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**Environmental  
challenges in China:  
determinants of  
success and failure**



# **Environmental challenges in China: determinants of success and failure**

Commissioned by  
The World Bank

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# Executive summary

*Air pollution remains a serious problem in China, but all things considered the situation is slowly improving. We discuss the reasons for this slow improvement, using lead, urban air pollution and ground-level ozone as examples. We find that general technological upgrading is a factor that explains much of the improvement. The upgrading originates with the liberalisation of the Chinese economy. Another important factor to explain the progress is greater awareness and greater willingness to prioritise environmental concerns among the Chinese public. This awareness has been stimulated by media attention, increased education and increased affluence.*

## Background

Air pollution is serious in China. Thousands of poor city-dwellers die every year from causes related to air pollution. Millions more are ill with pollution-related diseases. In rural areas, indoor air pollution is a major cause of death and disease. Other impacts of air pollution are less serious, but represent problems nevertheless. Examples include dust that reduces visibility in city streets and crops suffering from a lack of direct sunlight or increased exposure to ground-level ozone.

Despite chronic problems, the Chinese policy towards air pollution is not without successes. A few facts underscore this: Lead, once a main environmental threat, has been reduced almost to insignificance. Urban air pollution as measured by SO<sub>2</sub> and particulates probably peaked in the mid to late nineties. Since then emissions and ambient concentrations have been reduced. Although new problems on the horizon deserve attention, for instance ground-level ozone and NO<sub>x</sub>-emissions, there is little doubt that the Chinese are working seriously to reduce air pollution. Central leaders have gradually become more tuned in to environmental problems, and attention has increased in public policy as well as in the media and among the public. The ambition has moved from the simple and serious problem of lead to the subtle urban air problem and the even more subtle ozone problem.

## The problem

*What is it that explains the Chinese experience with tackling air pollution, and what might other countries learn from this experience?*

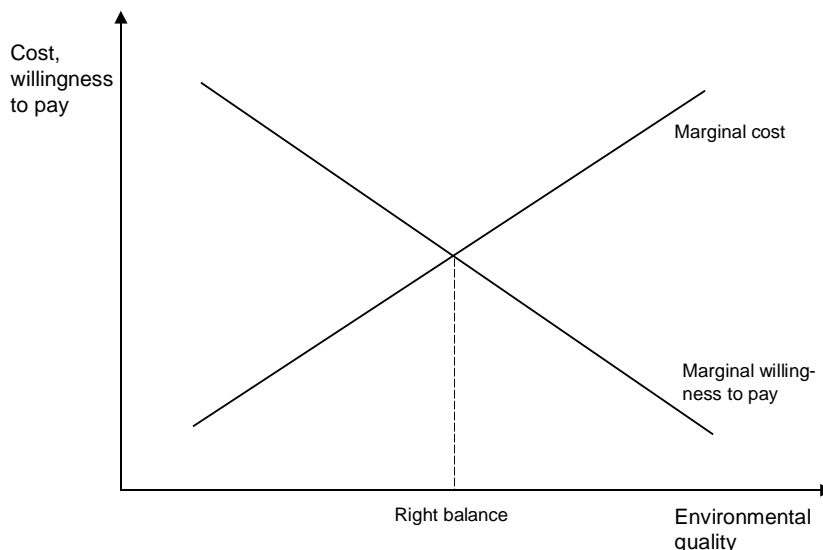
That is the question we pose in this report, which was commissioned by the World Bank as a background paper to the World Development Report 2003.

## The balancing act

In our view, Chinese environmental policy and Chinese policy outcomes at any point in time are best seen as consequences of a search for the right balance between environmental and other priorities. The search is imperfect and subject to conflict and power struggles, but when all is said and done the result gravitates around some sort of perception of right balance.

If Chinese environmental policy is the outcome of a search for a balancing point, it is important to explain what determines the balance. To this end we introduce the economic workhorse, the supply and demand diagram, see figure A. On the vertical axis we depict the cost of environmental actions in China, but also the willingness to pay for environmental actions. On the horizontal axis we depict the environmental quality of the country. We assume that this quality is measurable by some indicator.

*Figure A Striking the balance between environmental and other priorities*



We assume that at any point in time the marginal cost of improving environmental quality is increasing. This is to say that to take the first steps to improve the environment is cheap, but the steps thereafter are more expensive since the cheap solutions are in use. This seems to us a reasonable assumption.

We also assume that at any point in time the willingness to pay for environmental quality is decreasing. This is to say that most members of the public are willing to pay to improve the environment when environmental quality is low, but fewer are willing to improve it (as much) when environmental quality is high. This also seems a reasonable assumption.

Conceptually the right balancing point is the point where the marginal cost of environmental improvements equals the willingness to pay for environmental improvements. To the right of this point we find the measures that are too expensive to be deemed worthwhile. To the left we find the measures that are deemed worthwhile.

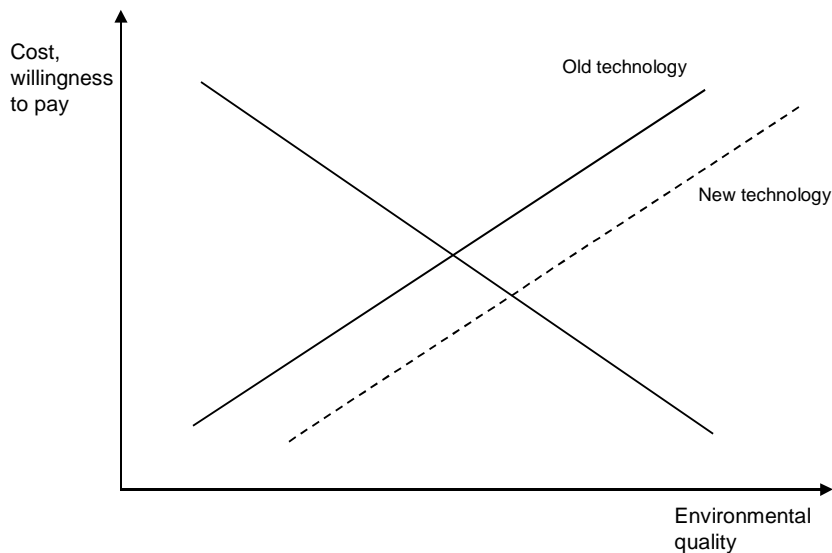
As one example of how Chinese environmental policy searches for the balancing point, consider the following quote from SEPA (2001):“..in the ninth five year period, the installation of sulfur removal facilities in thermal power plants was rather slow, largely because the manufacturing of the facilities was not satisfactorily localized and the prices were too high if they had to be imported.” Sulfur removal facilities, in other words, were considered worthwhile during the ninth five year plan (a host of analyses have called for the introduction of such facilities), but not worthwhile enough to defend the high price tag. They were to the right of the balancing point.

### Technology matters

What moves the balancing point over time? We have concluded that the Chinese are experiencing a moderate success in their fight to reduce air pollution in the sense that conditions are slowly improving and attention is moving from the immediately dangerous to the subtly unsafe. A reasonable interpretation is that the balancing point slowly swings in the direction of better environmental quality.

Most observers of Chinese environmental outcomes point to the essential role of technological improvement (see e.g., SEPA (2001)). Surely over the last decades the improvements in technology have been tremendous. In 1991 China’s power industry emitted 110 tons of SO<sub>2</sub> per million Yuan produced. By 1999 the figure was reduced to 24 tons. The chemical industry formerly emitted 7.1 tons per million Yuan, by 1999 the figure was down to 2.2 tons. The textile industry used to emit 2.3 tons per million, by 1999 it emitted 0.9 tons. Other industries report similar improvements.

*Figure B      Technological improvement and shifting the balance point*



In terms of the supply and demand diagram, the technological improvements make protection of the environment cheaper, as depicted in figure B. The reasonable response from society is to protect more of the environment – while also producing more ordinary goods. In fact, this is a valid interpretation of what has happened in China when it comes to urban air pollution: Society is a lot more productive and produces more than before, but since the peak in the mid nineties it has simultaneously paid more attention to the environment. Although the

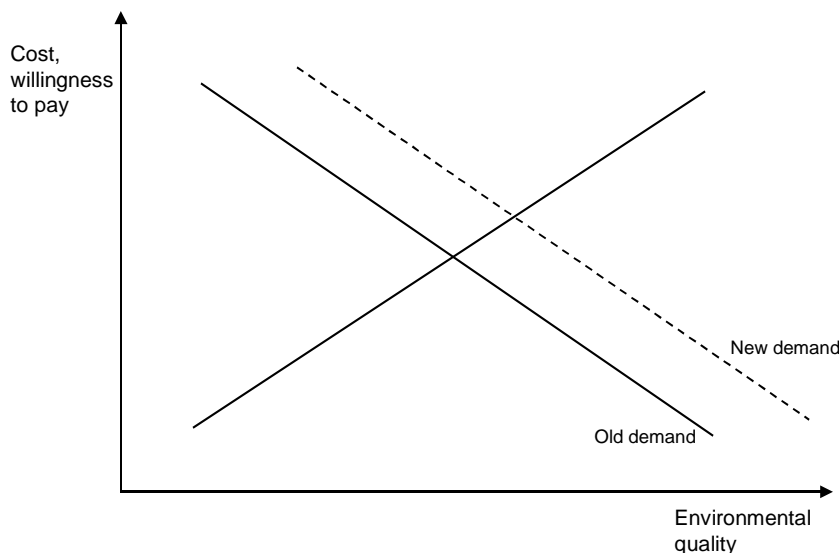
technological improvements are not environmentally motivated they have environmental implications.

### **A matter of preference**

The last decade, especially, has seen an increase in environmental awareness in China. The increased awareness seems to us to arise at all levels of society, from the central political leaders to the provinces and cities; from the media to the scientific community and further to the layman. According to a survey taken in early 2001 of 15,000 Chinese from all regions, 68 percent were willing to pay higher taxes to improve the environment. In another survey almost half the Chinese consider the environment among the country's top three social problems. In the early 1990s, research reports that the Chinese filed more than 130,000 citizen complaints annually to environmental authorities (Dasgupta and Wheeler, 1996).

The deeper reasons for the increased environmental awareness in the Chinese society may be found in the increased affluence of the Chinese citizens and an increased level of information and awareness that enters into a reinforcing loop with suppliers of information in the media. Of course the state of the environment also matters. Evidence to support this is found in e.g., Wang and Wheeler (1999). These deeper reasons are translated into increased demand for environmental improvements.

*Figure C      Increased demand for environmental improvements and shifting the balance point*



In terms of the supply and demand diagram, the increased willingness to pay for the environment induces more protection and more effort to improve the environment, see figure C. For instance, the tenth five year plan has among its priorities to install the sulfur removal facilities that were considered too expensive in the ninth five year plan. An important reason is that society is in a position to afford it now. Another reason, however, is that the cost of the technology is being brought down as the Chinese gain experience in producing sulfur removal equipment. To explain Chinese environmental changes it is necessary to invoke

both the supply and the demand side, i.e. both the technological advances and the increase in willingness to pay.

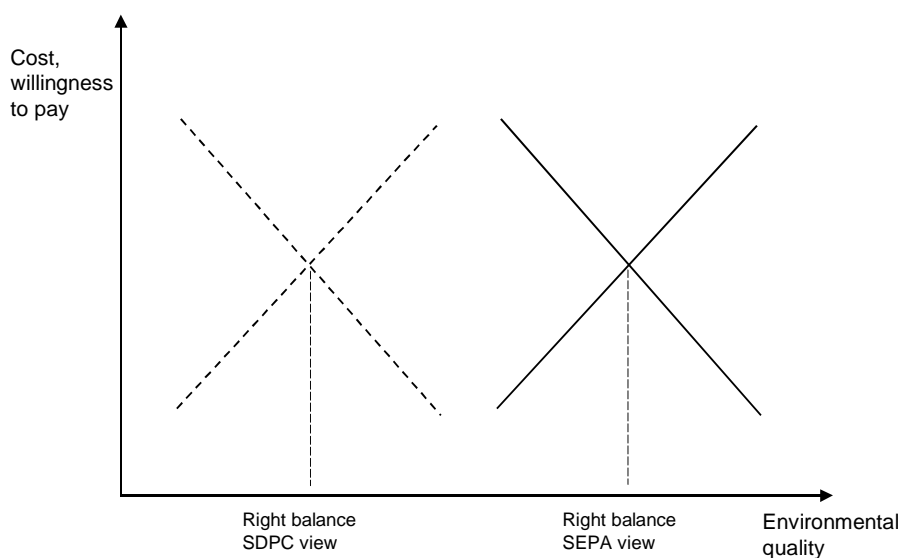
### How to find the balancing point

So far in our story we have assumed that the Chinese environmental policy outcome is gravitating around a balancing point, and that this balancing point is evolving through time. We hold this to be a better explanation than the alternative view that the balancing point stays the same, but the Chinese society has become better at estimating where it is.

