000 boxes to 110,860,000 boxes; and ethylene grew 12.4% from 490,000 tons to 2 million tons (1992).

The reason that incorporated cities' sewage emissions increased very little is the decline in industrial effluents in Table 1, column B. The 23.3 billion tons of 1981 fell to 21.9 billion tons in 1993, and further to only 21.6 billion tons in 1994. Logically thinking, a portion of industrial water does not become wastewater owing to evaporation and recovery at factories. Because not much water evaporates, the only possibility is a fast rising recovery rate. According to 1987 data, recovery rates were 72.9% for metallurgy, 59% for nonferrous metals, and 54.8% for the chemical industry. The metallurgy industry's 72.9% is very high. In Japan the rates for industrial water as a whole were 36.2% in 1965, 67% in 1975, and 75% in 1987. Since the 1981-1982 figures for China are unknown, it's impossible to follow the history of recovery rate improvement, but we can see that recovery techniques improved substantially in the 1980s.

Table 1 Sewage Emissions and Treatment in Incorporated Cities

(Mil. tons; %)

	Sewage emissions in incorporated cities	*Industrial emissions*	*Sewage emissions attaining standards*	*Compliance ratio (C/B)*	*Industrial waste/water treatment*	*Treatment ratio*	*Sewage discharge treatment attaining standards*	*Household sewage in incorporated cities (H)*	*Sewage treatment in incorporated cities*	*Household sewage treatment ratio*
	A(100 mil tons)	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*
1980	315.3 [10]									
1981	(288)	233 [6]	(60.6)	26 [6]	(30.3)	13 [6]		55 [6]		
1982	(295)	230 [6]	(75.9)	33 [6]	(39.1)	17 [6]		65 [6]		
1983	(307)	240 [6]	(88.8)	37 [6]	(45.6)	19 [6]		67 [6]		
1984	(325)	254 [6]	(96.5)	38 [6]	(55.9)	22 [6]		71 [6]		
1985	341.5 [4]	249 [6]	(102.1)	41 [6]	56.8 [4]	23 [6]	4 [4]	78 [6]		
1986	(339)	260 [6]	(110.5)	42.5 [6]	(62.4)	24 [6]		79 [6]		
1987	(341)	254 [6]	(116.8)	46 [6]	(63.5)	25 [6]		87 [6]		
1988	367.3 [4]	268.4 [4]	123.9 [4]	(46.2)	72.3 [4]	(26.9)	41.6 [4]	(98.9)		
1989	353.5 [4]	252.1 [4]	120.3 [4]	(47.7)	75.4 [4]	(29.9)	43.5 [4]	101 [8]		
1990	353.8 [3]	248.7 [2]	124.6 [2]	50 [2]	80.2 [2]	32.2 [9]	46.4 [3]	105 [8]		
1991	336.2 [4]	235.7 [4]	118.2 [4]	(50.1)	167 [8]	63.5 [8]	42.3 [4]			
1992	358.8 [3]	233.9 [3]	123.6 [3]	50.9 [1]	175.7 [3]	68.6 [1]	44.5 [3]			
1993	356 [1]	219 [1]	120 [1]	54.9 [1]	179 [1]	72 [1]	45 [1]		55 [7]	17.9 [7]
1994	365.3 [2]	215.5 [2]	119.7 [2]	55.5 [2]	198.5 [2]	(92.1)				

Note: Figures in parentheses are estimates by author. When different figures were available for the same year the most recent ones were used.

Sources:
1. *Environmental Yearbook of China*, 1994, p.84.
2. *Chinese Statistics Yearbook*, 1995, p. 692.
3. *Ibid*., 1994, p. 668.
4. *Ibid*., 1993, p. 822.
5. *Ibid*., 1989, p. 779. Limited to industrial enterprises and non-profit organizations.
6. *Environmental Yearbook of China*, 1990, pp. 48-49.
7. *Ibid*., p. 82. Deals with city sewage treatment, but is not limited to industrial sewage.
8. *Ibid*., 1992, p. 121.
9. *Ibid*., 1991, p. 100.
10. *Ibid*., 1990, p. 431.

Human waste appears in statistics for refuse and fecal matter, not in statistics for household sewage. Most wastewater is gray water from kitchens, laundry, and showers. Because many people were prohibited from owning automobiles, there is little wastewater from washing cars. Sewage probably consists mainly of that containing synthetic detergents. As much of China's water is hard, they need detergent with a large phosphate content.

Table 3 shows what data have been released on industrial water.

Table 2 Proportions of Industrial and Mining Wastewater and Household Sewage in Incorporated Cities

(%)

	Industrial and mining wastewater	*Household sewage*
1981	80	20
1982	78	22
1983	78.2	21.8
1984	78.2	21.8
1985	76.7	23.3
1986	76.7	23.3
1987	74.5	25.5
1988	73.1	26.9
1989	71.4	28.6
1990	70.3	29.7

Source: Calculations based on data from Table 1.

Table 3 Substances Contained in Industrial Wastewater in Incorporated Cities

(Tons)

	Heavy metals	*Hexavalent chromium*	*Arsenic*	*Cyanide*	*Phenol*	*Petroleum*	*COD* *(1,000 tons)*
1981		2,367 [1]				131,000 [1]	
1982		2,094 [1]				96,000 [1]	
1983		1,966 [1]				63,000 [1]	
1984		1,706 [1]				59,000 [1]	
1985		1,548 [1]				62,000 [1]	
1986		1,104 [1]				83,000 [1]	7,580 [1]
1987		897 [1]				84,000 [1]	7,290 [1]
1988	2,199 [2]	884 [1]	1,525 [2]	4,857 [2]	7,930 [2]	77,000 [1]	8,340 [1]
1989	2,089 [2]	753 [1]	1,281 [3]	4,468 [2]	7,613 [2]	71,000 [1]	6,790 [1]
1990	2,189 [4]	712 [1]	1,226 [4]	3,891 [4]	9,325 [4]	67,000 [1]	7,080 [1]
1991							
1992	1,516 [3]	872 [3]	4,113 [3]	6,422 [3]	65,100 [3]	711 [3]	
1993	1,621 [3]	907 [3]	2,480 [3]	4,996 [3]	75,400 [3]	622 [3]	

Sources: 1. Qu Geping and Li Jinchang, *Population and Environment in China*, China Environmental Science Publishing, 1992, p. 36.

2. *Environmental Yearbook of China*, 1990, p. 426.

3. *Ibid.*, 1994, p. 79.

4. *Ibid.*, 1991, p. 97.

Tables 2 and 3 show that the recovery rate of industrial water in incorporated cities has improved considerably, so that despite increased production volume the wastewater rate has declined substantially, and also that there are far lower amounts of pollutants in industrial wastewater. Instead, household sewage has become a problem since the 1990s. Because household sewage comes from dispersed sources, it is anticipated that the costs of gathering it for treatment will increase far more than the costs for factory wastewater.

Third is that the treatment rate for industrial wastewater has increased considerably, which is apparent from columns E and F of Table 1. The 13% treatment rate in 1981 climbed to 25% in 1987, 32.2% in 1990, and in 1991 to an unbelievable 63.5%. It was estimated at 92% in 1994. This rising treatment rate is no doubt connected to the falling amounts of pollutants in industrial wastewater, as seen in Table 3, above.

Similar data are columns C and D of Table 1, in which the increasing amount of wastewater attaining government-set emission standards and the rising compliance rate show this. But we have to examine this information a little more closely. Depending on the industry type, environmental quality standards run from grades 1 to 3, or 1 to 5. The grade 1 standard means wastewater contains the lowest amounts of pollutants, and as the grade number rises, so does the amount of pollutants. Needed are data that show how much treated wastewater attained the standards for which grade, but these are not available in macrostatistics.

Fourth is the state of most-polluting companies.

In May 1993 China first released information on the 3,000 companies with the largest pollutant emissions.[1] The pollutants of those 3,000 companies account for about 60% of all the emissions of the nearly 70,000 monitored companies, and apparently just 10% of them, or 300 companies, produce 60% of the emissions of the 3,000 most polluting companies. In other words, just 300 companies produce over one-third of the total emissions of the 70,000 monitored companies. Table 4 shows water pollutants.

It is evident that most heavy metal pollutants come from a certain small number (3,680) of companies. They produce nearly 80% of all phenol, and 62% of total pollutants. We can only compare two points in time, in 1991 and 1992, showing that despite improvement in heavy metals, it is worth noting the worsening in total pollutants, COD, and residual oil. So while claiming to hold down pollutant sources, a comparison of these two times shows that there is a mixed bag of mitigated sources and worsened sources. If we had one set of this data for the 1980s we would have a better idea of the extent to which the worst offenders have improved, but such data has still to be located.

Fifth, columns I and J of Table 1 show the statistics for the 1993 amount of city sewage treated and its treatment rate, which were 5.5 billion tons and 17.9%, respectively. These data are worrisome figures because "city sewage" is defined as follows.[2]

"In China 'city sewage' means mixed sewage including both city industrial wastewater and city household sewage, of which 70-75% is city wastewater. . . city industrial wastewater accounts for 70% of total industrial wastewater. City household sewage accounts for about 70% of total household sewage."

