PEOPLE'S REPUBLIC OF CHINA

SHANGHAI

Size of the country	*9 597 000 km² (66% is covered by mountains)*
Population	*1 264 500 000*
Population density	*132 inhab/km2*
Population growth rate (1993 – 1999)	*1 %*
Part of urban population	*31 %*
Life expectancy at birth	*70*
Infant mortality (per 1000 live birth)	*31*
Access to improved water sources (% of population)	*83*
Ethnic groups, their percentages in the population	*Hans: 92%, others: 8% (55 minorities)*
Official languages	*Chinese (mandarin)*
Gross domestic product	*980 billion USD*
Gdp per capita	*780 USD*
Inflation	*1,4 %*
Gdp growth rate	*7,5 %*
Gdp repartition in different sectors	*Agriculture: 17,3 %, Industry: 49,7% (manufacturing: 37,8%), Services: 32,9%.*
Illiteracy (% of population age 15+)	*17% (Male : 9%, Female: 25% (1995)*
Tourism	*51 M visitors (1996)*
Urban area	*Beijing 10,8 M* *Shanghai 12,9 M*

BUILDING A SUSTAINABLE ENVIRONMENT FOR SHANGHAI

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Introduction

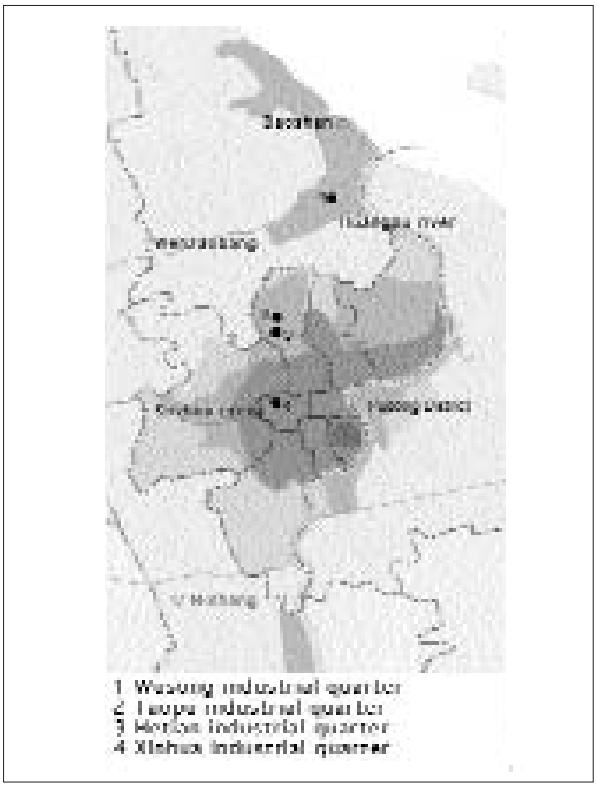

Figure 1. Shanghai urban area

Shanghai is the major economic center of China. The municipality covers a total area of more than 5,000 sq. km and is home to only one percent of the national population. Yet, the city produces five percent of the national GDP. In the 1990s, its ten-percent growth rate ranked first in the nation. The major contributor to the local GDP is the secondary sector (industry and construction), followed by services.

Shanghai sits in the middle of the Chinese north-south coastline. The East China Sea lies to the east, while Hangzhou Bay borders the municipality in the south. Its neighboring provinces to the West are Jiangsu and Zhejiang. The Yangzi river sets the limit to the North. Water resources in Shanghai are abundant. The major waterway that flows through the city is the Huangpu River. Its major tributaries are Suzhou Creek, Hongkougang, and Wencaobang. Furthermore, a dense network of small rivers and canals runs through the municipal territory (see figure 1).

In the late 19th century, Shanghai's privileged location attracted huge amounts of domestic

and foreign capital. These investments triggered industrial development in the city. By the late 1930s, there were already more than 5,000 industrial enterprises of varying size and the population reached 3 million. As early as 1930, Shanghai had become the major financial and trade center in East Asia. After 1949, the Chinese central government designated Shanghai as one of major industrial bases of China[1].

Thereafter, the major focus of the Shanghai economy until the mid-1980s was industrial development which, in the absence of controls, has induced several environmental problems like industrial exhausts and liquid waste discharge.

In the next sections we shall first discuss environmental problems in Shanghai. Lesson will be drawn from this past experience. Finally, we shall examine the issues and challenges of environment work in the near future.

The Scope of Environment Deterioration

The emission of sulfur dioxide (SO2) into the atmosphere and the discharge of industrial waste into the environment, especially rivers, are the two major environmental problems in Shanghai. These emissions and discharges have seriously polluted the city's natural environment.