That being said, it is not an easy task for any society to find where the balancing point is, and societies differ in how close to it they gravitate. In this situation one important condition for striking the right balance is to develop institutions that represent both (or more generally, all) sides of the coin and let them have a say. This is where other countries may learn from the Chinese experience.

In China there is a plethora of stakeholders wanting a say in environmental policy. At the national level, institutions responsible for industrial and pricing policy (e.g., the State Development and Planning Commission, SDPC) argue with institutions responsible for large, state owned enterprises (e.g., the State Economy and Trade Commission), who argue with the Ministry of Foreign Affairs etc. The State Environmental Protection Administration (SEPA) is another player, and the one with overall responsibility for the environment. All these institutions double at the provincial and county levels, creating a complex matrix of state-sponsored interests. In addition, Chinese society, like most societies, include stakeholders from the media, the scientific community and the society at large.

*Figure D The world according to different stakeholders*



It would be unreasonable to say that any of the stakeholders in China *only* considers their own narrow interests. They all try to keep a balancing act in mind. But the view of where that balance is, varies considerably from one stakeholder to the next. In figure D we have in a stylised way included “the world according to SDPC” (representing industry interests) and “the world according to SEPA”



(representing environmental interests). These institutions typically try to pull the accepted view of the right balance in their own direction. The challenge for China (and other countries in similar situations) is to find a social mechanism that aggregates the unbalanced views of these institutions into a reasonable balance of interests for society as a whole.

To design a sensible social mechanism is not simple. But in this work we have found a few things that an environmentally inclined stakeholder (either in SEPA or an environmentalist among the central leaders) should do if he or she wants to change the overall balance in his or her direction. Given that the problem is that the environmental interest is too weak, the perspective of an environmentally inclined stakeholder should be an interesting one:

An environmentally inclined stakeholder should move the signposts in his direction. By this we mean that he or she should create focal points that in effect define the least acceptable environmental quality, or define certain practices as unacceptable. In the Chinese case the decision to enter the WTO was such a signpost-moving experience. By entering the WTO Chinese industries that wish to compete abroad will have to follow ISO 14000 standards for environmental performance. Industries competing at home will have to “innovate or die”, which will continue the technological upgrading that benefits the environment. Of course WTO membership carries negative environmental implications as well, and the purpose here is not to carry out the overall analysis of its environmental impacts. The purpose is rather to argue that WTO was a non-reversible decision that forever changed the rules of the game with respect to the environment/economy trade off in China.

As another example, the decision a few years ago to publish monitoring data for air quality in major cities has hit a nerve with the public and changed the rules of the game with respect to environmental awareness and emphasis on environmental issues. The point here was to tap into public concern for the environment, play the public card so to speak. If the public puts a higher preference on the environment than the balance that emerges in the policy process, playing the public card will give the environmentally inclined stakeholder a powerful hand.

# 1 Introduction

Air pollution is a major public health concern in China: In 2001, 67 percent of all cities failed to meet the Class 2 criteria for the People's Republic of China, and 40 percent had one or more pollutant with a concentration higher than Class 3 (SEPA, 2001)<sup>1</sup>. Furthermore, the country's citizens are increasingly concerned with the poor state of their natural environment: A survey in early 2001 of 15,000 Chinese from all regions found that 68 percent were willing to accept higher taxes for a cleaner environment. 49 percent declared that environmental protection is China's greatest problem, followed by crime, overpopulation, unemployment, education and social insurance<sup>2</sup>. The government, however, does not always seem to want to admit to the gravity of the problem. For instance, officials in the environmental agency claimed in an official report in 2001 that "The total amount of air pollutant discharge has been effectively controlled" (SEPA, 2001, pp.5).

It is the intention of this paper to look at the present state of certain types of air pollution in China and to analyze the reasons why some problems have been tackled and others not. To this end, we identify three environmental problems, with different characteristics, solutions and policy implications. One is a problem that has been addressed and has been at least partially solved. This is the case of phasing out leaded gasoline. Another is a problem that has been addressed, but that has not been solved: Urban air pollution (we will focus on PM<sub>10</sub> and SO<sub>2</sub>) is perhaps the most serious environmental challenge China is facing. A third is a problem that has not been addressed although it deserves attention. We will here be discussing ground-level ozone. For each of these problems we identify key factors behind the success, failure, or inattention<sup>3</sup>. Finally we synthesize common tendencies among these factors, and attempt to answer the following questions: Which are the driving forces behind the way in which China handles environmental issues? Why have the problems of lead, urban air pollution and ground-level ozone been treated so differently?

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<sup>1</sup> Class 2 is stricter than class 3. For instance, the total suspended particulates (TSP) limit of class 3 is 0.30 mg/m<sup>3</sup>, while the class 2 limit is 0.20 mg/m<sup>3</sup>. For SO<sub>2</sub> the class 3 limit is 0.10 mg/m<sup>3</sup> and the class 2 limit is 0.06 mg/m<sup>3</sup> (SEPA, 2001).

<sup>2</sup> From Beijing Environment, Science and Technology Update, June 1, 2001, found at <http://www.usembassy-china.org.cn/english/sandt/index.html>.

<sup>3</sup> Note that although we use terms like success and failure, the solution to these problems do not always come about as a result of a specific policy (in which case one could have talked about a successful policy) but rather as a result of exogenous changes, e.g. in the demand for energy.

## 2 The story on lead

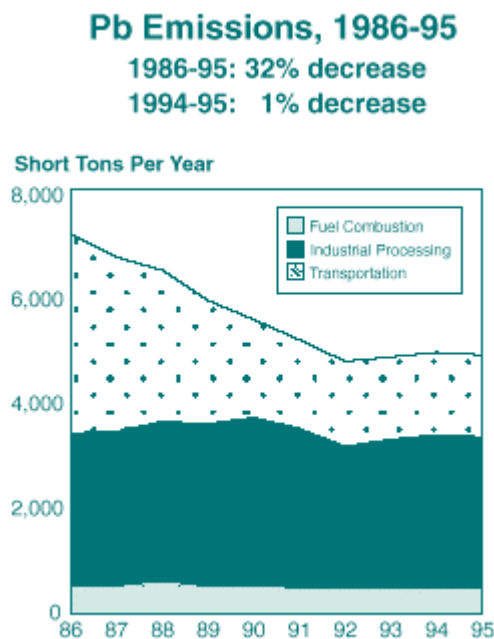
### 2.1 Benefits, costs and emission trends

#### Benefits and costs of reducing emissions to air

The impact of lead on human health is no longer questioned: Through air emissions, lead enters the blood and causes cardiovascular diseases, neuro-behavioral effects and IQ loss in children, and increases mortality. Importantly, lead seems to be harmful at all levels of exposure (no lower threshold limit). Thus, lead can be characterized as an obvious and high-priority environmental problem, at least from a public health perspective.

A primary source of emissions of lead is leaded fuel. Figure 1 shows how overall lead emissions in the US have decreased with the decrease in emissions from motor vehicles.

Figure 2.1 Lead emissions in the US



Source: <http://www.epa.gov/lead/403ea.pdf>

Due to evidence that gasoline was a major source of lead emissions, developed countries decided to limit lead contents. After the EU reduced the limit on the maximum allowed level of lead to 0.15 g/l in 1986, urban air lead levels in London were halved in the course of just a few months (Wilkinson, 1999). Introducing unleaded fuel was the subsequent step, and studies were undertaken in England to measure the decrease in blood lead levels. One study found that compared to the period before unleaded fuel had been introduced, blood lead concentrations had fallen by up to 80 percent in British children (Wilkinson, 1999).

There is a general consensus that the benefit-cost ratio for eliminating lead from gasoline is overwhelmingly positive. In the US, the benefits have been estimated to outweigh costs more than 10 times (Lovei, 1998). Furthermore, with the exception of the fairly large capital investments upfront in gasoline pumps, the switch can be implemented at modest costs (USD 0.01-0.03 per liter) (OECD/UNEP, 1999). In fact, many argue that switching to unleaded fuel pays off even if environmental concerns are not taken into consideration, since cars running on unleaded fuel require much less maintenance than those running on leaded gasoline. Finally, the technical aspects of switching to unleaded fuel are easy to understand, making the policy easy to implement.

Note, however, that the success of different countries in introducing unleaded fuel depends on certain features of their vehicle fleet: For one, a slow turnover slows down the process of adopting the new fuel type. Similarly, introducing unleaded fuel before introducing catalytic converters (that require unleaded fuel) takes away one of the incentives to switch. However, as we will see, despite both of these conditions being present in China, the country managed to go through with the policy quickly and efficiently.

### **The change in emissions of lead over time in China**

Ambient levels of lead is not systematically monitored in China and the trends are not known (World Bank, 2001). Thus, the evidence that lead emissions are significant and constitute a problem in China is limited to isolated studies and estimates. For instance, SEPA estimates that in the 1980s, approximately 15,000 tons of lead were discharged into air and water (SEPA, 2001). Some research has been done on the sources for these emissions: Researchers estimated that in 1997, 65 percent of the lead in Beijing's air came from gasoline<sup>4</sup>. Finally, as we refer to in the next section, some studies were undertaken of the health effects of lead on Chinese children. Thus, it is probably safe to say that despite the lack of systematic data, Chinese authorities have known about the problem and have been forced to act in order to control emissions.

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<sup>4</sup> From <http://www.usembassy-china.org.cn/english/sandt/leaddoc.htm>

## 2.2 Regulatory developments

### The origin: Developments at China Petro-chem

In Western countries, the dangers of lead emissions became evident in the 1970s and 1980s, and spurred research into the possibilities of reducing lead levels in gasoline. China followed with a few years lag. The first sign that China was concerned with lead emissions came in the 6<sup>th</sup> five year plan (1981-85). In this plan, the company China Petro-Chem organized a “key program on fuels and lubrication oils”. The motivation for this program is not known to us, but scientific evidence and developments taking place in other countries probably showed the company and Chinese authorities where the wind was blowing. The program would probably not have been implemented unless the company anticipated a demand for e.g. unleaded fuel, and it is likely that somebody in the policy environment informed the company of the new directions in the government’s fuel program. During the 8<sup>th</sup> five year plan (1991-95) China Petro-Chem put forward a suggestion to increase the share of unleaded gasoline in total gasoline sales. This suggestion was reflected in the Revision of the Air Pollution Control and Prevention Law that the National People’s Congress passed in 1995. Article 38 of the revision stipulates that the state should encourage and support the production and utilization of high-grade unleaded gasoline and limit that of leaded gasoline. The revision of the law gave the efforts to reduce leaded fuel a backing in a high-level authority. This is important in a country like China where the vertical line of responsibility is very strong.

Foreign authorities also involved themselves in this process: The World Bank has called for the complete phaseout of lead in gasoline in developing countries, and the US EPA actively got involved by sponsoring a workshop in Beijing that took place in October 1995. The workshop provided recommendations to the Chinese government on fuels, leaded gasoline phaseout, emissions controls, and transportation planning. According to the EPA, their cooperation has been instrumental in China's adoption of legislation calling for the phaseout of lead in gasoline. EPA has continued to work closely with SEPA and other organizations on implementing regulations, and organizing training workshops on mobile sources control and lead phaseout<sup>5</sup>.

Although developments were taking place before, it is 1997 that turned out to be the watershed year in China’s efforts to control lead emissions. That year, Chinese media provided reports that lead poisoning was a serious health problem that needed to be studied thoroughly. In the same year, a health news magazine (Jiankang Bao) reported that 70 percent of Beijing’s children had lead levels exceeding the standard set by the First World Child Lead Poisoning Prevention Conference (<http://www.usembassy-china.org.cn/english/sandt/leaddoc.htm>). Also in 1997, a symposium sponsored by SEPA, the US EPA, the World Bank, and the WHO, General Motors and other car manufacturers, was organized in Shanghai to discuss and debate whether and how to eliminate lead from gasoline. It is noteworthy that only one year later, Chinese authorities implemented their push for phasing out leaded gasoline.