In addition to city sewage there is probably pure city industrial sewage and pure city household sewage. It's hard to say without looking at the sewerage system structure, but we can perhaps interpret this to mean that while the treatment rate for pure city industrial wastewater is quite high, the rate for the mixed sewage that runs into household sewerage was quite low in 1993, at 17.9%. In other words, because household sewage is hardly treated, the treatment rate after it becomes mixed sewage probably falls precipitously. It's also possible to assume that the factories using sewerage pipes and gutters, which are the same facilities as household sewerage systems, are SMEs that have a collective ownership

Table 4 Water Pollutants of Major Polluting Companies

	Waste water discharge		*COD*		*Cadmium*		*Lead*		*Arsenic*	*Phenol*	*Residual oil*
	(Bil. tons)	*% of total*	*(1,000 tons)*	*Ratio*	*(tons)*	*Ratio*	*(tons)*	*Ratio*	*Ratio*	*Ratio*	*(tons)*
1991	14.53	61.9	4,244	59.1	125.8	91.6	832.5	73.9	57.6	78.9	34,428
1992	15.68		5,538		94.9		669.8				39,422.9
92/91	1.08		1.16		0.75		0.8				1.14

Note: The ratio above refers to the ratio to the total wastewater discharge from 72,000 companies. The number of polluting companies was 3,680 in 1991 and 3,826 in 1992.
Source: *Environmental Yearbook of China*, 1994, p. 136.

system. Although newly built large factories probably treat their own effluents, these data seem to support the interpretation that construction is not proceeding well on treatment facilities for small and medium-sized factories and for household sewage.

The foregoing five items describe the sewage situation in incorporated cities. To summarize: Production volume has increased sharply during the last 10 or 15 years, but there has been substantial improvement in the industrial wastewater from major state-owned companies. We can in particular see a big improvement in the reuse of water by industry. In the control of pollutants, companies have made progress in recovering heavy metals, but there has also been considerable improvement for other substances. Still, it seems that hardly a thing has been done about wastewater from SMEs and homes.

2.1.2 River Pollution

Water includes that emitted by a certain limited number of companies that are watched, and that from companies thus far not watched, and all ends up together. Even if monitored companies improve, an increase in emissions from unmonitored companies means there will be no mitigation of watershed pollution. Let us look at some data on the state of watershed pollution.

(1) The state of pollution

Surface water pollution

A 1990 survey[3] of riverbanks in 94 urban areas turned up pollution in 65 locations, for a pollution rate of 69.1%. Survey results have now been released for priority survey locations of 123 locations throughout China in 1993 and 110 locations in 1994. These are shown in Table 5, Changes in Water Quality of Seven Major Watersheds.

Water quality grades 1-5 are based on "surface water quality standards," and have detailed provisions. Grades 1 and 2 are within the permissible range, but grades 4 and 5 are a problem. Grade 5 is quite serious. I have added arrows to show the change from one time to another. Down arrows indicate increases (improvement), while up arrows indicate decreases (worsening). But since the rainfall amount and time of measurement can make big differences, it's not proper to assess using only two points in time.

As a supplement I therefore drew Figure 1, which converts pollutants to numerical assessment values and makes them into combined indexes. The values jump wildly up and down for the Liao He, Songhua Jiang, and Huang He rivers; they are measured at the same time every year, but when there is much rain before the measurement, concentration falls, and if there has been no rain for a time, concentration rises. One can readily see the differences in the degree of pollution among the Chang Jiang and Zhu Jiang rivers, the rivers in the southern monsoon zone, and four northern rivers. If we use 1981-1983 averages as the standard, the rivers that seem to be improving are the Songhua Jiang, Zhu Jiang, and Chang Jiang rivers, while the others are seriously polluted. This shows that pollution is not being mitigated.

Regional differences are evident in both Table 5 and Figure 1. At its worst, 87% of the Liao He watershed was grade 4-5 in 1993. This area is the heart of heavy industry built in the 1950s. In 1993 the Liao He, Songhua Jiang, and Hai He did not attain grades 1-2 at all, which impresses us once again with the severity of the pollution. The Huai He, which runs through Anhui and Jiangsu provinces, is polluted nearly as much as northern rivers. This area is not arid, so some thought will be needed to determine the reason.

Table 5 Changes in Water Quality of Seven Major Watersheds

Watersheds	*Year*	*No. of measuring points*	*1st and 2nd grades (%)*	*3rd grades (%)*	*4th and 5th grades (%)*
Nationwide	1993	123	25 ↓	27 ↓	48 ↑
	1994	100	32	29	39
Chang Jiang	1993	50	37 ↓	31 ↑	32 ↑
	1994		42	29	29
Huang He	1993	16	13 ↑	18 ↓	69 ↑
	1994		7	27	66
Zhu Jiang	1993	7	29 ↓	40 ↓	31 ↑
	1994		39	43	18
Huai He	1993	13	18.3 ↑	15.7 ↓	66 ↑
	1994		16	40	44
Songhua Jiang and Liao He	1993	6	0 ↓	38 ↑	62 ↓
	1994		6	23	71
Liao He	1993	8	0	13	87
	1994			n.a.	
Hai He	1993	16	0 ↓	50 ↓	50 ↓
	1994		32	24	44

Sources: *Environmental Yearbook of China*, 1994, pp. 79-80.
Ibid., 1995 Edition, pp. 66-67.

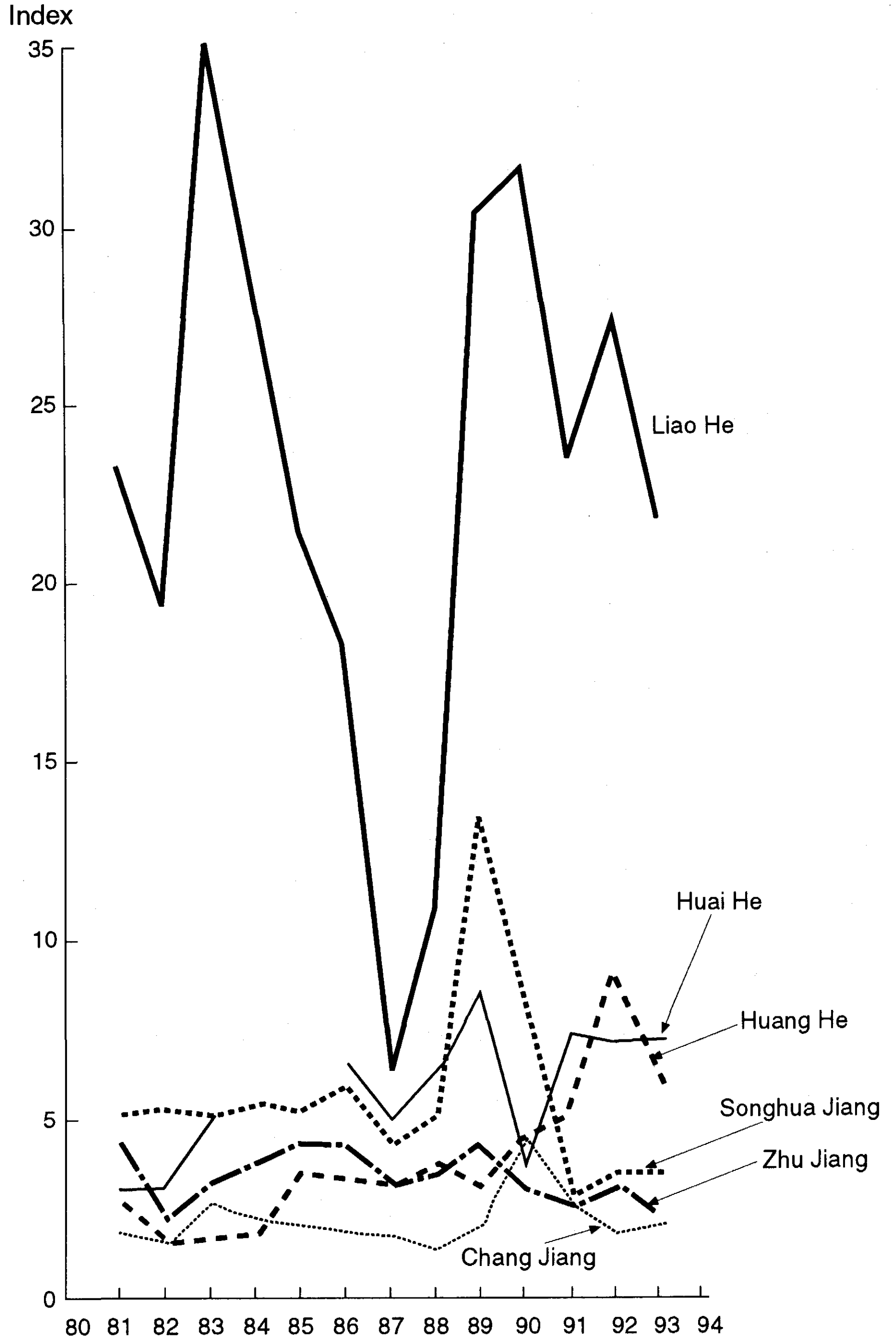
I will include some information here on the extent to which river surveys have been performed on tributaries in major watersheds. Of 1,200 rivers throughout the country, 850 are apparently polluted to varying extents.[4] It appears this information is based on surveys performed around 1991 and 1992. About 70% of rivers are polluted. The investigation of so many rivers suggests that rivers across nearly all of continental China are subject to surveys. Washing machines will increasingly find their way into the farming villages (20% of homes had them in 1994), and the state will no doubt encourage the development of village and town enterprises, so there is little cause for optimism over the future of the rivers.

Groundwater contamination

Costs may rise depending on whether one obtains water from surface water or groundwater, because using surface water costs much more. Particularly in plains such as on the continent, the large population in the eastern region means high costs for transporting surface water. What's more, in winter surface water freezes in the north and northwest. Thus around 1990 two out of three incorporated cities, and 81% of irrigation, depended on groundwater.[5] And during the 1987-88 season 183 of the total 382 incorporated cities suffered from water shortages, 40 of which were serious.[6] Around 1994 this rose to 300 cities, 100 of which had serious shortages.[7]

The greater the shortage of water supplied, the more serious its contamination. In addition to urban factory wastewater and household sewage, rural areas will see still larger num-

Figure 1 Pollution Indices of Six Major Watersheds



Source: *Environmental Yearbook of China,* 1995, p. 178.

bers of town and village enterprises and electric washing machines (owned by 20% of households in 1994), not to mention the added burden of heavy fertilizers and pesticides.