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<sup>5</sup> From <http://www.epa.gov/oia/prchina.htm>

## **The phase-out program: The State Council and SEPA**

In order to carry out the policy measure of phasing out lead, the State Council undertook efforts on several fronts:

- SEPA was asked to draft the formal regulation that would eliminate leaded gasoline by the year 2000. (SEPA, 2001). SEPA was also asked to organize the 12 ministries that would be affected by the measure in order to establish a National Coordinating Team for the Elimination of Leaded Gasoline. SEPA's role was strengthened after it took on responsibility for controlling vehicle emissions in 1998 (ERM, 1998).
- Subsequent to the conference in 1997, a vehicle industry policy was issued that required all new cars to be able to run on unleaded gasoline (or diesel if more than 5 tons) from 2000.
- An important industrial policy instrument in China is to close down inefficient factories. As part of the program "Close Down of 15 Kinds of Small Scale factories" issued by the State Council in 1997 and 1998, 3849 lead/zinc mining enterprises were closed down. (We discuss this and related policies later).
- In 1997, the Beijing Municipal Government issued a notification that the sale of leaded gasoline would be prohibited from 1998. Similar notifications were made in Guangzhou and Shanghai. It is a common procedure in Chinese environmental politics to try out new regulations in a few select sites before they become national regulations.
- Gasoline in China is sold at approximate U.S. prices. During the phase out trials, the price of unleaded gasoline was subsidized to match that of leaded gasoline.

After these trials and preliminary developments, in September 1998 the State Council issued the regulation that phased out lead at a national level. Called *Notification on the deadline of production, sales and consumption of leaded gasoline* it required the whole nation to stop producing leaded gasoline from January 1, 2000, to stop selling leaded gasoline from July 1, 2000 and to stop producing vehicles using leaded gasoline from July 1.

### **Enforcement**

All evidence indicates that the measures to phase out leaded fuel have been complied with in general. The regulation reportedly did not meet much resistance from vehicle owners (who, after all, did not have to pay more for the gasoline), nor from gasoline retailers (<http://www.usembassy-china.org.cn/english/sandt/-leaddoc.htm>). However, it has been pointed out that some vehicle owners have been complacent and waited until an inspection before making the necessary changes. This attitude is not particular to leaded fuel or to China, and may be expected to become less widespread as enforcement increases and environmental consciousness in the Chinese society develops. Although enforcement may be a weak point in Chinese environmental politics in general (we will get back to this later), laws exist at least in theory for how to prosecute those not complying with lead standards: When the ban on the sale of leaded fuel was introduced in Guangzhou, local authorities mandated that any petrol station found to be selling

leaded gasoline face a fine of RMB 10 000, and that the leaded fuel was to be confiscated (ERM, 1998).

## 2.3 Why a rapid phase out of lead emissions?

The phasing out of leaded gasoline in China can be said to have been a success. Once the authorities had decided to go ahead with the policy, it was implemented and complied with quickly. SEPA (2001) states that “at all levels, especially in big cities, great importance has been attached to vehicle emission problems” (pp.61) and that standards are becoming increasingly stricter. The success of this policy can be traced to several factors:

One is related to the costs and the benefits of the measure. As previously noted, the general consensus is that the benefits of phasing out leaded fuel well outweigh the costs of doing so. In the Chinese context, domestic costs and domestic abilities were key: The breakthrough in controlling lead emissions from cars came when domestic producers reported their ability to produce the unleaded fuel on the one hand and vehicles able to run on such fuel on the other.

Another reason is related to the fact that emissions of lead were largely concentrated in a single source; gasoline. This made the problem tractable and policies more manageable. It was also significant that the largest part of the car fleet consisted of trucks and buses that used low-octane, no-lead gasoline. Thus, the switch only concerned private cars and the operation was consequently smaller in nature. The concentrated nature of the source probably also contributed to the authorities’ success in implementing what amounted to a traditional command-and-control policy. It is clear from the way in which policies developed that even in a “simple” case like this, reaching an agreement and carrying out policies is a very complicated process in the Chinese context.

Third, China adopted a learning-by-doing approach by having certain cities pilot the switch to unleaded gasoline (Beijing, Shanghai, Nanjing and Guangzhou). There is general agreement about the importance of the pilot program for the policy’s successful implementation and that one of the main drivers in accelerating the speed with which the change took place was the successful experience of these larger cities. It is also important to point out that, due to the poor state of the road infrastructure at that time, the car fleet was mainly clustered around the provincial capitals. This again may have made the policy easier to carry out.

Fourth, and related to the above point, the phase-out may have benefited from the dirigiste nature of the Chinese economy. Imposing a no-lead policy on the production of gasoline was simplified given that the oil refining industry is centrally planned (80 percent of all gasoline in China is produced by Sinopac).

Fifth, the coordination of 12 ministries into the National Coordinating Team for the Elimination of Leaded Gasoline probably was an important policy development. A general feature of policy making is that it is difficult for different ministries to agree on policies with environmental implications, and to collaborate in the implementation of these. This is a problem in most countries but especially

pronounced in China. It is probable that the effort to involve all relevant decision makers helped make this a success story.

Finally, the example of other countries must be said to have been important. The fact that richer countries in Europe and the US led the way in phasing out lead probably served as an inspiration, and if not, at least it helped push down costs and relay information about the benefits of a lead phase-out in China. In fact, Japan was the first in achieving a phase-out of gasoline (in 1980). Germany, the US and other countries followed in the mid-1990s. China was probably also able to go through the phase-out more quickly because they could learn from the mistakes made previously in Europe and the US: It took the Chinese four years to do what the US had spent 10 years achieving.



## 3 Urban Air Pollution

In this section we discuss urban air pollution as expressed by concentrations of SO<sub>2</sub> and PM<sub>10</sub>. These are representative of urban air pollution problems anywhere in the world and are the most serious urban health threats in China (World Bank, 2001). However, nuances exist between the two in terms of their trend in emissions and the policy responses they have provoked. These nuances will be pointed out in the text when appropriate.

### 3.1 Benefits, Costs and emission trends

#### Benefits and Costs of reducing air emissions

Emissions of SO<sub>2</sub> and the related problem of acid rain are issues that have received a lot of attention in the Western world in the past 20 years. As with pollution more generally, China and other developing nations have only recently put the problem on their agenda. This is partly due to the fact that SO<sub>2</sub> pollution tends to mimic the course of a country's economy: only as it grows do these emissions become noticeable. In fact, SO<sub>2</sub> emissions related to income tend to follow the *environmental Kuznet's curve*, with emissions first increasing and then decreasing as GDP per capita increases. Some studies estimate maximum emissions to occur at a GDP per capita of USD 1,200 (World Bank, 1992), others estimate the peak at USD 4000 (Grossman and Krueger, 1995)<sup>6</sup>. It is believed, however, that China has managed to turn the trend already, and that sulfur emissions have been decreasing since the mid 1990s (Nygard, 2000).

Particulates, whether measured as TSP or the finer PM<sub>10</sub>, is a more recent item on the policy agenda, both in China and elsewhere, and peaks at a higher level of GDP/capita. It is a serious form of air pollution in China. Thus, it is expected to increasingly become the focus of environmental authorities, especially in the big cities in China. In fact, SEPA (2001) proposes to shift the focus of air pollution to PM<sub>10</sub>, both in terms of regular measurements and control on emissions.

The aims of this section are to describe China's experience with SO<sub>2</sub> and PM<sub>10</sub> emissions and to assess the success with which it is dealing with the problem.

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<sup>6</sup> Note, however, that in a recent paper by Stern & Common (2001), sulfur emissions are shown to have a much higher turning point when non-OECD countries are included in the sample and that the global emissions-income relationship essentially is monotonic.

Please note that we here limit our discussion to the urban dimension of SO<sub>2</sub> (and particle) emissions. That is, we look at urban sources and the effect on the urban population, and exclude SO<sub>2</sub> emissions more generally as well as the problem of acid rain. This is due to our wish to focus our discussion on urban air pollution<sup>7</sup>. Also note that of the two, SO<sub>2</sub> emissions receive relatively more attention in this paper, simply because more information is available.

Both PM<sub>10</sub> and SO<sub>2</sub> emissions in China are costly in terms of their effect on human health. How costly is highly uncertain. According to one estimate, 4000 people in Beijing die annually from respiratory diseases related to SO<sub>2</sub> emissions. The corresponding numbers for Chongqing and Shanghai are 4000 and 1000 respectively. (See e.g., Dasgupta, Wang and Wheeler, 1997). A number of studies, both at the macro (e.g., World Bank, 1997) and micro level (e.g., Aarhus et al., 1999; Aunan et al 2002) estimate the benefits of SO<sub>2</sub> and PM<sub>10</sub> reduction in China to far outweigh the costs.

### **The Change in air quality and emissions over time in China**

When commenting on the Year 2000 State of the Environment report, Environment Minister Xie Zhenhua said that “the trend of worsening environmental pollution in China has been “basically” brought under control”<sup>8</sup>. This guarded statement illustrates both the progress and the remaining challenges of Chinese air pollution policy. SO<sub>2</sub> is a good example: Overall, SO<sub>2</sub> levels in China have been reduced since 1995. Furthermore, the number of cities whose annual average SO<sub>2</sub> concentrations exceed national Class 2 standards decreased from 39 to 28 percent between 1990 and 1999. However, SO<sub>2</sub> emissions overall have increased 3.8 percent relative to 1991 levels, and the problem is far from solved (SEPA 2001). For instance, air quality is getting worse in many small cities and counties of China. To quote SEPA (2001): “The industrial enterprises in rural areas, especially those of raw material production, have brought the air pollution to areas that have little air pollution before.”

Considerable doubt exists over the reliability of Chinese SO<sub>2</sub> (and TSP) emission data. For instance, Aunan et al. (2002) have examined SO<sub>2</sub> emissions in Shanxi province, China’s main coal producing province and a major source of its SO<sub>2</sub> emissions. Official figures (NBS, 1999, 2000) put Shanxi industrial SO<sub>2</sub> pollution at 700 000 tons in 1997, and 1.1 million tons in 1998. This in itself is suspicious. According to Aunan et al. however, average Shanxi emissions for the years 1995-1997 is better put at 1.5 million tons with a constant trend. This is 40 per cent larger than the official 1998 figure and 115 per cent larger than the official 1997 figure. In informal conversations some observers express doubt that actual emissions are as small as SEPA claims them to be since SEPA is the center of administrative reporting as opposed to technical reporting, which we interpret to mean outsider versus insider reporting. We have also heard the claim that the

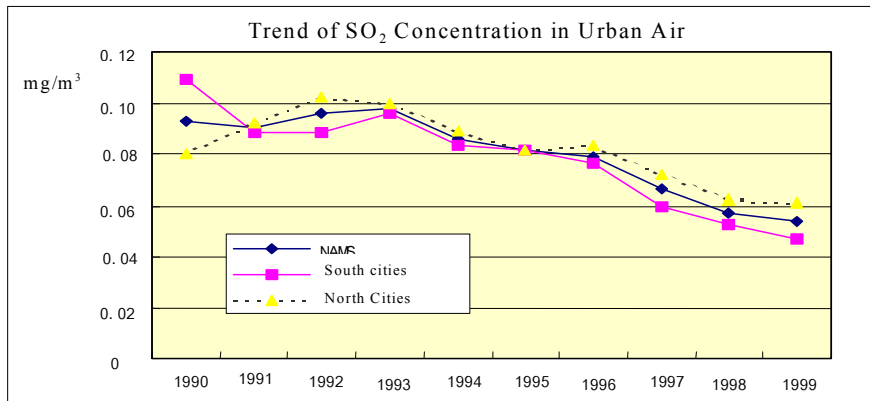
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<sup>7</sup> The problem of acid rain resulting from SO<sub>2</sub> emissions from power plants has a regional and even international dimension (although less so in China: 90 percent of acid rain produced in China is believed to remain within China (Angell, 2000)); the cause of the problem and its impacts may be geographically dispersed and thus introduce us to a whole different set of issues. We return to regional issues when we discuss ground-level ozone below.

<sup>8</sup> From China’s Year 2000 “State of the environment” report (U.S. Embassy, 2001).

emission reductions coincide with a change in base of the Chinese SO<sub>2</sub> levy from marginal to total emissions. A similar doubt surrounds figures for other pollutants such as carbon dioxide<sup>9</sup>.

Figure 3.1 Trends in SO<sub>2</sub> concentration in urban air



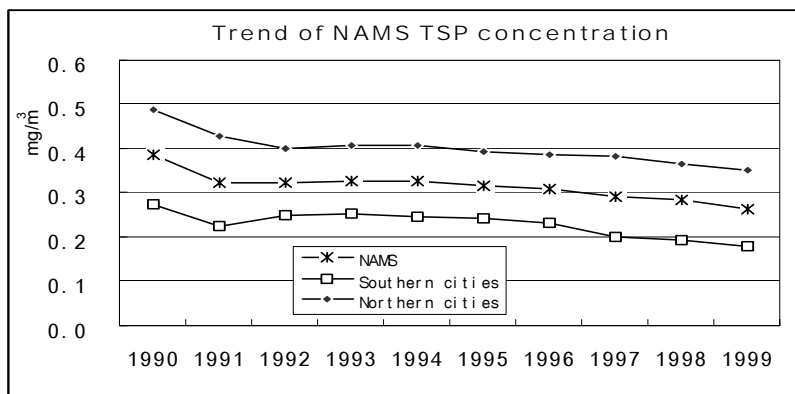
Source: Adapted from SEPA (2001), which cites China National Environmental Monitoring Center (NAMS). Note that the figure shows an average of large and medium/small cities. The concentration in large cities is on average double that of this graph (SEPA, 2001 table 1.7)

When it comes to particles, a problem is that systematic data for PM<sub>10</sub> do not exist. However, based on correlations between PM<sub>10</sub> and TSP (a broader measure of particulates, and one that is less harmful to human health), one has been able to determine that PM<sub>10</sub> is the most important air pollutant in China, both in terms of frequency and range of violations of national standards (World Bank, 2001).

Measurements of TSP (often in terms of “soot” and “dust”) are more common than those of PM<sub>10</sub>: The average concentration of TSP decreased by around 30 percent in the 1990s, and SEPA (2001) claims to have “reduced significantly” the problem. However, many cities still suffer from serious particulate pollution: In 1998, the annual average concentration of TSP in urban districts of Beijing exceeded Class 2 of the National Standards for Air Quality by 89%. The fact of the matter is that particle matter is still a largely uncontrolled pollutant.

<sup>9</sup> Reports that China’s energy output has fallen 17 percent since 1996, while GDP grew 36 percent, and that energy efficiency has been increased by 50 percent have been questioned. In the July 27, 2001 issue, Beijing Environment, Science, and Technology Update reports that “there is good reason to believe that the reported energy efficiency gains have been greatly exaggerated”. The Update claims that Chinese official statistics are “notoriously unreliable and subject to political manipulation at all levels”. IEA officials claim that the fall in total energy production is closer to 5-8 percent since 1996.

Figure 3.2 Trends in TSP concentrations in urban air



Source: Adapted from SEPA (2001), which cites China Environmental Monitoring Center (NAMS). As for SO<sub>2</sub> the figure shows an average for large and small cities, but this time the difference is not that large.

By international standards China's experience with particulates is worrisome: According to the WHO, in 1995 five Chinese cities were on the top-ten list of cities with the worst TSP pollution<sup>10</sup>. The trend is equally disturbing: whereas TSP levels in e.g. Mexico City are decreasing, albeit slowly, they are on the increase in many Chinese cities<sup>11</sup>.

## 3.2 Regulatory Developments

Since particle matter is largely uncontrolled, we focus in this section on the driving forces behind the attempts at controlling SO<sub>2</sub> concentrations.

### The origin of SO<sub>2</sub> regulation:

When SO<sub>2</sub> emissions were recognized in China the scientific community in Europe and the US had already recognized the problem and knowledge was spreading quickly. Heated public debates regarding acid rain and international responsibility were taking place in the media worldwide. Thus, one can say that the impetus to controlling this pollutant came from a combination of the international recognition of SO<sub>2</sub> emissions as a serious pollution problem and the growing local realization that China's population was beginning to suffer from it.

### The measures to control SO<sub>2</sub>:

The policy to control SO<sub>2</sub> in China consists of specific measures that are embedded in a legal and institutional policy framework. Three important aspects of the policy framework are the following:

1. The first air pollution control law went into effect in 1987, and a trial system for levy collection in two provinces was approved in 1992. However, SO<sub>2</sub> emissions were only comprehensively dealt with in the plan for Total Emissions Control of Major Pollutant Discharge (TEC). TEC was approved by the State Council in 1996, and established

<sup>10</sup> From <http://www.usembassy-china.org.cn/english/sandt/index.html>

<sup>11</sup> From [http://www.who.int/environmental\\_information/Air/Guidelines/Chapter2.htm](http://www.who.int/environmental_information/Air/Guidelines/Chapter2.htm)

nationwide goals for the control of major pollutants by the year 2000 (e.g., ECON, 1999). TEC changed regulatory focus from concentration-based control (i.e. concentration in the waste stream) to mass-based control.

2. The amended Air Pollution Prevention Law was passed in April 2000. This law incorporates goals on the reduction of SO<sub>2</sub> emissions, including total volume control for each province (SEPA, 2001). Approval is not to be given to any new coal-mining project, and for existing mines, depending on the sulfur content in the coal, some are to be closed down while others are to limit their production. Furthermore, desulfurization facilities are to be installed, or the coal has to be washed to lower the sulfur content.
3. Another policy that aims to curb SO<sub>2</sub> emissions is the Program for Acid Rain and Sulfur Dioxide Control Zones. Under this program the 11.4 percent of Chinese territory that is responsible for 60 percent of SO<sub>2</sub> emissions, have been designated as control zones for acid rain and SO<sub>2</sub>. The target for these zones is to reduce their SO<sub>2</sub> emissions to 1990 levels by 2010<sup>12</sup>.

The measures taken with the support of this framework include the following, from the general to the specific:

- *Restructuring and general technological upgrading.* There is no doubt that general technological upgrading has been the major cause of reductions in SO<sub>2</sub> emissions in China, and also the major cause of the (smaller) reductions in particle emissions. SEPA (2001) gives ample evidence, some of which we cite here<sup>13</sup>. SEPA distinguishes between three components of the upgrading process:
  - √ One component is industrial restructuring. Six industrial sectors, known as the *dirty sectors*, are responsible for the bulk of coal consumption and thus air pollution in China<sup>14</sup>. Their importance in the Chinese economy decreased from 31 percentage of production in 1993 to 28 percent in 1998. This is a three percentage points, and ten percent decline over just five years.
  - √ Another, and maybe more important component is technical upgrading within important industries. For instance, the SO<sub>2</sub> intensity in the power sector declined from 110 tons per million yuan in 1991 to 25 tons in 1998! (note that we do not have access to data quality statements regarding this statistics.) Comparable but less extreme improvements are reported for other industries. In a similar vein, the western part of China, having the least modern technology and the poorest population, bears

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<sup>12</sup> From <http://www.harbour.sfu.ca/dlam/newsletters/9804.html>

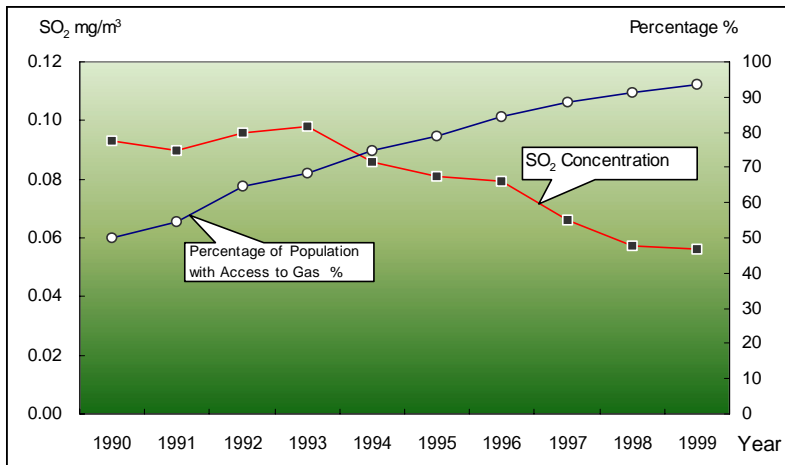
<sup>13</sup> For the experience prior to 1993, see Garbaccio, Ho and Jorgenson (1999). Their main thesis is that technological upgrading within industries is the main source of energy efficiency improvements and thus emission improvements until that point. Macro-economic composition effects actually increased emissions in their sample.

<sup>14</sup> The six are power, construction materials and non-metallurgical products, black metallurgical and pressing processing, coal mining and selection, chemical materials and products, oil processing, and coke refinery.

more than its proportion of SO<sub>2</sub> emissions. The richer eastern part bears less than its proportion of emissions.

- √ Fuel switch is the third major component. Many of the major cities in China have introduced town gas and electricity instead of coal as the major fuel source of restaurants and urban households. (Some switching to low-sulfur coal has also occurred.) Figure 4 indicates that this policy has been highly successful:

*Figure 3.3 Trends in SO<sub>2</sub> concentrations and town gas access in key cities*



Source SEPA (2001). The term “key cities” is not explained in the source.

- *General economic and industrial policies.* The upgrading of technology and industrial restructuring has been part of the general Chinese growth process. In addition, price reform has encouraged energy efficiency: The subsidy on coal was reduced from 37 percent in 1984 to 28 percent in 1995, and has since been further reduced. The subsidy for gasoline was reduced from 55 percent in 1990 to 2 percent in 1995. Things are different for the third part of the package, the introduction of town gas. Town gas requires heavy public investment, an investment that to a large extent has been motivated by environmental concern. This development is therefore not a by-product of the growth process but rather the product of intentional (environmental) policy.
- *Environmental management standards and emission standards.* China released several new emission standards and environmental management standards in 1996, with a warning that enterprises that did not meet the standards by year 2000 would be closed down. Besides, a campaign was launched in 1996 to close down “15 kinds of small scale enterprises” immediately. (The standards and the campaign addressed several environmental discharges besides SO<sub>2</sub> and TSP). We discuss the implementation of this policy below.
- *The China Trans-Century Green Project Program.* This huge investment program, although not a regulatory measure to control sulfur emissions, has nevertheless had implications for these emissions. It consisted of 1591 environmental projects in the first phase from 1996-2001, and was intended to complement the Total Emission Control program and ensure that targets were met. Most of the projects were sulfur removal projects and wastewater treatment projects. We discuss the implementation of this plan below.

- *The pollution levy system.* Polluters of, for instance, SO<sub>2</sub>, have to pay an emission levy in China. The pollution levy system is one of the “three old systems” for pollution control that were set up between 1973 and 1981. It is therefore quite an old system, although the detailed rules on the base of the levy etc. have changed over the years. See, e.g., Wang and Wheeler (1999) for more details. Recent reviews of the effectiveness of the pollution levy system tend to be much more favorable than older reviews. In particular, Wang and Wheeler (1999) find that the levy has a significant impact. Using data for 3000 factories in year 1993, they find that discharges of TSP decline 0.65 percent for each one percent increase in the levy, a significant impact. Still, it is generally thought that the levy is quite low compared with the damage cost of pollution. The pollution levy system may be equally effective on the revenue side. It helps finance the environmental protection bureaus (EPBs) that are the main regulatory bodies for environmental issues throughout China. A stable revenue source for these bodies is probably important for independence. The levy also helps finance environmental investments in enterprises, and the revenue not used by the EPBs is recycled back to the enterprises.
- *Public awareness and participation.* China has a tradition for using campaigns and competition as an incentive for leaders and a tool for awareness among the public. Currently cities may strive to gain the title of “National Model City for Environmental Protection”. Two of the criteria to meet are to have an urban gasification rate of more than 90 percent, and to spend more than 1.5 percent of city gross product on environmental investments (see, e.g., ECON, 1999). Recently, major Chinese cities have started to publish monitoring data of ambient air quality. This is another way of raising public awareness. The impartiality of computer monitoring is cherished: An advisor for Beijing’s 2008 Olympic bid recently told local journalists, “Beijing had twice as many good or better air quality days in 2000 as in 1998!” Detecting journalistic skepticism, she declared, “Records are kept by continuous computer monitoring – they can’t be faked!” (Beijing Environment, Science and Technology Update, 2001) [March 23.]

## **Enforcement**

As we have seen, Chinese authorities have had a variety of instruments at their disposal for controlling SO<sub>2</sub> emissions. In theory they are to impose fines on those that do not comply with the regulations. But the government reportedly has not enforced its own rulings very effectively, especially in poorer regions like Shanxi<sup>15</sup>. Poor enforcement also characterizes the regulation of coal mines. In both cases, enforcement is rendered more difficult by the structure of the Chinese administrative system: The central authorities set the goals and instruct the provinces in how to implement measures, but have little control over the process. Stories of coal mines or power plants being shut down only to reopen a few weeks later are commonplace. Furthermore, the incentive structure of local government officials is complicated and counterproductive to the efficient implementation of environmental policies.