How widespread is the pollution? If we take drinking water sources as an example, surveys covering 95 sources for 44 incorporated cities showed that the water of 51 sources exceeded environmental standards for drinking water,[8] which comes to 54%. Apparently over 90% of the Chinese people in incorporated cities throughout the country who depend on groundwater are drinking contaminated water.[9]

Whatever the surface water situation, groundwater is becoming more contaminated each year.

Eutrophication of lakes and coastal waters

The nutrient content of 34 major lakes in 1990 characterized by 15 lakes (44%) ranging from oligotrophic to mesotrophic, 10 lakes (29%) ranging from mesotrophic to eutrophic, and nine eutrophic lakes (26%). Red tide apparently occurred 34 times around the country in 1990[10], and 19 times in 1993.[11] In 1994 the eutrophication of large lakes became still worse.[12]

Combining several sources of information shows that the eutrophication of inland lakes is worsening.

2.2 Air Pollutants

2.2.1 Amount of Publicity Given to Statistics on Air Pollutants

Air pollutants can be put in the following order, in terms of the technical difficulties involved in measuring them: (1) optical oxidants, non-methane carbohydrates, and ultramicro harmful chemicals; (2) CO_2; (3) SOx, NOx; (4) flue dust of particulate matter; and (5) dustfall. Table 6 and Figures 2-7 show the data on air pollutants released by the Chinese government, collected and compiled as much as possible. Figures are available for the relatively easily measurable ones, from (5) to (2)' CO_2. For CO_2, however, we were only able to locate data from one year, 1989, as shown in Table 6. It seems that emissions of CO_2 were estimated from the use of flammable fuels during the year. There are no publicly available figures, however, for measurement results on optical oxidants and non-methane carbohydrates.

In addition, figures for (3) SO_x and NO_2, (4) suspended particulate matter and dustfall are only available beginning in 1981. It is possible that they were measured before that year, but in a way that could not be converted into uniform statistics. It is likely they were only being measured in a tentative way.

As is done for waste water, Table 6 was compiled from production and emission volumes on the basis of surveys conducted at some 167,000 manufacturing firms in incorporated cities (1985-86). In compiling these statistics, we found that the first and second columns and the fifty and sixth columns were easy to mix together. Up until 1990, it is difficult to judge whether they were limited to industrial and mining figures, or whether they were emissions in incorporated cities. It is only 1991 that these can be clearly separated.

Table 6 contains four statistics, for total emissions, SO_2, industrial flue dust, and industrial particulate matter, and is clearly divided into two groups in terms of emission volumes: one total emissions and SO_2, and the other flue dust and particulate matter. When compared to 1982 figures, total emissions had increased 2.1 times in the 12 years leading up to 1994, and SO_2 had increased 1.43 times, but flue dust remained constant, and particulates had decreased by 1/2.4. By this it can be understood that the recovery of flue dust and particu-

Table 6 Air Pollutants in Incorporated Cities

	Total emissions in incorporated cities				SO_2		*Industrial flue dust*	*Industrial flue dust removed*	*Industrial particulates*	*Industrial particulates removed*	CO_2
	Total	*Industries*			*Total*	*Industries*					
			Heat sources	*Production processes*							
	(Bil. m³)				*(1,000 tons)*		*(1,000 tons)*	*(1,000 tons)*	*(1,000 tons)*	*(1,000 tons)*	*(Mil.tons)*
1981							14,540[3]		14,220[3]		
1982	5,441.2[1]				12,750[1]		14,580[1]		13,030[3]		
1983	6,094.1[1]				13,000[1]		13,530[1]		10,920[3]		
1984	6,696.9[1]				12,430[1]		13,110[1]		11,260[3]		
1985	7,065.4[1]				13,030[1]		13,240[1]		12,820[3]		
1986	6,667.9[1]				12,500[1]		13,840[1]		11,700[3]		
1987	7,727.0[1]				14,120[1]		14,450[1]		10,040[3]		
1988	8,238.2[1]				15,230[1]		14,360[1]				
1989	8,268.5[1]				15,640[1]		13,980[1]				420[1]
1990	8,538.0[1]				14,950[1]		13,240[1]		7,810[5]	19,870[5]	
1991	10,141.6[4]	8,469.9[4]	5,364.7[4]	3,105.0[4]	16,220[4]	11,650[4]	13,140[4]	65,240[4]	5,790[4]	21,610[4]	
1992	10,478.7[2]				16,850[2]		14,000[2]		5,760[2]	2,4510[6]	
1993	10,960.4[2]	9,342.3[2]	6,004.1[2]	3,338.2[2]	17,950[2]	12,920[2]	14,160[2]		6,170[2]	26,410[5]	
1994	11,363.0[5]				18,250[5]		14,140[5]		5,830[5]	26,290[5]	

Sources: 1. Qu Geping and Li Jinchang, *Population and Environment in China*, China Environmental Science Publishing, 1992, p. 136.
2. *Environmental Yearbook of China*, 1994, p. 84.
3. *Ibid.*, 1990, p. 50.
4. *Ibid.*, 1992, p. 121.
5. *Chinese Statistic Yearbook 1995*, p. 692.
6. *Ibid.*, 1994, p. 668.

Table 7 Removal and Recovery of Flue Dust and Particulates in Factories

(%)

	1991	*1993*
Rate of dust removal of factory combustion furnaces	85.3	86.2
Rate of dust removal of factory production processes	64.7	70.1
Rate of recovery of industrial particulates		81.1

Sources: 1. *Environmental Yearbook of China*, 1992, p. 121.
2. *Ibid.*, 1994, p. 84.

lates had advanced significantly. It is technically difficult, however, to recover exhaust fumes and SO_2, and it can be understood that little technical progress has been made in this area.

Removal and recovery rates for flue dust and particulates in factories were published in 1991 and 1993. They are indicated in Table 7.

As of 1991, the dust removal rate for combustion furnaces went above 85%. The dust removal rate for production processes was 65%, and by two years later had climbed above 70%. It is clear that improvements are being made. We can give a positive appraisal to these efforts, though it must be recognized that this is only for large and medium sized companies.

However, the key to reducing emissions of SO_2 is removal efforts during the refining process. Since the major energy source is coal, the key is how much of it can be cleaned, and whether desulfurization could take place during the processing of briquette and oval briquettes. The reason why SO_2 emissions are increasing is because coal washing and coal dressing are extremely uncommon.

2.2.2 The State of Pollutants in the Atmosphere

The statistics in the tables above are for the most part limited to manufacturing enterprises, but the components of air pollutants, which I will now present, include not just manufacturing but also other causes such as various industries, traffic and transportation, and everyday living. It is as comprehensive as this.

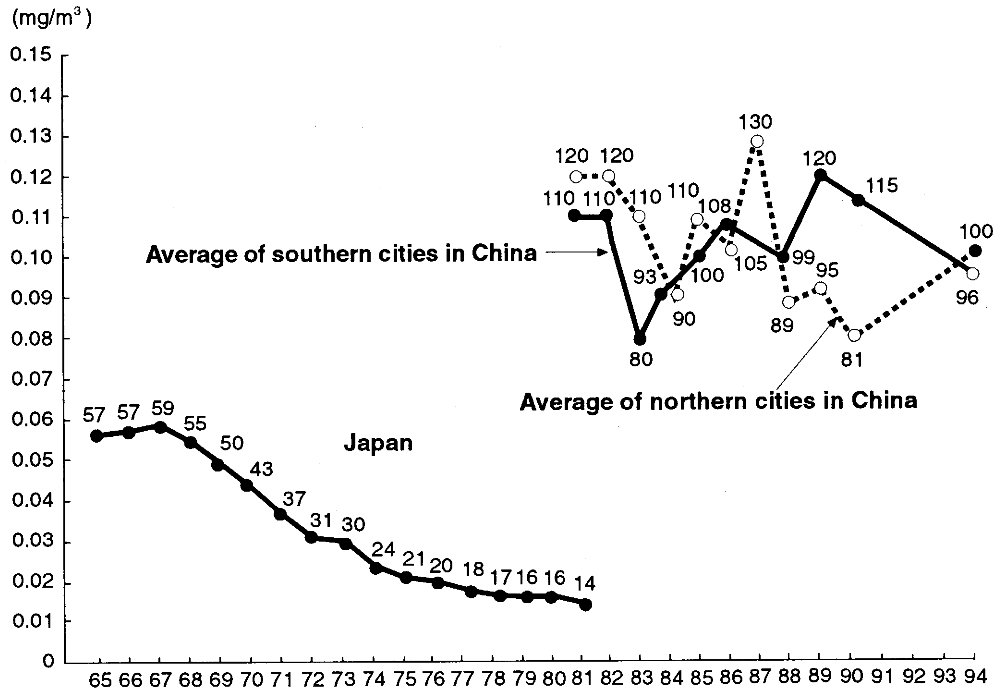
Figures 2 and 3 examine SO_2. In China, the climate differs greatly north and south of the Huai He River. The south is a monsoon region, whereas the north is arid. The industrial structure is also very different. The north has many heavy industries, whereas the south has many light industries. With this in mind, we will begin by looking at Figure 2.

First, if we compare China with Japan's experience, we find that in 1981, the concentration of SO_2 in the air in the north cities was 8.6 times that of Japan, and in the south was 8 times as great. It is estimated that in Japan the concentration has only changed by 0.01 from 1980 to today, so by the 1990s it was 10 times the concentration in Japan.

Second, in Japan the situation has improved drastically since the end of the 1960s, and since the 1980s has stabilized. In China, by contrast, improvement is not yet to be seen. This is an important point.