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<sup>15</sup> From China Energy Efficiency Information Bulletin, October/November 2001, Vol. 7, No. 3 (<http://www.pnl.gov/china/bulle7-3.htm>).

In what follows, we discuss in more detail the enforcement of the three policy measures *standards and close-down of factories*, *the green project programme* and the *pollution levy*.

### **Standards and the close-down of factories**

The stricter environmental standards were given in 1996 with a deadline at the end of year 2000. In particular, factories that did not meet the standard were to be shut down. Aspects of this policy have been evaluated in various documents from the U.S. embassy in Beijing.

According to China's Year 2000 "State of the Environment" report, more than 90 percent of the 283 000 industrial enterprises across the country met the standards by the time limit, including 85 percent of the 18 000 large enterprises that were responsible for two-thirds of total emissions. U.S. Embassy (2001a) [China's year 2000 "State of the environment" report] remarks dryly that "these are the same numbers SEPA reported last September [that is September 2000], even though several provinces claimed to have undertaken dramatic crackdowns on polluting firms in the last part of 2000." A January 2001 article in the China Daily says that "some 28 000" enterprises failed to meet the standard, i.e. exactly ten per cent of the total. This article also informs that 520 large state owned enterprises have been given a two year stay of extension of the deadline. The reason was fear for employment and the local economies.

The U.S. embassy (2001b) [Ninth five-year plan environmental report card] gives an interesting account of the process leading up to these developments:

"In some cases, these success rates were the result of dramatic (and perhaps implausible) fourth-quarter rallies. For example, a SEPA inspection team that visited Hainan in August 2000 reported that less than half of key enterprises there had met the emissions standards. In September, SEPA reported that just 43.3 percent of enterprises in Chongqing Municipality and 49.5 percent in Sichuan Province had met the targets. But Chongqing reported that more than 90 percent of its enterprises were in compliance by the end of October and 99.8 percent by the end of December. Sichuan claimed 99.7 percent of its polluters had made the grade or been closed by year-end. Guangxi, Shanxi and Xinjiang also reported astounding improvements in the final months of the campaign.

In February an official with SEPA's air pollution control division said that nationwide a little over 90 percent of all polluting enterprises and about 85 percent of the key enterprises had met the standards. This was virtually identical to what SEPA reported in September, implying that SEPA had not yet accepted the eleventh-hour reports from the provinces. The official said SEPA would reassess the situation in June, when more complete data would be available."

As far as we know, no revised account of the data emerged in June or later, but it could be we have overlooked it.

In the view of environmental officials, the achievements are "fragile" and represent only the first step towards arresting environmental degradation in China. (U.S. Embassy, 2001b). Shanxi Province is a case in point. More than one-fifth of the 18 000 large enterprises were located in this province. Nearly 10 000 enterprises were shut down between 1996 and 2000, one seventh of the total shut down nationwide. These efforts were praised by Environmental Minister Xie



Zhenhua during an inspection tour of the province in August 2000<sup>16</sup>. But a provincial environmental official called the achievement of Shanxi “very fragile”. He said it would be hard to prevent enterprises from returning to “their polluting ways” or opening back up once the campaign was over. In November 2001, gas explosions took place in five of Shanxi’s coal mines over the course of nine days, leaving more than 100 people dead. Four of those five mines had been ordered to close and operated illegally. The fifth had received order to suspend production<sup>17</sup>.

The cases of “fragile” or “very fragile” enforcement should not lead one to believe that the industrial structure in China is entirely static. To the contrary, as we have discussed above, there is an impressive process of technological upgrading going on. The point may rather be that the day-to-day economic development has a deeper impact on the industrial structure and on emissions than the campaigns to close down factories. The campaigns are important too, but their impact is maybe more similar to the icing on the cake than to the actual cake.

### **The Trans-Century Green Project Program**

The 1591 investment projects under the green project program have met with an unpleasant fate. Not many of them have become reality, at least not in the form they were originally stated. There are several reasons for this. One is that the projects to a large extent were more like project ideas than actual projects. Few of them had feasibility studies to back them up, and the EPBs often had to put them together over the space of a few days.

Another, and maybe more important reason for the failure is that the projects lacked sound financing scheme. The projects were to make use of the existing capital investment system, and should be funded by local communities and enterprises (ECON, 1999). Given such a framework the green project program could not make a substantial impact. The example of the green project program shows the limitations of policy making by means of campaigns that are not fastened to economic and institutional realities.

### **The pollution levy system**

The Chinese pollution levy system is probably the most extensive pollution charge system anywhere in the world. Yet it has some peculiarities, as summarized in Wang and Wheeler (1999). Polluters report their emissions and the local environmental authorities are responsible for verification. The levy can be reduced or even eliminated at the discretion of local regulators after inspections. The levy may also be postponed if the polluter cannot afford to pay it, although reductions or exemptions are not allowed in such cases. From these arguments it would seem that enforcement of the levy is open to negotiation. However, since they receive part of the revenue, the EPBs have an incentive to collect the revenue. In fact, some observers have worried that the EPBs are so eager to obtain

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<sup>16</sup> More on inspection tours as an information gathering device below.

<sup>17</sup> The story continued with authorities staging a crackdown in northern Shanxi, involving 2 000 inspectors and leading to at least 13 arrests on charges of negligence.

the revenue that they allow larger emissions that they would have done otherwise<sup>18</sup>.

The evidence on levy collection and enforcement that we are aware of, is mostly from fairly old data (1993). At that time it turned out that the Eastern provinces had much higher levy rates, in fact up to eight times higher (Wang and Wheeler, 1999). Interestingly, it has been shown that the levies are 0.7 per cent higher whenever there are one per cent more citizen complaints of pollution, providing “a potent feedback loop” to quote Wang and Wheeler (1999). The rate is higher when air quality is bad. TVIES, large firms, profitable firms and firms in the building material sector pay higher rates than SOEs, small unprofitable firms and, significantly, the power sector. These differences in rates may in fact go together with both of the theories mentioned above, i.e. of resilient or over-zealous regulators.

### **3.3 Why The Continued Problem of Urban Air Pollution?**

The fight against urban air pollution in Chinese cities is by no means a complete failure, but the problem persists despite considerable attention over several years. The reasons for the lack of success (or at least not fast success) in this field can be traced to several factors:

First, measurement of emissions in cities exists but is of varying quality (Angell, 2001). This may seem like a trivial problem, but does make it more difficult for the authorities to develop cost-effective goals.

Several other reasons relate to the energy sector and to China’s access to coal. The Chinese government aims to reduce SO<sub>2</sub> and TSP emissions both by shifting productive capacity in the economy to sectors with lower energy requirements and by lowering the energy and pollution intensity in all sectors. And although there has been progress in this respect, the mix of energy resources and the abundance of coal makes it evident that China will rely on coal in the foreseeable future.

In addition to shifting production to less polluting industries, and lowering the emission intensity of these, controlling SO<sub>2</sub> and TSP emissions requires improvements in energy efficiency. Again, despite progress China still has some way to go: its energy intensity has decreased since 1980, but is still much higher than that of the US or Japan (SEPA, 2001).

For urban air concentrations specifically, lowering SO<sub>2</sub> and TSP emissions hinges on the switch of households from coal to cleaner types of energy (natural gas or electricity). The burning of coal with a high sulfur content is the major cause of SO<sub>2</sub> pollution in Beijing, where coal accounts for over 70 percent of fuel supply.

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<sup>18</sup> The World Bank (2001) writes (p. 100): “Many lower-level EPBs are heavily dependent on retained pollution levies to cover their operating costs, which creates numerous perverse incentives. For example, it is in the interest of EPBs for enterprises to keep polluting and pay their pollution levy, rather than to comply with discharge standards and stop paying.”

In order to turn the trend around, Beijing residents have been encouraged to switch to natural gas for cooking. Additionally, boilers in the central urban areas of the city are required to use natural gas as their main fuel and need to obtain emission certificates before starting operation<sup>19</sup>. Recent improvements in Beijing's air quality have been attributed to the increased use of alternative energy sources, and the government is emphasizing this policy as key to the continued success of lowering SO<sub>2</sub> emissions (SEPA, 2001). As we have seen, a similar trend is evident throughout the country.

Another aspect of industry structure affecting air pollution is the increased prevalence of Town and Village Industrial Enterprises (TVIEs)<sup>20</sup>. SO<sub>2</sub> emissions by these entities had a slightly increasing trend during the 1990s (especially the early years), while other types of enterprises to a greater extent decreased these same emissions. Their share of GDP has been increasing and monitoring them is generally recognized to be difficult due to their small scale, geographic dispersion and low environmental consciousness (SEPA, 2001). However, as a result of the initiative "Close down of 15 kinds of small scaled factories", the development of these enterprises has been constrained since the late 1990s.

To conclude this discussion it is probably safe to say that China's natural resources are working against its efforts to curb air pollution since coal is both cheap and plentiful. It is difficult to force through measures that are costly and run counter to a country's natural wealth. At the very least, switching to other sources of energy will take time and require a political willingness to forego economic gains in the short run.

However, on the bright side, and contributing to the impression that SO<sub>2</sub> emissions can be controlled in China in the not too distant future is the fact that Chinese authorities seem increasingly willing to experiment with new methods for controlling the problem. The cities of Benxi and Taiyuan, as well as Anhui Province and maybe other cities and provinces that we are not aware of, are designing systems for emission trading of SO<sub>2</sub> emissions. Factories discharging excessive amounts of the harmful pollutant can get around the limits by buying permits from other companies and avoid paying a fine. The companies that manage to cut their harmful emissions will be able to sell the remaining amount on their quota for a profit. Emission trading is also being considered on the water pollution side, this is a broad trend in China.

In an interview with international environmental experts quoted by U.S. Embassy (2000) [*China's clean air price tag: US\$40 billion*], Qu Geping, Chairman of the committee for environment and natural resources of the National's Peoples Congress and considered the patriarch of Chinese environmentalism, claimed that it would cost US\$ 40 billion to bring air quality in all 46 Chinese key cities up to level II standard. The embassy comments that such an investment would surely pass the cost-benefit test, but it might not be perceived that way: "Qu and others who care about air quality in China face the unenviable task of making this case to a political leadership that confronts numerous other urgent, deserving and under-

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<sup>19</sup> From <http://www.harbour.sfu.ca/dlam/newsletters/9804.html>

<sup>20</sup> TVIEs contribute to urban air pollution, even if many or most are located on the outskirts of cities and in more remote areas.

funded priorities.” Maybe this quote summarizes what the mixed success of air quality improvements is about: One part lack of information, and a second part revealed preference about what is important and deserves emphasis<sup>21</sup>.

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<sup>21</sup> Another quote along the same “revealed cost-benefit” line, from SEPA (2001): “In the ninth five year period [1996-2000], the installation of sulfur removal facilities in thermal power plants was rather slow, largely because the manufacturing of the facilities was not satisfactorily localized and the prices were too high if they had to be imported.”

## 4 The story on ground-level ozone

### 4.1 Benefits, Costs and emission trends

#### **Benefits and Costs of Reducing Emissions**

Ground-level ozone is an environmental hazard almost on par with PM<sub>10</sub>. In 1989, the US Environmental Protection Agency (EPA) estimated that more than 66 million people in the US lived in counties where the ozone standard was being exceeded at one or more monitors (Krupnick and Portney, 1991). The pollutant affects humans directly by reducing air quality, and indirectly by affecting agricultural production. It is a major component of smog and the EPA has found that it is linked to respiratory ailments such as asthma as well as chronic illnesses such as emphysema. Evidence indicates that there is no identifiable threshold below which people are not affected.

Once thought to be primarily an urban problem, O<sub>3</sub> concentrations are now recognized as extending well beyond city limits: Ozone has strong oxidizing properties and causes injury and premature mortality of plant tissues. Reduced yields follow as a consequence of poor photosynthesis and nutrient uptake. This phenomenon is hitting some parts of China already, with some studies indicating that the crop of soy beans is reduced ten per cent or more compared with its potential level (Aunan et al., 2000). Other studies (Chameides et al., 1999, and Mauzerall and Wang, 2001) indicate similar effects on winter wheat production and potential to reduce soybean and spring wheat production by 20 and 30 percent, respectively. Overall, more than 5.3 million hectares of land are estimated to be affected by air pollution in China<sup>22</sup>.