Third, there are huge differences between the cities in north and south areas of China. The cities in the south compare roughly to Japan in the 1980s and 1990s, but the cities in the north are roughly 40 to 50 times as polluted. We can estimate from this that there is a problem with SO_2 in northern cities.

Figure 2 SO_2 Concentration in the Air (Annual Average)



Note: The figures are 1,000 times the scale values.

Sources: Japan: Planning and Coordination Bureau, Environment Agency, *Kankyo Tokei Yoran* (Environmental Statistics Bulletin), 1983, Gyousei, p. 11.

China: *Environmental Yeaarbook of China,* 1992, p.187, except for 1993 taken from *Xinhua Yuebao,* 1994, p.62.

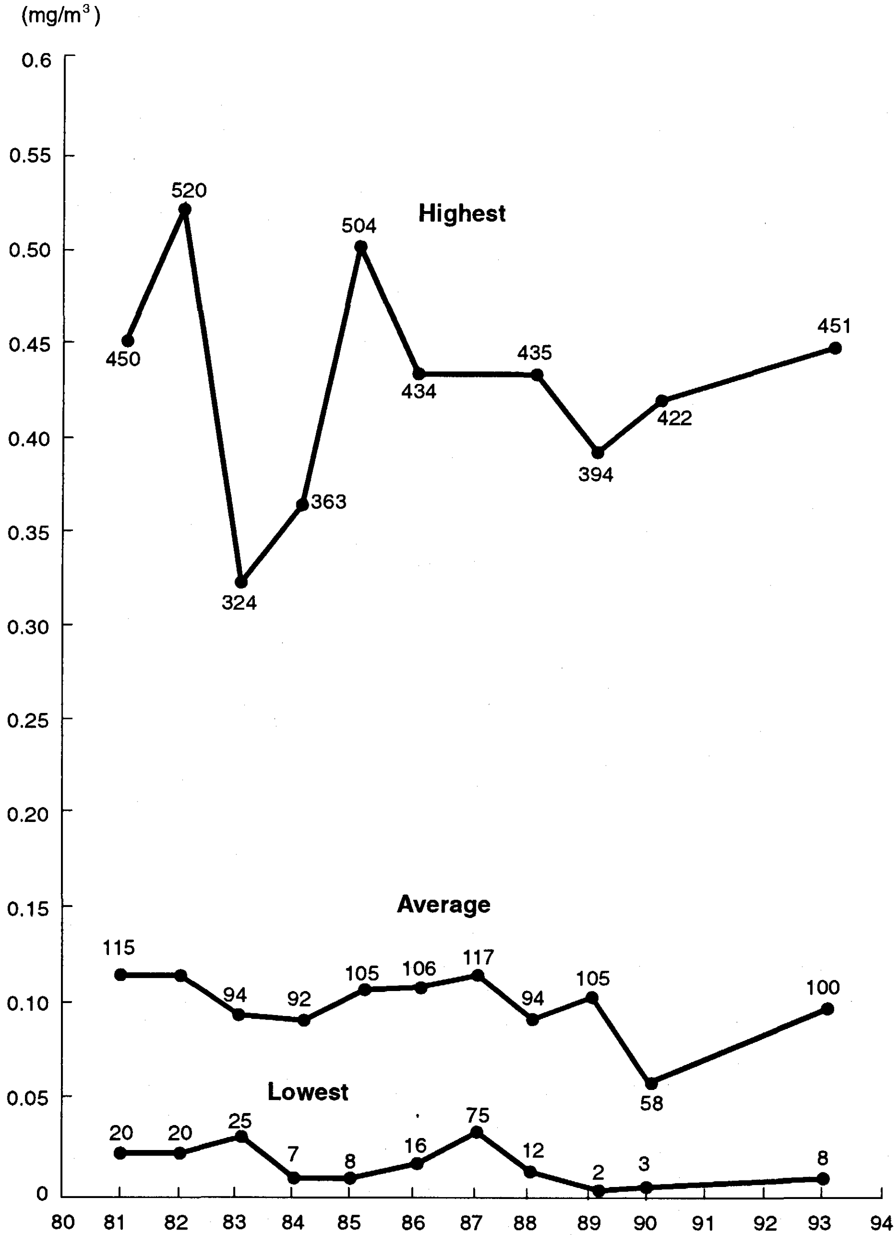
However, among the southern cities, the southwestern provinces of Sichuan, Guizhou, and Yunnan cannot be considered typical. It is said that they are the heart of the acid rain problem. Table 8 demonstrates this. It is compiled from incorporated cities in northern and southern China in the order of levels of SO_2 concentration in the 1990s. The levels are particularly high for the four cities beginning with Guiyang in Guizhou Province and ending with Chongqing in Sichuan Province.

Table 9 shows the pH value of rainwater in selected cities. Generally, it can be said that acid rain is common in places where the rainfall contains pH values under 5. Because pH measurements are not done on an annual basis, they cannot be directly compared to the SO_2 concentrations, but it helps us to understand that there is a lot of sulphur in the air in cities south of the Huang He. It is likely that the reason why southern cities in general terms have lower concentrations of SO_2 than their northern counterparts is that the coastal cities have extremely low concentrations.

In other words, the concentration of SO_2 is quite high in Chinese cities, with the exception of the northern and southern coastal cities.

According to 1993 statistics for 73 cities,[13] pH values ranged from 3.94-7.63, with 49.3% having a pH of less than 5.6. In the 12 cities of Gangzhou, Changsha, Nanchong,

Figure 3 Highest and Lowest SO_2 Concentrations (Nationwide)



Note: The figures are 1,000 times the scale values.
Source: *Environmental Yearbook of China,* 1992, p. 187, except for 1993 taken from *Xinhua Yuebao,* No. 6, 1994, p. 62.

Table 8 Ranking of Daily Average of SO_2 Discharges in Northern and Southern Cities in 1990

(mg/m^3)

Ranking	*Northern cities*		*Daily average*	*Ranking*	*Southern cities*		*Daily average*
1	Taiyuan	(Shanxi)	0.394	1	Guiyang	(Guizhou)	0.372
2	Shijiazhuang	(Hebei)	0.269	2	Yibin	(Sichuan)	0.348
3	Qingdao	(Shandong)	0.263	3	Nanchong	(Sichuan)	0.346
4	Wulumuqi [Urumqi]	(Xinjiang)	0.201	4	Congqing	(Sichuan)	0.338
5	Zibo	(Shandong)	0.147	5	Changsha	(Hunan)	0.186
6	Shenyang	(Liaoning)	0.146	6	Yichang	(Hubei)	0.177
7	Baotou	(Neimenggu)	0.126	7	Gejiu	(Yunnan)	0.145
8	Tianjin		0.125	8	Guilin	(Guangxi)	0.138
9	Tangshan	(Hebei)	0.122	9	Guangzhou	(Guangdong)	0.1
10	Jinan	(Shandong)	0.117	10	Shanghai		0.098
11	Luoyang	(Henan)	0.105	11	Hangzhou	(Zhejiang)	0.097
12	Anshan	(Liaoning)	0.1	12	Hengyang	(Hunan)	0.088
13	Beijing		0.099	13	Fuzhou	(Fujian)	0.086
14	Yuncheng	(Shanxi)	0.096	14	Chengdu	(Sichuan)	0.082
15	Huhehaote [Hohhot]	(Neimenggu)	0.092	15	Suzhou	(Jiangsu)	0.077
16	Shijushan	(Liaoning)	0.075	16	Nanchang	(Jiangxi)	0.072
17	Jilin	(Jilin)	0.067	17	Xuzhou	(Jiangsu)	0.071
18	Zhengzhou	(Henan)	0.065	18	Xiamen [Amoy]	(Fujian)	0.067

Source: *Environmental Yearbook of China*, 1991, p. 158.

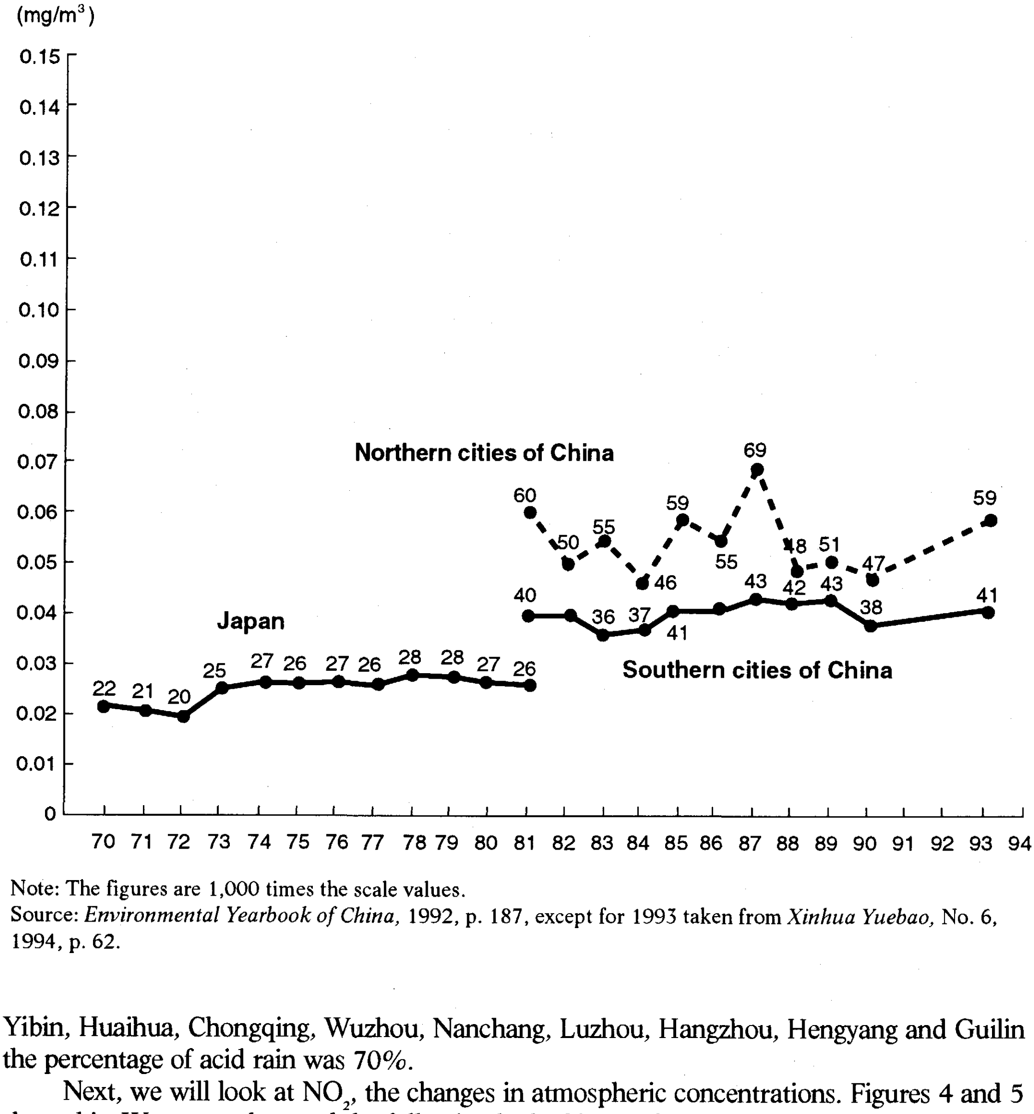
Table 9 Rainwater pH Values

City		*pH values*[1]	*Daily average of SO_2 in 1990*[2] *(mg/m^3)*
Guiyang	(Guizhou)	4.07	0.372
Chongqing	(Sichuan)	4.14	0.338
Changsha	(Hunan)	4.3	0.186
Nanjing	(Jiansu)	4.59	
Hangzhou	(Zhejiang)	4.72	0.097
Yibin	(Sichuan)	4.87	0.348
Shijiazhuang	(Hebei)	5.36	0.263
Wuhan	(Hubei)	5.47	0.048
Beijing		5.96	0.099
Tianjin		5.96	0.125
Jinan	(Shandong)	6.1	0.117

Sources: 1. Qu Geping and Li Jinchang, *Population and Environment in China*, China Environmental Science Publishing, 1992, p. 38.

2. From Table 8. The source for Wuhan, which is not included in Table 8, is from *Environmental Yearbook of China*, 1991, p. 159.

Figure 4 NO_2 Concentration in the Air (Annual Average)



Note: The figures are 1,000 times the scale values.
Source: *Environmental Yearbook of China,* 1992, p. 187, except for 1993 taken from *Xinhua Yuebao,* No. 6, 1994, p. 62.

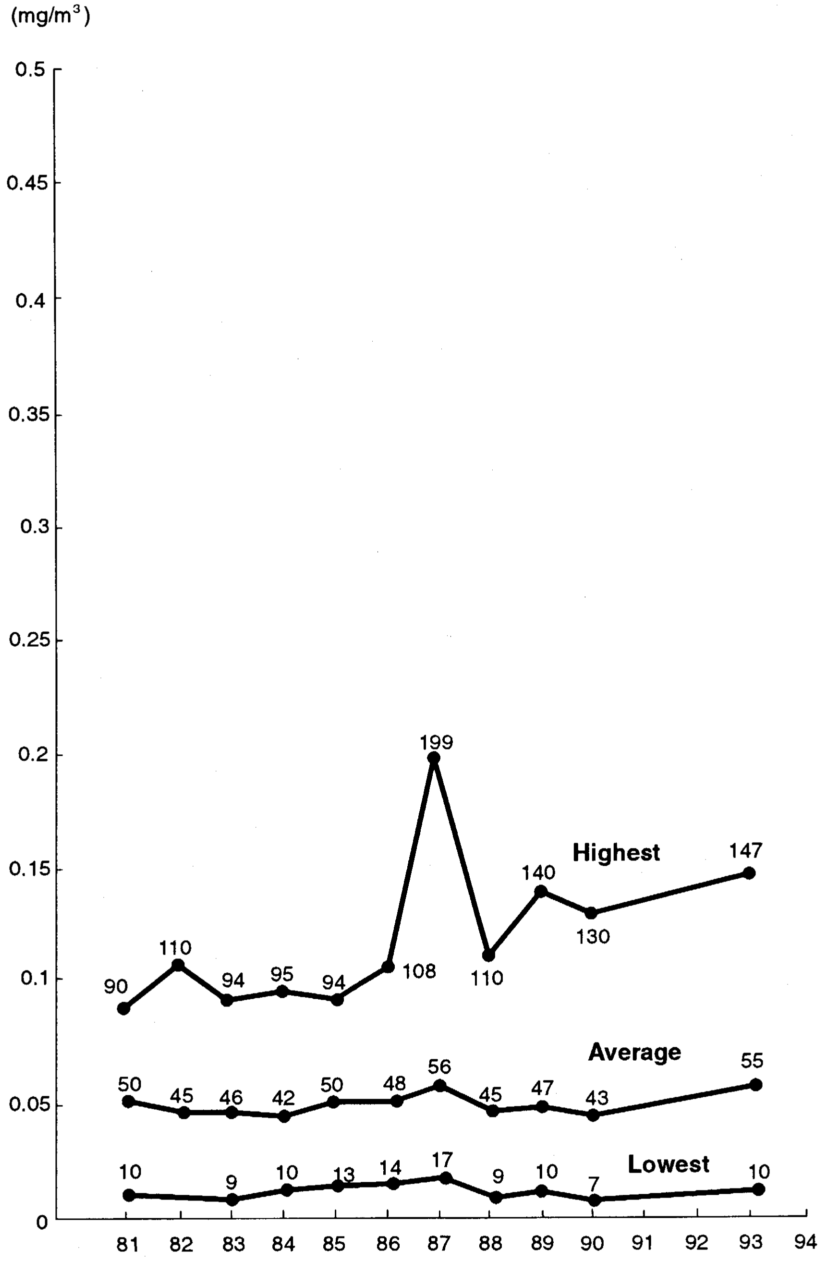
Yibin, Huaihua, Chongqing, Wuzhou, Nanchang, Luzhou, Hangzhou, Hengyang and Guilin the percentage of acid rain was 70%.

Next, we will look at NO_2, the changes in atmospheric concentrations. Figures 4 and 5 show this. We can understand the following by looking at them.

First, in 1981, Chinese northern cities had 2.5 times, and southern cities roughly 2 times, the figures of concentrations in Japan. In Japan, figures had been rising, rather, since 1973. This was caused by the spread of private automobiles starting in the beginning of the 1970s. In 1967-68, roughly 20% of households owned a car. Starting in the mid-1980s, major Chinese cities entered into an era of company-owned cars. The spread of private cars by households is still very low, but is beginning to become more widespread in the late 1990s. It is thus projected that the trend will not improve but will deteriorate in the future. Figure 5, which shows the upward movements starting in 1993, gives an omen of this.

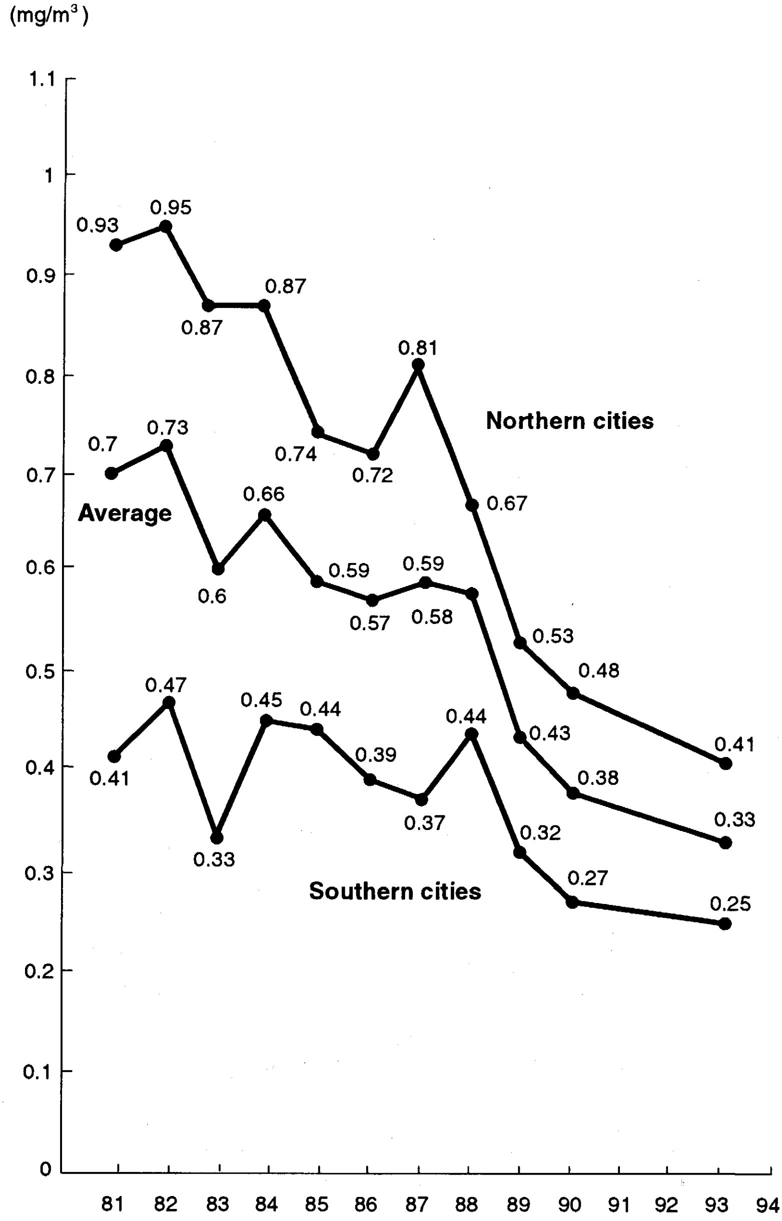
Second, as for SO_2, the gaps between northern and southern cities are large. The source of this gap is in the industrial structure rather than in the spread of automobiles.