As we discuss later in this chapter, benefits and costs of reducing ozone levels have been calculated for many countries, including China. As opposed to lead emissions in particular, it is not always clear that the benefits of reducing ozone concentrations necessarily outweigh the costs. This is mostly true for areas where control measures have already been taken, and the resulting marginal benefits are lower than marginal costs, but may also be true more generally.

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<sup>22</sup> From China Daily, June 5, 2000 (<http://www.harbour.sfu.ca/dlam/newsletters/0006.html>)

## Ozone levels in China over time

Ozone pollution is likely to increase in China in the years to come, due to several factors including a growing vehicle fleet. Yet there is no systematic measurement of ground-level ozone, no policies, and almost no attention to the problem. In a report published in April 2001, SEPA recognizes that “Currently, the contents of ozone and organic matters in the atmosphere in cities have not been well recognized” and that “...there is no regular monitoring on ozone and organic matters...at present” (pp.34).

## 4.2 Why the lack of attention to ozone?

One explanation for the lack of attention to ozone relates to the cost-benefit dimension of the problem. Studies for the US have suggested that a 25 percent reduction in O<sub>3</sub> from early 1980-levels would result in economic benefits of USD 1.9 billion, while a similar study for the Netherlands estimates the *annual* benefits to be €310 million (Mauzerall and Wang, 2001, Kuik et al., 2000). For China, estimates suggest that O<sub>3</sub> pollution in 1990 caused decreases in crop yields worth approximately USD 2 billion (ibid). Kim et al. (1998) concur that benefits doubtlessly could be obtained both in terms of human health and agricultural production by lowering emissions standards, although they point out that standards should be allowed to vary from region to region depending on the relative benefits obtained (these benefits, as far as human health effects are concerned, obviously increase with the size of the affected population). However, when taking the cost of lowering emissions into considerations, the evidence becomes less clear-cut: Some studies in the US show that the benefits of additional improvements in ozone reduction are fairly small compared to those of controlling PM<sub>10</sub> (Krupnick and Farrell, 1996). Kim et al. show that the benefit-cost ratio varies depending on local conditions. Thus, some doubts linger as to the relative sizes of benefits and costs for reducing O<sub>3</sub>. This may be one explanation why ground-level ozone has not received much attention (in China and elsewhere) so far: it simply is not very clear to policy makers that reducing ground-level ozone is a cost-effective pollution priority. At least, it is not as clear-cut as for instance the case for reducing lead was<sup>23</sup>.

Second, economic conditions, or rather, the stage of economic development at which China finds itself is also rendering the task of controlling ground-level ozone more difficult: The reduction of this pollutant is perceived as costly since it involves regulation of services and goods that the average Chinese is longing for. This is particularly true for the use of motor vehicles, and makes executing decisions related to vehicle control politically unattractive: Given that the share of Chinese households that can afford a car is rapidly increasing, any measure intended to reduce ozone emissions through curbing car use will undoubtedly be unpopular. This is a phenomenon that has already been experienced in the US,

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<sup>23</sup> Note, however, that new EU legislation on ozone went into effect in March 2002, a sign perhaps that the Union is taking the problem increasingly seriously. The directive's key requirement is that member states ensure that a WHO standard of 120 ug/m<sup>3</sup> is exceeded no more than 25 times per year averaged over three years by 2010, and that this limit should be met without any exceedences by 2020. The law also requires public notification when the levels exceed 180 ug/m<sup>3</sup> (from ENDS Environment Daily issue 1176, March 12, 2002).

where early gains in the reduction of ozone were achieved by imposing regulations on big stationary sources such as oil refineries and auto manufacturers, but where additional improvements required people to change their habits in the private sphere (e.g. regarding lawn mowing and transportation) (Krupnick and Anderson, 1996).

Third, controlling ozone pollution is difficult due to the nature of its sources: Photochemically reactive Volatile Organic Compounds (VOCs) and  $\text{NO}_x$  are the two main precursors of ozone, but their interaction is unclear. This makes it more difficult to design effective policy measures to curb emission. More research is probably needed before significant progress can be achieved.

## **5 Determinants of Chinese environmental priorities**

It is the task of this report to analyze why different air pollution problems have been treated so differently in China. Are there particular driving forces behind the way in which the Chinese handle environmental issues? This chapter pulls together some of the lessons we have learned from the handling of lead, SO<sub>2</sub>, PM<sub>10</sub> and ground-level ozone, and combines them with other information relevant for illuminating the Chinese way of solving environmental issues.

In order to change, an environmental problem has to go through several stages: Information has to reach the decision makers, costs and benefits of proposed measures have to be balanced somehow, and finally decisions are implemented. Each stage brings new determinants of environmental action into play. We discuss them in turn.

### **5.1 Collecting and disseminating information about environmental problems**

Collection and dissemination of information about environmental problems are preconditions for environmental policy making. Collection of information is important in order for the political centre to detect what is going on in the provinces. Dissemination could go from the Centre and out to the general public, in which case it primarily is an instrument in the balancing act that leads to environmental priorities being set. We will return to this aspect of information later in this text. But dissemination could also signal a positive willingness to detect environmental information. Or dissemination could go from the original detector of information to the rest of society including the Centre, in which case it from the point of view of the Centre has to do with detection and collection of information. In this section we assume that collection of information becomes so much easier if there is a positive climate for dissemination that we see one as an indicator of the other.

It is fair to say that China has become a lot more open about its environmental problems during the last ten years. As far as we can tell, this has come about through an interplay between policy makers and regulators, including SEPA, and



the media. Environmental NGOs and pressure from the public have also played a role.

### **The origins: The 1989 Environmental law**

As is often the case in China, after-the-fact accounts of the change start with a national initiative or regulation. In this case the change starts with the 1989 Environmental Law. It stipulates that “The departments with administrative responsibility for environmental protection of the State Council, each province, autonomous region and municipality directly subject to the central government shall periodically publish reports on the environmental situation.” The State Council soon started issuing annual reports about the state of the environment in China. Local governments however, resisted the dissemination of information until approximately 1997/98. The reasons for their resistance have to do with fear for social unrest, problems with public image, problems with foreign investors etc. Box 6.1 gives some vivid examples.

*Box 5.1 Local environmental officials express fears of openness.*

Here is what the local officials told two Sanlian Life Weekly reporters in early 1997:

#### **Shanghai: Fear of the Question “Why Did the Government Give Us Such Bad Air?”**

“Deterioration or improvement in the environment doesn’t happen over just a year or two. If we were simply to release environmental information to the public, the disadvantages would outweigh the advantages. The environmental consciousness of people today is very weak. Even if we sent the environmental quality notice to every home in Shanghai, many people wouldn’t read it. But maybe the people who did read it would cause some social unrest. They might say, “The government did a bad job. Why did you give us such bad air?”

#### **Beijing: International Image, Fear Civil Disorders**

“It [publishing notices about the environmental situation] is linked to social stability, the public image of Beijing and to other matters such as foreign affairs. Let me give you an example: Beijing Municipality has three seriously polluted rivers. We call them “The Three Roundworms”. Today, after a great deal of effort, we have solved the pollution problems of two of these rivers. But we will not be able to solve the problem of the third river anytime soon. If we were to tell the people, “This river is very seriously polluted but we can’t be able to do anything about it.”, wouldn’t that be encouraging civil disorder?”

#### **West China: We Need Poverty Alleviation, Not Environment**

West Central China: “The main objective of the undeveloped areas is poverty alleviation. With our human and financial resources so weak, we need to do something. Moreover, some environmental data is kept secret out of diplomatic necessity.”

#### **Air Monitoring Official: Public, Investor Reaction Feared**

An environmental monitoring official stated the following: “Just because we can do it doesn’t mean we should do it. We should make public environmental quality

information, but we need to think about the consequences. For example, Beijing does not release its environmental quality information out of concern for its public image. Moreover, we are developing our economy and attracting foreign investment. But foreign investors are more and more concerned about the environmental quality of the region in which they are investing. If we were to release the environmental quality notice, the foreign investor would cancel investment plans. This would result in unnecessary harm to China's economic development and especially to the economic development of the coastal provinces."

### **Shenyang: Frankness Pressures Polluters, Improves Air**

Gao Jizhong, former Vice Mayor of Shenyang in charge of environmental protection, spoke out in favor of openness. He said "...The [air pollution forecasts] helped spread knowledge about environmental protection and to make people more aware of the importance of environmental protection. ...[They] brought a lot of pressure to bear on the polluters. For example, the Shenyang Smeltery [Shenyang Yelianchan] "contributes" forty percent of Shenyang's sulfur dioxide pollution. Our broadcasts made the plant more conscious of this." and "Shenyang's pollution is written all over the face of the city. Even if you say nothing, people will still know about it. Shenyang's air pollution problem is the result of many historical factors. If we want foreign merchants to trust us, we need to attack the problem at its root."

Source: Quoted from U.S. Embassy (1998).

Starting in 1997, the largest cities in China began publishing air quality monitoring data. Beijing, for example, began weekly air pollution reports on February 28, 1998 just before the opening of the National People's Congress in March. It is difficult to find explanations for why this change took place at exactly this point. The literature is full of statements like "the situation in China, and in urban centers like Beijing in particular, regarding worsening air pollution has become increasingly undeniable for both the government and the public alike." (ERM, 1998). In other words, the change somehow forced itself through.

The U.S. Embassy (1998) points out that the foundation was there in terms of the 1989 law and that national leaders encouraged the dissemination of environmental information: "Embassy officers are often told that high officials are big fans of investigative reporting on Chinese television, with the implication that the TV reports are an important source of information for the officials." The Embassy report quotes the "just-published best-selling book" "Confrontation: An account of the three periods of ideological liberation in China" which notes that "over the past three years" Jiang Zemin, Li Peng and Zhu Rongji made 40 inspection tours to understand what is really going on and evaluate the progress of reform. In a conversation with U.S. senators in Fall 1997, Qu Geping, who maybe is the most influential environmental figure in China noted that the National People's Congress of China may be the only parliamentary body in the world that needs to send investigation teams through the countryside to see if laws are being obeyed. Qu also said that using the media to expose violators and to praise enforcers of environmental regulations was the main tool of the NPC to get local government compliance with national environmental protection regulations. Thus, one can

conclude that the *backing from the National law and the Central government* was a necessary condition for increasing environmental openness.

### **The Continuation: De-politization of environmental information**

However, knowing that the foundation was there does not explain why the change took place. One obvious change around 1997-98 was the restructuring of the government. The U.S. embassy (1998) points out that “One of the principles of China’s sweeping government reorganization is the separation of business operations from government regulatory organizations [zhengqi fenkai] in order to remove structural incentives for corruption from the Chinese government system. The reform program, if thoroughly implemented, might remove impediments to the accurate reporting of pollution statistics.” Publishing environmental data was no longer equivalent to criticizing yourself or some of your policy peers. In a way, environmental information became de-politized. The Chinese Academy of Social Sciences researcher Shen Jiru has argued similarly, according to the report. Thus, the *separation of business from politics* was another condition for increasing openness. It should maybe be added that such separation definitely should not reduce the worry reflected above that environmental information will deter business investment.

### **Current practice:**

As part of the change in the government structure, SEPA assumed a new role as a ministry, and, at least formally it took on the role of coordinating all ministries and commissions regarding environmental issues. Once the publishing of monitoring data was established in some cities, it became popular and the system is now expanded to the 46 most important cities in China. Since June 2000, the national television network has been reporting daily air quality indices for 42 cities in its evening news bulletin. The World Bank (2001) remarks that this system is a “radical change. [It] makes data manipulation much more difficult and allows independent analysis...It may have been one of the most effective public education exercises yet undertaken in the environmental field.” (p.110)<sup>24</sup>.

In fact the EPBs throughout China have assigned their own Monitoring Centres, and our impression is that a vast amount of environmental information is collected at each of these offices. Besides, there has been a gradual build-up of monitoring equipment. Equipment such as PM<sub>10</sub> monitors, mobile monitors etc. were not commonplace even in large cities in the late nineties, but the situation is improving. With a well-educated workforce, finding young engineers to operate and interpret the monitoring data seems to be no problem. (See also Angell, 2000). The problem still is to accumulate and bring forward the information, but there is less and less secrecy. We put forward the hypothesis that the *build-up of environmental monitoring institutions and monitoring equipment over time has created a momentum to disseminate more information*. Air quality monitoring data is one sign, but the World Bank (2001) remarks more generally that “one of the strongest elements of SEPA’s environmental strategy has been its work on

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<sup>24</sup> In all fairness it should be added that SEPA since 1989 also conducts an annual, quantitative assessment of environmental quality in 46 key cities and 524 ordinary cities. Twenty weighted indices covering the areas of air, water, solid waste, noise and tree coverage are used to assign an overall score for each city. Results are related to the media. The World Bank (2001) deems this policy to have “limited effect”.

public participation, public dissemination of environmental information, and environmental information at all levels.”. The central government continues to emphasize openness about environmental problems: During a visit to SEPA Premier Zhu Rongji stated in the spring of 2001 that all environmental information should be made public.<sup>25</sup>

In October 2001, SEPA organized a multi-sectoral conference on environmental governance strategies. The event marked the first time that representatives from the legislature, lawyers, private enterprises, Chinese NGOs and government officials gathered at one forum to discuss environmental issues. Public disclosure of environmental information has improved greatly, cf the discussion above. Another example of attempts at involving the public is Tianjin’s public review of EIA processes: In July 2000, the EPB in Tianjin held a public review of their EIA for an expansion project of a power supply company. Residents were allowed to express their concerns, which were subsequently incorporated into the recommendations of the EIA report<sup>26</sup>. Another new initiative by SEPA is to award titles of “National Environmental Protection Model City” to cities that are satisfactorily tackling their environmental problems. The selection criteria include five environmental quality indicators, 10 indicators for urban environmental infrastructure, four indicators for environmental management and four social economic indicators<sup>27</sup>. See also box 6.2.

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<sup>25</sup> The experience of the authors is that this statement is well known among environmental authorities, but it is not by itself sufficient to release detailed environmental data in the provinces.

<sup>26</sup> From <http://www.harbour.sfu.ca/dlam/newsletters/0009.html>

<sup>27</sup> Ibid

*Box 5.2 Will hosting the Olympics improve Beijing's air quality?*

Beijing's citizens have become optimistic about the air they are breathing now that the city has been selected to host the summer Olympics. China's Vice Premier has fuelled their hopes by promising to show the world a capital city with "blue skies, clear water and green landscapes."

The Environment Minister responded to the celebration of the award by reminding Beijing's citizens that the Olympics provides both challenges and opportunities for the city's environment. The demands placed on Beijing's environmental protection authorities over the next seven years will become greater, their work will become more urgent, and standards will have to be made stricter. Beijing announced, as it was applying to the IOC, that in the coming five years, RMB45 billion would be invested in treating the environment, and that they aimed to reach class 2 air quality 70 percent of the time by 2005 (Peoples' Daily, Feb.23, 2001). The plans include a measure to have 90 percent of buses and 70 percent of taxis run on "clean" natural gas, by 2007.

However, in November, Beijing Science, Technology, and Environment Update reported that Beijing's air pollution situation took a sharp turn for the worse in mid-October, "dashing the hopes of citizens that the city's air quality would somehow magically improve this winter following Beijing's successful bid to host the summer Olympics". Again, the city's top problem turned out to be particulates. To clean up its air for the Games, the city plans to quintuple the supply of natural gas to the city to 4–5 billion cubic meters (<http://www.usembassy-china.org.cn/english/sandt/index.html>)

There is little doubt that being awarded the Olympic Games has put environmental degradation in the spotlight in Beijing. Statements like "Beijing is bidding for the 2008 Olympics. Environmental protection is of vast importance" in Science and Technology Daily (Sep. 27, 2000) attest to that. It is obviously a different question whether or not the city will be able to follow up on its promises. Nonetheless, the incentive created by this award in areas as diverse as technology, infrastructure and the environment is a recurrent feature of this type of events and something that could and should be exploited to the benefit of Beijing's citizens.

Complaining to EPBs about environmental problems is quite common in China. Dasgupta and Wheeler (1996) report that in 1991-1993 the environmental authorities received over 130,000 complaints per year, mostly related to air, water and noise pollution. Currently this practice is made easier by the introduction of telephone hotlines for reporting environmental problems<sup>28</sup>.

The analysis of Dasgupta and Wheeler indicates that environmental quality is not the main determinant of environmental complaints, although it matters for TSP,

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28 From Beijing Environment, Science and Technology Update, June 15, 2001 ([www.usembassy-china.org.cn/english/sandt/index.htm](http://www.usembassy-china.org.cn/english/sandt/index.htm)).

which is easily visible. The main determinants are income and education and there is a clear tendency for more complaints to occur in the richer, coastal provinces. Thus, *rising living standards and higher education* condition for environmental responsibility. This contrasts with the traditional image of the Chinese public, which is captured in the following quote from U.S. Embassy (1997) [*Environmental NGO's in China: Green is good, but don't openly oppose the party*]: "The Chinese people have not traditionally felt responsible for maintaining "common areas" as is the case in most western countries. Everything outside one's gate is the responsibility of the government, and officials devoted either funds or resources in the form of required labor to maintain roads, canals or natural resources. Given this mind-set, the "people" have not worried about dumping their garbage in the streets or pouring waste from factories into local streams. It's the government's responsibility to clean up, not theirs." It could be that this, not particularly flattering, description does not hold in an educated and more affluent society.

It is a short step between forming complaints about environmental problems and organising an environmental NGO. Although efforts by NGOs to influence environmental politics apparently are hampered by the lack of openness and top-down approach in the administrative system in China, as well as difficulties in registering with the authorities, conditions for these organizations are improving (Beijing Environment, Science and Technology Update, Nov.2, 2001). According to experts speaking at a forum on Chinese and international environmental NGOs, China now has more than 2,000 environmental NGOs of various types, ranging from government-sponsored NGOs to independent, grassroots groups. Over 90 percent of the NGOs are located in cities of the relatively well-developed eastern coastal region. (Beijing Environment, Science and Technology Update, Nov. 16, 2001). NGOs contribute to solving environmental problems both by lobbying authorities and by informing the citizenry<sup>29</sup>.

### **Lessons from the cases of lead, SO<sub>2</sub>, PM<sub>10</sub> and ground-level ozone**

We have described a process whereby environmental information gradually has become de-politicized in China. It seems that this process had its roots in the Central level government, while provincial and local governments perhaps have been more secretive. The ordinary Chinese have become more aware of environmental issues, and more interested in environmental information, as he and she have obtained more education and their standards of living have risen. The media is being used to publish environmental information, and as it has become more de-politicized the media can also conduct their own investigations, which adds to the information flow.

In what follows we will compare this general impression with the three cases discussed earlier.

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<sup>29</sup> Note, however, that working for an NGO is still not without its problems: In one instance, a photographer working for a provincial department was fired from his job after voicing concern to authorities in Beijing about the threat loggers were posing to a habitat for endangered species (Report from the US Embassy in Beijing, Dec. 1997, <http://www.usembassy-china.org.cn/english/sandt/index.html>).

## **Lead**

In the case of lead we have described that according to the accounts we have read, the impetus for change came from China Petro-Chem in the 6<sup>th</sup> five year plan. However, it is likely that the managers of this company have been stimulated in their efforts by developments in foreign companies and countries. Removing lead from gasoline was an international topic at the time. Therefore the international cooperation activities of the company were probably important. This is the kind of cooperation and stimulation that one suspects will increase as China enters the WTO and opens up even more to the international society.

However, it is unlikely that the company would have initiated their own research activities unless it expected the rest of the Chinese policy environment, and the public at large, sooner or later to become aware of the dangers of lead and the availability of alternatives. The building of awareness among these other stakeholders probably had to do with impulses from abroad. The scientific community within China probably contributed as well.

The background for controlling lead also contains media information on the dangers of lead to the Chinese, but these articles appeared in 1997. 1997 was after central policy makers had become aware of the problem and a policy was worked out. Thus, they built support for the chosen policy among the public and maybe even provincial and local policy makers. Such support fed back on central policy makers, but probably did not reveal much information directly.

## **Particles and SO<sub>2</sub>**

Increased environmental awareness among the public has probably been a factor behind the attention devoted to SO<sub>2</sub> and particles, and urban pollution in general. We found in the chapter on SO<sub>2</sub> and particles that the pollution levy is higher in areas where citizens complain on pollution often. And publication of monitoring data on urban pollution, which is termed a huge success, has been important both as a response to environmental awareness and as a means to stimulate further awareness. More generally, opinion polls indicate that environmental pollution is high on the public agenda of social problems.

## **Ground-level ozone**

It is an interesting question where the concern for ground-level ozone in China will come from. The authorities hear about the problem through channels such as environmental researchers and research institutes. At the monitoring center and in the EPB system, some complain that there are no systematic ozone measurements, but our impression is that the current focus of Chinese officials is to complete the PM<sub>10</sub> measurement system. Still, it is from this environment, which includes the central SEPA in Beijing and international players such as the World Bank, that attention to the problem probably will originate.

In the media, ozone is equivalent to atmospheric ozone and the related environmental problem of ozone depleting substances. A recent search of a main data-base for environmental press clips in China ([www.enviroinfo.org.cn](http://www.enviroinfo.org.cn)) revealed 69 hits on atmospheric ozone, and none on ground-level ozone. China has devoted a lot of attention to reducing consumption and production of ozone

depleting substances, and is proud of its achievements. The thought that there is another form of ozone, which there is too much of, would confuse this impression.

One could also look to the NGOs, but our impression is that the NGOs are too weak and too inside the government's general agenda to bring up a completely new theme. Besides, NGOs have the most success with fairly concrete themes, of which there are many in China e.g., within biodiversity. Ground-level ozone does not share these characteristics.

## **5.2 The balancing mechanism**

Although great environmental problems remain, it is fair to say that Chinese society has paid significantly more attention to environmental issues in the 1990s than at any time before. The balance of priorities in the general population has tilted in favour of increasing environmental concerns. Based on the story of lead, urban air pollution and ground-level ozone, this section asks why this is so and if there are lessons other countries can draw from it.

It is perhaps useful to divide the balancing mechanism into two levels. At a basic, undercurrent level, costs and benefits of environmental goals provide a framework for decision-making and maybe the long-run determinants. On the surface, however, different institutions fight for different goals and for control over the decision-making process. The outcome of this struggle determines the short-run balancing of concerns. Both the long-run undercurrents and the short-run waves are subject to outside influences. We describe these themes in turn.

### **Undercurrents: Shifts in technology and preferences**

The World Bank (2001) describes the shift in environmental priorities in China in the 1990s in these words: "The economic and social changes that characterized the 1990s in China were also reflected in the environmental agenda. The structure of industry and industrial pollution changed significantly; urban and rural environmental issues became much more visible and important; and the growing middle class became more aware and concerned about the deteriorating state of the environment. Political awareness also increased."

### **Shifts in technology**

This quote nicely summarizes the undercurrents of Chinese environmental priorities. First, consider "the structure of industry and industrial pollution". As we discussed in chapter 3, shifts in technology and a gradual phasing in of cleaner technologies are making an impact on coal consumption and energy consumption in general. With this shift come improvements in energy and pollution intensities. Although official data may overstate the improvement, see our discussion in section 4.1, there is little doubt that the improvement is real and stands in contrast to many other developing countries.

As far as we can tell, the technological changes have less to do with environmental concerns and more to do with concerns for economic development and economic growth. Although great challenges remain, our overall impression is that the rapid technological change has made it easier over time to achieve environmental improvements.



This hypothesis is obvious in the case of lead. The phasing out of leaded gasoline would have been much harder to obtain if unleaded gasoline had not been available at a reasonable cost, or if vehicles that run on unleaded gasoline had not been available.

We see the same tendency in the case of urban pollution, SO<sub>2</sub> and PM<sub>10</sub>. The pollution intensities have fallen dramatically over time and remain the highest in the Western region where technology as a rule is older. But the upgrading of technology has more to do with an upgrading of the economy than with explicit environmental investments.

Decreases in SO<sub>2</sub> emissions and the demand for coal in the late 1990s is also believed to have come about as a result of a slump in the business cycle, in part due to the Asian Crisis. This observation, however, contrasts with official Chinese statistics of continued and strong economic growth during this period, and again draws into doubt the reliability of the country's government statistics.

Even the case of ground-level ozone seems to fit the pattern of demand changes driven mostly by technology. In the case of ground-level ozone the technology to reduce the problem is not readily available, e.g. there are no small modifications of cars that can solve the problem, demand is on the rise, and the problem is much harder to tackle.

### **Shifts in preferences**

The quote from the World Bank (2001) also states that “the growing middle class became more aware and concerned about the deteriorating state of the environment”. As far as we can tell, the Chinese society is moving into a much more environmentally conscious state, as illustrated by the survey referred to in our introduction: Half of all Chinese find environmental protection to be among the top three social problems of the country, and as many as 68 percent are willing to pay higher taxes to protect the environment<sup>30</sup>.