Figure 5 Highest and Lowest NO_2 Concentration (Nationwide)



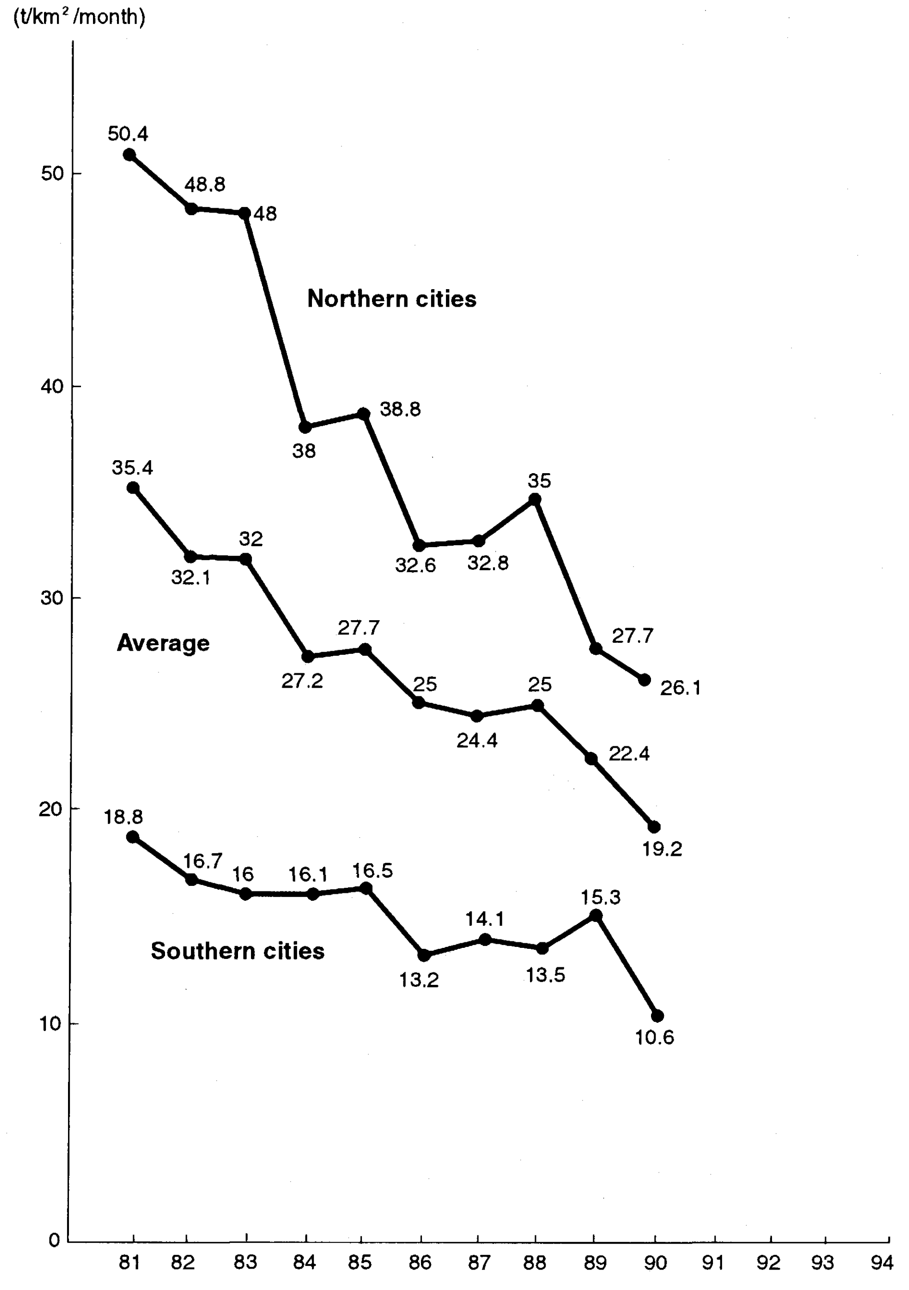
Note: The figures are 1,000 times the scale values.
Source: *Environmental Yearbook of China*, 1992, p. 187, except for 1993 taken from *Xinhua Yuebao*, No. 6, 1994, p. 62.

Figure 6 Concentrations of Suspended Particulate Matter



Source: *Environmental Yearbook of China,* 1992, p. 187, except for 1993 taken from *Xinhua Yuebao,* No. 6, 1994, p. 62.

Figure 7 Dust Fall Amount



Source: *Environmental Yearbook of China,* 1992, p. 187, except for 1993 taken from *Xinge Yuebao,* No. 6, 1994, p. 62.

Third, there is an enormous difference between the highest and lowest figures as seen in Figure 5. In 1993, it was an almost 15-fold gap.

Next, we will look at the concentration of suspended particulates and volume of flue dust precipitation. Figures 6 and 7 present these figures. There are two points to be understood from these two figures.

First, both were decreasing in a stable manner throughout the 1980s. This stands in great contrast to SO_2 and NO_2. This can be understood to be a result of the in-factory treatment of flue dust and particulates.

Second, the differences between northern and southern cities clearly appear. This is likely a result of the industrial structure.

The aforementioned comments on atmospheric pollution can be summarized as follows. The turning point for the removal of flue dust and particulates, which is relatively simple, was reached in the 1980s. There has of yet been no decrease, however, in chemicals such as SO_2 and NO_2. In particular, it seems that the problem with NO_2 will only increase with the rapid arrival of an automobile society. Furthermore, for chemicals (such as optical oxidants and non-methane carbohydrates), which are even more difficult to remove than SO_2 and NO_2, it is fair to say that the study phase is just beginning.

2.2.3 Solid Waste

According to the 1995 Environmental Yearbook of China, "industrial solid waste" includes metallurgical residues, coal dust, burnt boiler scraps, rocks and dirt extracted from coal ore, chemical industry residues, rocks and dirt from mining, radioactive residues, and others (p. 432). The category "others" only applies to 5.9% of the publicly announced industrial solid waste in 1994. From this we can assume that there were four major sources: various industries (for burnt boiler scraps), the metallurgical industry, the chemical industries, residues, mining, and radioactive industries. Among secondary industries, solid waste from demolished scraps from the construction, demolition, and light industries such as textiles, papermaking, and foodstuffs industry are not included, with the exception of the burnt boiler scraps they produced. In addition, as for the previously mentioned sewage water and atmospheric pollutants, statistics for corporate patterns are limited to some 70,000 factories and mines. Thus, the definition of "industrial solid waste" is too narrow to include what is usually considered in that category. Of course, household waste is not included.

In consideration of this, published figures have been compiled into Table 10.

The overall production volume figures for 1994 show that more than 600 million tons of mining and industrial solid waste was produced, and for that same year the volume of coal ore produced was 1.2 billion tons. I do not know how much sludge is produced from one ton of coal ore, but I believe that the whole mining industry would produce at least 600 million tons. For instance, the quality of Chinese iron ore is relatively low, and is close to low-grade ore. It is under 42-43%. To produce one ton of pig iron, 2.4 tons of iron ore are necessary, and 1.4 tons of sludge emerges from the process. In 1994, total steel production was 90 million tons. This means that 126 million tons of sludge were produced. If statistics are compiled in this way, we can assume that the 600 million tons produced by 70,000 mining firms is probably too low.

In addition, there are some figures contained in the statistics which are clearly odd. One is that the total amount of waste produced in 1986 was 600 million tons, versus 460 million tons for the previous year. It is inconceivable that the figure could have jumped 140 million tons in the course of just one year. There are three similar instances in the accumulated volumes. These are unavoidable during the first stage of statistical compilation. Given the premise of this type of statistics, I drew up charts to show the meaning of the trend values shown in Table 10.

Figure 8 shows changes in the volume of solid waste produced and total use of solid waste. The dotted line shows the trend in the values. Looking in this way, we find that the volume produced has been stable after 1992. The fact that there has been almost no change for three solid years indicates that there has been success in controlling the produced volume. In contrast, the volume of solid waste recycled into bricks or low-quality building materials has increased rapidly since 1990.

In other words, in regards to the environmental situation of mining and manufacturing solid waste from the 700,000 enterprises, it can be said that the worsening situation has begun to see improvement.