We have described in our discussion of urban pollution that recent academic studies from the World Bank demonstrate that environmental policy is in fact stricter in the areas of China where the relatively well-off and well-educated live. For instance, Wang (2000) finds that community variables such as income, education and population density are important in explaining firm behavior (in this case discharges of Chemical Oxygen Demand) in China. Wang and Wheeler (1999) find that enforcement of the Chinese air pollution levy is endogenous in that it is influenced by citizen complaints. Citizen complaints are again influenced by local community characteristics such as income and education levels. The results for education are particularly striking: they suggest a literacy-elasticity somewhat above the range 1.7-1.8. Dasgupta and Wheeler (1996), which we have discussed earlier, point to the same phenomena.

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<sup>30</sup> The figure of “one half” is from a 2000 survey. The 2001 survey, published on December 26, found that 41.2 percent ranked environmental protection among the top three, right behind unemployment (45.2) but before social security (32.6). (Beijing Environment, Science and Technology update, 2001b) [December 28.]

Taken together, the combined shifts in technology and preferences go a long way in explaining the Chinese position on the environmental Kuznets curve. The “demand curve” for environmental quality increases over time (moves to the right) and as education and income grows. The “supply curve” for environmental quality is constant or maybe decreases over time (moves to the right) on par with technology shifts. (Although it may also increase (move to the left) from the pressure of economic growth.) These forces somehow find their way into a slow improvement of environmental quality and a progression of environmental concern from the immediately dangerous (lead) to the subtle issues (groundlevel ozone).

### **Influence from Abroad**

One source influencing this mechanism is influence from abroad. Influence may take the form of pressure, for instance the pressure of WTO membership, or assistance, for instance assistance by the World Bank and others. Sometimes the line between pressure and assistance is blurred.

A country that is open to trade or that wants to expand trade significantly, will have incentives to emphasize environmentally "friendly" production methods more than economies that are more closed. This assumption is supported by recent research, for instance on the opposite “pollution haven” hypothesis. In China’s case, the entry into the WTO has strengthened the importance of adhering to environmental standards such as ISO14000. Five standards were adopted and when 382 firms achieved the standards in early 2001 environment minister Xie hailed it as a great achievement<sup>31</sup>. The U.S. is also an influential player through its adoption of China as a Most-Favored-Nation.

Pressure or assistance may also come from the World Bank, and other international lending institutions such as the IMF. The World Bank published a paper in 1992 (The Environmental Strategy Paper for China) that they recognize “appears to have had significant influence on the government’s thinking about environmental issues” (The World Bank, 2001, pp.127). The World Bank in 2001 had an investment portfolio where rural development took up 29 percent of the total number of projects, transportation 17 percent, urban development and environment also 17 percent and the energy sector the remaining 16 percent (The World Bank, 2001). Of the environmental projects, about 35 percent were projects primarily focused on environmental issues, while the remaining 65 percent were not primarily environmental, but included one or more “environmental components”. Lending for air pollution control, admits the World Bank, is relatively low, reflecting among others the lower priority of these issues in the government’s urban development agenda. Thus, the direction of influence can be said to go both ways: from the international community to China, but also from Chinese authorities to the lending institution’s investment portfolio for that country. After all, one has realized the futility of financing a project that is not on the to-do list of the country’s authorities.

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<sup>31</sup> The standard were (1) Environmental management systems - specification with guidance for use; (2) Environmental management systems - general guidelines on principles, systems and supporting techniques; (3) Environmental auditing - general principles; (4) Environmental auditing - auditing of environmental management systems; and (5) Environmental auditing - qualification criteria for environmental auditors.

The US embassy in Beijing is very active in the environmental field, and hosts important internet resources with information on all aspects of environmental protection in China. As a final example, we have seen that in the case of the phase-out of leaded gasoline that the U.S. EPA claims a share of the honor for the achievement. European and other institutions no doubt pride themselves with similar achievements in Chinese environmental policy.

### **Institutional changes**

While the changes in technology, changes in preferences and the pressures from abroad are examples of “undercurrents”, changes at the institutional and policy level are in our view examples of events that change priorities on a surface level. That being said, there are sometimes important loops between “surface” changes and undercurrent changes. WTO membership is an example of this: the decision to apply was in part a result of changes in preferences (an undercurrent), but the membership in turn caused institutional and other changes in the country.

It is fair to say that environmental issues have been more and more emphasized in Chinese politics ever since the Stockholm conference on the environment in 1972. But it is also fair to say that many environmental problems have increased in size since 1972. The first round of attention and emphasis came with the “three old systems” (EIA, emission levy and the “three simultaneous”) that were started between 1973 and 1981. A second round came when five more environmental policies were passed onwards from 1989, the “five new systems”. A third round started in 1996 with new regulations by the State Council, e.g., on emission standards from year 2000. The subsequent ninth five year plan 1996-2000 was the first to include explicit and monitorable environmental performance objectives and a pollution investment program. In 1998 the agency NEPA was upgraded to the ministry SEPA. A fourth round seems to be under way at the moment, with ambitious environmental goals for the tenth five year plan and a new reorganization of the government that would integrate environmental concerns more into mainstream policy making. More than 700 billion yuan, nearly double the spending of the previous five-year plan, is being set aside for the purposes of a “nationwide cleanup plan” (Saigon Times Daily, Jan.14, 2002). Meanwhile, the legal basis for environmental policies as well as efforts to evaluate progress are areas that are being developed simultaneously. The importance of the domestic scientific community is also growing, as was seen in its influence on the government’s stance on the Montreal Protocol. This is a fairly recent change and one that is related to the increasingly open manner in which information is collected and decisions made.

This is not to say that every policy decision benefits of the environment. As we have seen, the environment loses on the policy arena quite often, and probably more often than it should according to unbiased, scientific cost-benefit analysis. Thus, it is probably safe to say that social welfare in China would increase if environmental conditions had been better (for instance, we have seen that most evidence suggest that the benefits of measures to curb SO<sub>2</sub>, TSP and particulates outweigh the costs).

## 5.3 Execution of decisions

We have previously referred to the tension that often surges between SEPA centrally and the local EPBs. Furthermore, in discussing the phase-out of lead, we argued that efforts were made at integrating several ministries and that this contributed to the success of the policy. In what follows we discuss how both the vertical and the horizontal dimensions in the Chinese administrative system affect the execution of policies.

### **Horizontal integration: SEPA versus other ministries and agencies**

How powerful is SEPA? This will obviously influence the success with which it carries out policies. Although not a full member of the State Council, and without the resources and budget control typical of a ministry, SEPA was “upgraded” from the level of a vice ministry to that of a ministry at the last reorganization of government (a new one is in the offing). Its main responsibilities are to manage and supervise national environmental protection, to prevent and control pollution, and to promote sustainable economic and social development. However, it has been argued that the environmental agenda in China has become so complex that it cannot be satisfactorily managed by SEPA (The World Bank, 2001). Most environmental problems cut across lines of administrative responsibilities as well as industry interests, and SEPA has the ungrateful task of trying to enforce policies on ministries that are more entrenched and that have greater power than itself. EPBs have primarily been dealing with industrial point sources, and are not well prepared to tackle multi-dimensional, cross-sectoral urban environmental issues. They tend not to participate in municipal planning, and environmental protection suffers as a consequence (World Bank, 2001). SEPA recognizes this in their 2001 report: “The overall planning of the cities should incorporate the implementation of sustainable development strategy, taking environmental protection as an important target and task...”(pp. 73).

### **Vertical integration: SEPA versus provincial and local EPBs**

Also, in a country as large as China, how does one successfully execute decisions at the provincial level that are made by the central government? Unlike many other countries, the central government in China does not enforce central environmental laws directly, but indirectly through intermediate layers of government. Circulars arrive with guidance from the central government but these are not always followed closely. By decentralizing the decision process, it becomes more difficult to coordinate. SEPA, as opposed to its counterpart in many other countries, does not control the budgets or operations of the EPBs. The budget of the local EPB is controlled by the provincial government, and the head of the EPB is named by the provincial governor. Poor communication between the central and local governments apparently also contributes to the poor control by SEPA over TVIEs. SEPA recognizes that environmental enforcement efforts are greatly complicated by a lack of enforcement capacity, as well as difficulty in

ensuring that local-level governments faithfully implement national-level laws and regulations<sup>32</sup>.

## **Enforcement**

Enforcement is a crucial extension of the concept of execution. SEPA recognizes that it is a thorny issue for the following reasons (2001):

One aspect concerns the punishment for breaking the law: Enforcement is difficult since until recently no clear legal responsibility of those that exceed ambient standards apparently existed. Furthermore, according to some, the concept of obedience to law is still quite weak in China. As an example of this, the Chinese congress periodically has to send teams to the provinces to investigate whether or not laws are being carried out. Punished polluters also have a tendency to return to a state of noncompliance: In some regions repeat polluters make up 10 percent of those caught and 30 percent of plants that have been told to shut down, reopen at some point<sup>33</sup>. Earlier we commented on the incident in Shanxi where four out of five accident-prone mines had been ordered to shut down, and the fifth was suspended<sup>34</sup>. However, in the amended criminal code that went into effect in October 1997, breaking environmental regulations was for the first time explicitly discussed. Nine articles involved the discharge of pollutants and Article 338 specified up to three years imprisonment and/or a fine for individuals involved in illegally discharging pollutants<sup>35</sup>.

The consistency and strictness of enforcement vary greatly across provinces in China: Actual collection of pollution levies is for instance much higher in Beijing than in Shanghai and Sichuan. These variations can be traced to differences in economic factors (e.g. local pollution load and the size of the exposed population) and in community capacity to enforce (influenced by the education level and bargaining strength of the local community, and expressed through citizen complaints) (Dasgupta et al., 1997). The study by Dasgupta et al. furthermore shows that a 1 percent increase in the effective discharge levy (actual collection of the levy) leads to decreases in SO<sub>2</sub> intensity by 0.3 percent and in suspended particles by 0.8 percent. Thus, enforcement is key in lowering emissions, yet Dasgupta et al. show that effective levies have actually fallen since 1987. This does not bode well for pollution control in China.

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<sup>32</sup> From Beijing Environment, Science and Technology Update, Nov.2, 2001, <http://www.usembassy-china.org.cn/english/sandt/index.html>

<sup>33</sup> From Beijing Environment, Science and Technology Update, June 1, 2001, (<http://www.usembassy-china.org.cn/english/sandt/index.html>).

<sup>34</sup> Further evidence from Shanxi Province is provided in the RFF directed project on behalf of the ADB to initiate emission trading in Taiyuan, the provincial capital. RFF writes in the inception report: "Several officials we spoke with were of the opinion that the Taiyuan city government has the authority to engage in a demonstration without any formal permit from SEPA" (p. 50) and footnotes "The Chinese members of the project team are somewhat less concerned about finding a clear legal basis for a demonstration than are the U.S. members, as the role of law in decision processes in China is in an early formative stage." See also Zhang (2001).

<sup>35</sup> From <http://www.harbour.sfu.ca/dlam/newsletters/9706.html>

## Corruption

There is also reportedly a high incidence of corruption at local levels in China, which makes implementation less effective. Beijing Environment, Science and Technology Update in their Jan. 12, 2001 issue quote Chinese environmentalists as saying that corruption at all levels of government is China's biggest environmental problem<sup>36</sup>. False accounts and mismanagement of funds worth USD120 million (or 27 percent of the total budget) have been found in the collection and management of waste emission fees in 46 cities. It is interesting to note that the impression of mismanagement is widespread also in the general public: 86 percent of those asked in an environmental awareness survey carried out by SEPA and the Ministry of Education believe that lawbreaking and lax enforcement are important contributors to pollution<sup>37</sup>.

Although not necessarily linked to corruption, in August 2001, SEPA announced sanctions against local governmental officials in eight provinces for failing to enforce environmental regulations. The officials ranked in seniority from heads of prefectural governments to district administrators and were accused of "incompetence with regard to enforcing pollution standards"<sup>38</sup>.

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<sup>36</sup> From <http://www.usembassy-china.org.cn/english/sandt/index.html>

<sup>37</sup> From Beijing Environment, Science and Technology Update, Sep. 8, 2000, <http://www.usembassy-china.org.cn/english/sandt/index.html>.

<sup>38</sup> From Beijing Environment, Science and Technology Update, Sep.7, 2001, <http://www.usembassy.china.org.cn/english/sandt/index.html>

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