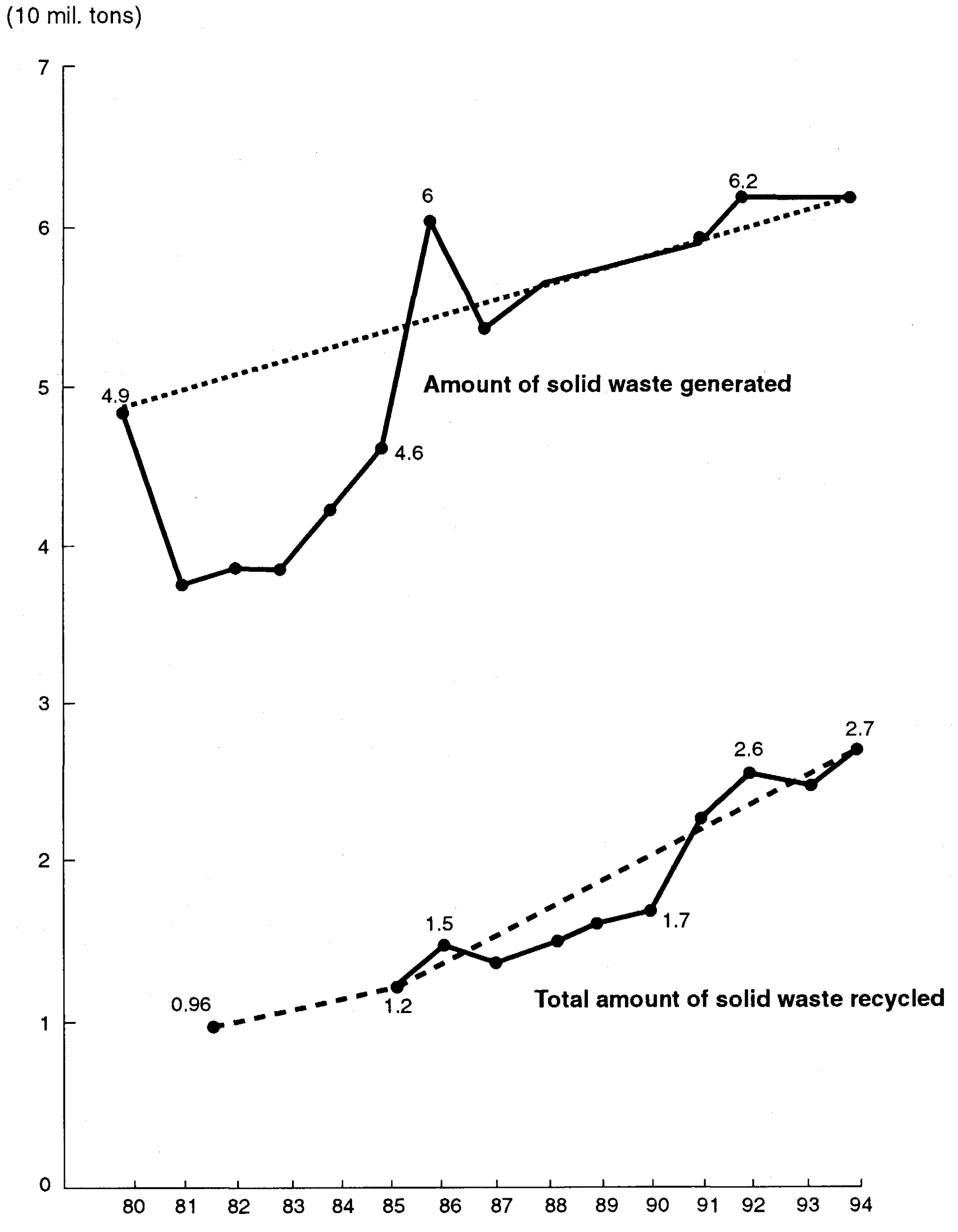
We can confirm this from Figure 9. This figure indicates changes in the volume of solid waste dumped and the volume of use of solid waste. We have interpreted the Chinese phrase

Table 10 Industrial and Mining Solid Waste

	Total amount produced (10,000 tons)	*Dumped outside facility* (10,000 tons)	*Into rivers and sea*	*Total amount recycled* (10,000 tons)	*Ratio* (%)	*Cumulative waste amount* (10,000 tons)	*Area covered by accumulated waste* km²	*Arable land* km²
1980	48725			9625				
1981	37664 [1]				19.9 [11]	348332 [1]		
1982	38369 [1]				21.0 [11]	364019 [1]		
1983	38545 [1]				20.1 [11]	545138 [1]		
1984	42435 [1]				22.5 [11]	482897 [1]		
1985	46153 [1]			12187 [7]	26.2 [11]	506718 [1]		
1986	60364 [1]	13306 [1]		14730 [7]	24.2 [11]	741541 [1]		
1987	53541 [1]	8678 [1]		13712 [7]	25.6 [11]	633658 [1]		
1988	56132 [1]	8545 [1]		14715 [7]	26.3 [11]	655646 [1]	536 [3]	
1989	57173 [1]	5265 [1]		16137 [7]	28.2 [11]	674892 [1]	554 [4]	35.7 [9]
1990	57791 [1]	4767 [1]	1000 [1]	16943 [8]	29.3 [11]	648173 [1]	40.4 [9]	
1991	58759 [5]	3376 [5]		22284 [5]	36.6 [5]	596253 [1]	505.4 [5]	52.1 [10]
1992	61884 [5]	2587 [5]		25554 [5]	39.6 [5]	591608 [5]	545.2 [2]	
1993	61708 [2]	2152 [2]	737 [2]	24826 [2]	38.7 [2]	597000 [2]	520.5 [2]	40.7 [2]
1994	61704 [5]	1932 [5]	691 [6]	26693 [5]	41.8 [5]	646282 [5]	557 [5]	38 [6]

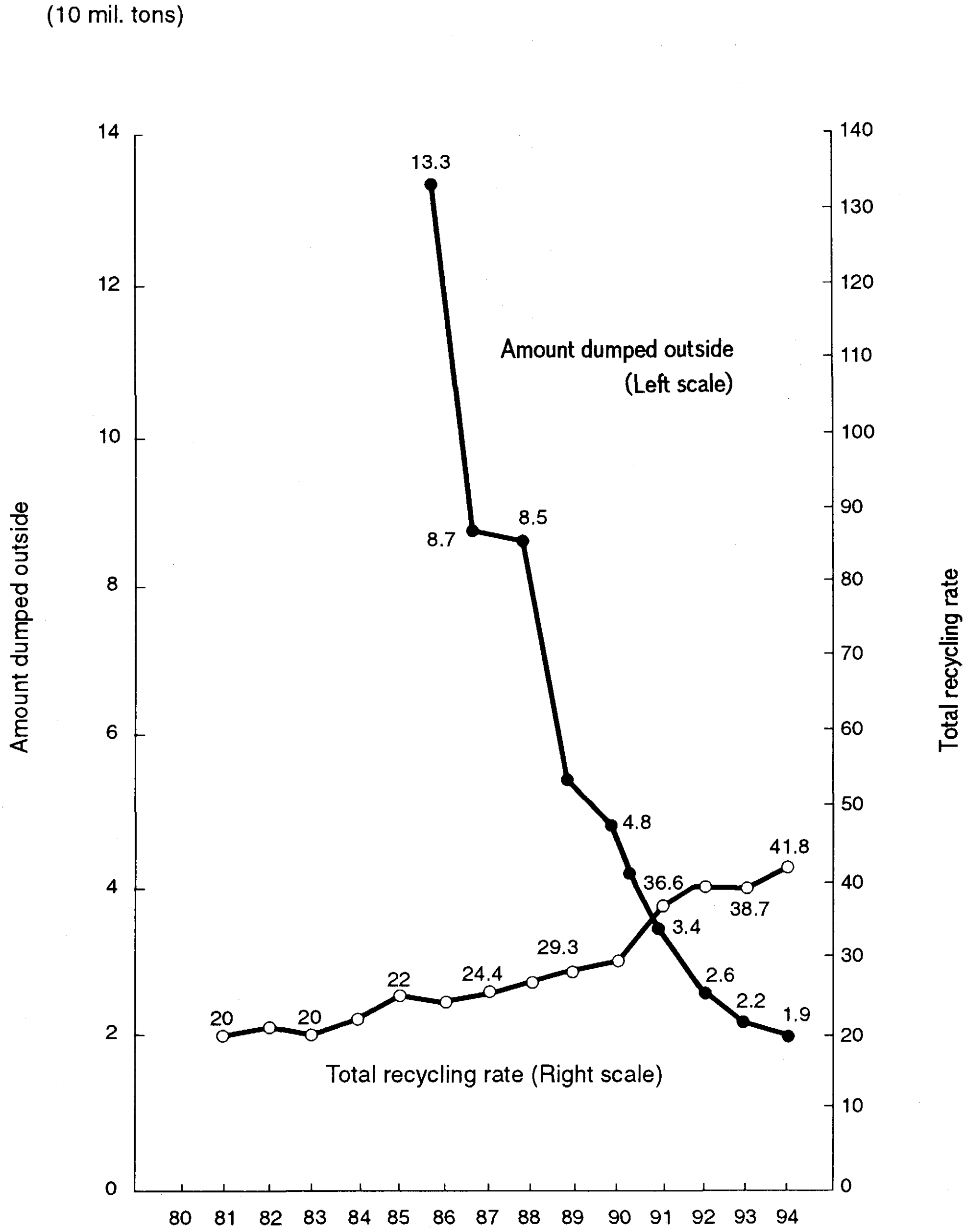
Sources:
1. Qu Geping and Li Jinchang, *Population and Environment in China*, China Environmental Science Publishing, p. 39.
2. *Environmental Yearbook of China*, 1994, p. 84
3. *Ibid.*, 1990, p. 39.
4. *Ibid.*, p. 427.
5. *Ibid.*, 1995, p. 429.
6. *Ibid.*, p. 445.
7. *Ibid.*, 1990, p. 126.
8. *Ibid.*, 1991, p. 100.
9. *Ibid.*, p. 98.
10. *Ibid.*, 1992, p. 121.
11. Environmental Protection State Bureau, *China Environmental Statistics* 1981-1990, China Environmental Science Publishing Co., pp. 139-140.

Figure 8 Amount of Solid Waste Dumped Outside Facilities and Total Recycling Rate



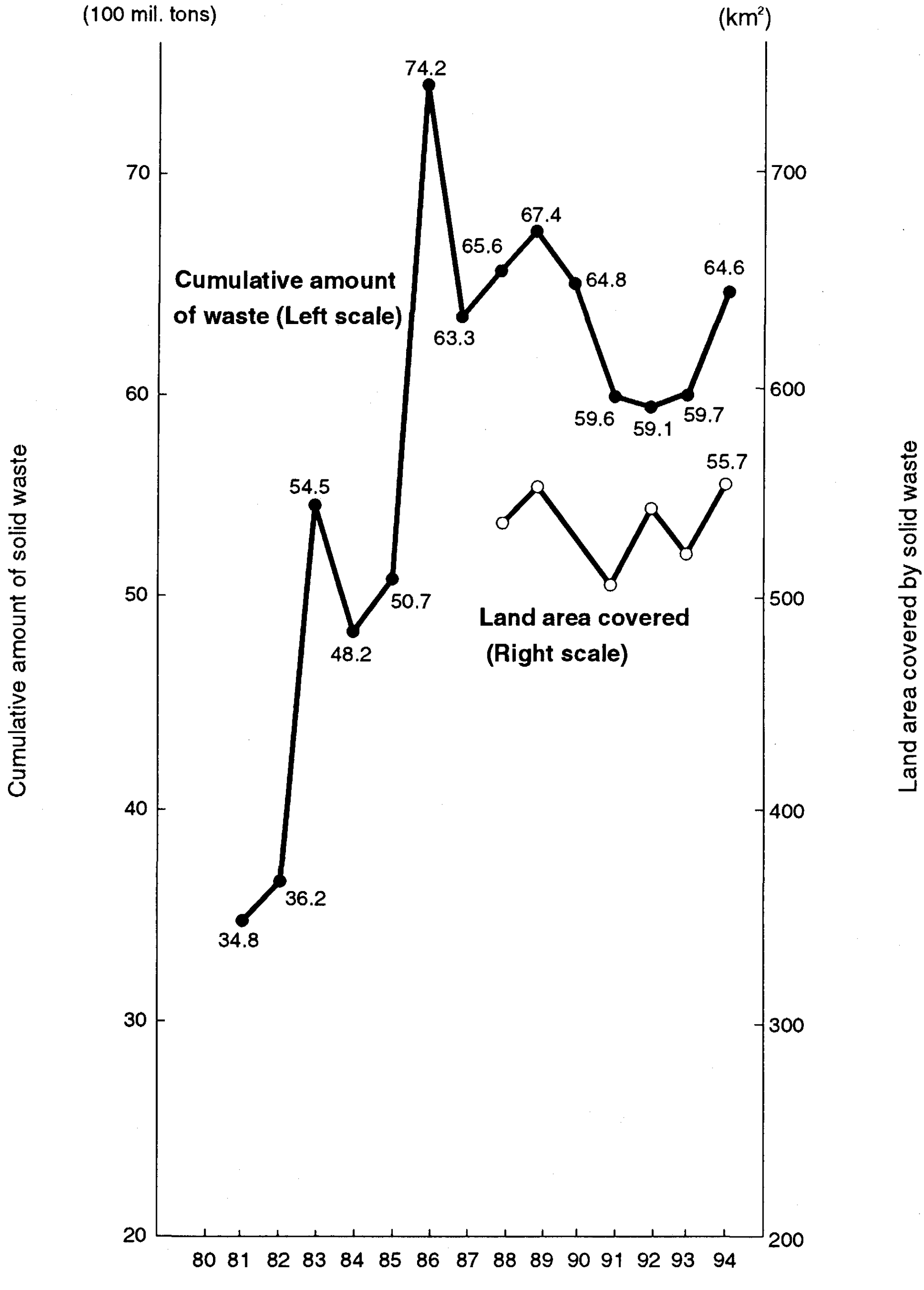
Source: Compiled from Table 10.

Figure 9 Amount of Solid Waste Dumped Outside Facilities and Total Recycling Rate



Source: Compiled from Table 10.

Figure 10 Cumulative Amount of Waste and the Land Area Covered



Source: Compiled from Table 10.

"released amount of industrial solid waste"(工業固体廃物排放量) as indicating the amount discarded outside factories. This is a type of illegal dumping. As shown by Figure 9, the volume has decreased precipitously. By contrast, the volume of solid waste recycled increased to nearly 30% in 1990 compared to 20% in 1980, and by four years later, in 1994, had risen 12 points to 42%.

Figure 10 shows changes in the accumulated solid waste and the area of land occupied by this waste. It is unclear whether the statistical figures are limited to the 70,000 mining and manufacturing enterprises, or whether they include solid waste from town and village enterprises (TVEs) in rural areas, and other fields. In view of the presentation of the statistical values, however, it seems, as for the other items, that they are limited to one section of mining and manufacturing enterprises. It also appears that solid waste from the TVEs in rural areas is not included. Common sense, however, dictates that their solid waste is not dumped in separate areas.

Looking at the accumulated data, we find that the 3.5 billion tons in 1981 had swollen to 7.4 billion tons in 1986, but this is because the surveys were carried out more extensively, and it is unlikely that it represents an actual accumulation. The important point is that the figures have not changed since 1990. This accords with the survey data from Figures 8 and 9.

In 1988, the land area where solid waste had been discarded totaled 536 square kilometers. By 1994 this had risen slightly to 557 square kilometers. This is roughly equivalent to the total land area of Singapore. The last column in Table 10 shows that the amount of the land which was arable ranged between 36 and 50 square kilometers. This works out to between 3,600 and 5,000 hectares. This is roughly equivalent to the land area of a medium-sized Japanese city. For instance, Fujisawa City in Kanagawa Prefecture has a land area of 7,000 hectares. In accordance with a law on the recovery of farmland(復墾規定), farmlands converted to use for mine development or brick-manufacturing must later be reconverted to agricultural land. In the 1990s, this line began to fall.

From the above, we see that there are significant difficulties with the statistics on solid waste, but we can conclude that the situation began improving starting in 1990.

3. Conclusion

From the analysis above, we can summarize the environmental situation during the years 1992-93 as follows.

3.1 The Situation in Incorporated Cities

(1) Surveys on the pollution situation in large- and medium-sized manufacturing and mining firms in incorporated cities, as well as full-scale countermeasures, have begun. However, there have only been partial efforts in terms of surveys and countermeasures for small- and medium-sized firms, areas outside of mining and manufacturing, and household wastes.

(2) There has been progress in the process of recovering and removing pollutants from mining and manufacturing, in the order of solid waste, sewage water to atmos-

pheric pollutants. In other words, most progress is being made in the most visible areas. There has only been partial progress in areas which cannot be seen.

(3) There have been improvements in the in-house treatment of polluted water. In contrast, however, there has been a worsening of pollution in the rivers and lakes where city, agricultural, and general industrial sewage is concentrated.

(4) Among non-visible pollutants, there has been relatively good progress in dustfall, but the situation for suspended particulate matter, SO_2 and NO_2 is actually getting worse. It appears that there has not even been an attempt to deal with CO_2. There is practically no awareness of the problem of ultramicro harmful substances such as optical oxidants, non-methane chemicals, and tri-chloro-ethylene, which require sophisticated analysis technology. Measures were taken early on, however, in terms of heavy metals and radioactive substances.

3.2 Is There a Need to Reform the Attitude of "Prospering Environmental Science, Deteriorating Environment"?

The answer to this question is no. It has only been ten years since environmental statistics began to be taken, and they are not yet comprehensive. In addition to the incorporated cities, there are more than 15,000 small incoperated cities and towns called *"Jian zhi zhen"*(建制鎮) well as agricultural villages, which are home to some 800 million people. The surveys in these areas have been extremely scarce. It is likely that the released volumes of pollutants and untreated volumes will increase greatly as surveys become more comprehensive. The Chinese government will have to rectify its attitude that 3,000 companies release 65% of pollutants, 6,000 release 75%, and 9,000 release 85%. This is suggested by the fact that the amount of not-yet-grasped volumes of SO_2 and NO_2, which are shown in Figures 2 and 4, and the pollution indices of major watersheds, shown in Figure 1, are increasing.

Consequently, at the time of writing this I concluded that there was no need to change the attitude that "Environmental science prospers while the environment deteriorates."

3.3 Ecosystem Destruction with No End

I had originally planned to write about this topic as well, but space limitations do not permit me to. At the 1992 Rio Earth Summit, unlike previous meetings, a great emphasis was placed on the problem of ecosystems. This is shown by the various resolutions adopted at Rio, which I presented at the beginning of this paper. In 1993, in response to these, China drafted two documents, "China's Agenda for the 21st Century – A White Paper on Population, Environment, and Development in 21st Century China," and "China's Environmental Protection Action Plan, 1991-2000." Great portions of these documents refer to the problem of the destruction of ecosystems. And none of these problems desertification, the retreat of grasslands, land erosion, alkalification, land subsidence, increasing debts for forest resource income, the abandonment of arable land, and soil depletion have shown any improvement.

If asked to summarize the environmental situation, including the loss of ecosystems, I would have to repeat, "environmental science prospers while the environment deteriorates."

Notes

1. *Environmental Yearbook of China,* 1990 Edition, China Environmental Science Institute Press, p. 50-51.
2. *Ibid.,* 1990 Edition, p. 45.
3. *Ibid.,* p. 97.
4. China's Agenda for the 21st Century "A White Paper on Population, Environment," and Development in 21st Century China, China Environmental Science Institute Press, 1994, p. 113.
5. *Ibid.,* p. 113.
6. *Environmental Yearbook of China,* 1990 Edition, p. 31.
7. *Ibid.,* 1994 Edition, p. 43.
8. Qu Geping and Li Jinchang, *Population and Environment in China,* China Environmental Science Institute Publishing House, 1992, p. 37.
9. *Environmental Yearbook of China,* 1994 Edition, p. 43.
10. Qu Geping and Li Jinchang, *op. cit.,* p. 36.
11. *Environmental Yearbook of China,* 1994 Edition, p. 80.
12. *Ibid.,* 1995 Edition, p. 67.