In 1983, the quantity of sulfur dioxide in the air was around 0.1 mg per m^3. This was 1.67 times the national standard. In the late 1980s, the quantity of sulfur dioxide increased to 0.14 mg per m^3. " Acid rain " became a frequent phenomenon in the municipality[2]. Rivers also suffered severe degradation. In the late 1950s, some sections of Suzhou Creek had turned black and malodorous all year round. At the confluence of Suzhou Creek and the Huangpu, a clear demarcation line, in terms of color, could be seen between the waterways. Yet, water in the Huangpu itself was far from clean. In 1963, water near the intake of the Yangpu Water Plant, which was located in the lower section of the Huangpu, turned black and foul-smelling for 22 days in that year. Thereafter, year after year the period of black and smelly water gradually increased to 49 days per year[3]. The issues of sulfur dioxide emission and discharge of industrial waste had to be solved in order to maintain or recreate a sustainable environment.

In the 1980s, it became apparent that the key cause of Shanghai's environmental pollution was the high density of industries in the urban area. The local authorities initiated a new policy to encourage state-owned industrial enterprises to move to the neighboring rural areas. This policy, which was also connected to the nation-wide policies of economic reform, stimulated industrial activities in the municipality. In particular, township enterprises *(xiangzhen qiye)* mushroomed in all the rural towns and farming areas. However, this transformation was not accompanied by measures for the protection of environment or by the rigorous enforcement of existing regulations. Many township enterprises took to discharging their waste directly into the air and the waterways. Some waterways were cloaked with the accumulation of industrial waste to a point where the flow of water was stopped. The disorderly discharge and dumping of industrial exhausts and solid wastes only increased the effects of pollution from the already heavily polluted urban areas on the air and water resources in the rural areas. Economic development was causing new problems to the entire municipal territory. To put a brake on these negative trends, a set of comprehensive measures had to be implemented to protect the environment and, at the same time, sustain economic growth.

Building a Sustainable Environment

To build a sustainable environment calls for an effort that includes legislation, planning, financial investment, management, and law enforcement. Individual measures must be part of a comprehensive plan.

Before 1976, there was no measure or framework for a comprehensive treatment of industrial waste in Shanghai. Waste treatment activities were limited to a few industries where industrial wastes might cause fierce environmental damage to the environment. These industries included papermaking, chemicals, dye, leather, metallurgy, medicine, etc. In the early 1980s, because of the fast growth of the economy, coupled with various environmental problems, the Shanghai municipal government realized that it was time to rehabilitate the environment in a comprehensive way. It started to work on an environmental protection master plan, a regional environmental protection plan and a few specially focused plans.

In 1982, a task force was set up to prepare a technical study for a " Comprehensive Protection Plan for the Huangpu River. " Due to the significant increase of organic pollution in the river, the supply of drinking water to the population was seriously under threat. Close to 800 experts from both China and overseas joined in the designing of the project. The task force eventually proposed a strategy and a scheme of action for the preservation of water resource in Shanghai[4].

At the same time, the government started to formulate an " Environmental Protection Master Plan of Shanghai, " which covered 11 urban districts *(qu)* and rural counties *(xian)* in the municipality[5]. The plan addressed the following aspects: regulation of the geographical distribution of the population in the Shanghai region, rationalization of the industrial layout and structure, reduction of the pollution load on the environment, and new criteria to define a functional areas (industrial vs. residential areas).

The Shanghai Environmental Protection Bureau (Shanghai huanjing baohuju) (SEPB) was founded in March 1979 to take charge of all environmental protection work in the city. In 1986, all the districts and counties in the municipality had to set up their own local environmental protection bureaus. Under the supervision of the Shanghai Environmental Protection Bureau, these bureaus were to take up environmental protection work at the local level. They assigned environment inspectors to the neighborhoods *(jiedao)* and townships *(xiang)* under the jurisdiction of the local government to assist the heads of neighborhoods and townships to manage environmental protection work. In this way, a network for environmental management was organized as a three-tier structure under the supervision of the Shanghai Environmental Protection Bureau[6].

In 1979, the State Council promulgated the Law of Environmental Protection of the People's Republic of China[7]. In accordance with the law, the Shanghai municipal government and SEPB adopted a series of local regulations to provide the legal basis for local environmental protection work. The major regulations include " Shanghai environmental protection regulation " (Shanghai shi huanjing baohu tiaoli) and " Protection regulation for upstream water resources of Shanghai Huangpu river " (Shanghai shi huangpu jiang shangyou shuiyuan baohu tiaoli). To reinforce their capacity for environmental management, the local authorities also adopted a series of environmental protection rules such as " Assessment rules for environmental impact " (Huanjing yingxiang de pinggu biaozhun), " Rules for discharge permission and fee " (Paiwu xuke he shoufei biaozhun), etc.

Government Financial Input in Environment Protection

In the mid-1980s, environmental protection work in Shanghai entered a stage of comprehensive improvement at the municipal level. Government funding for the protection of environment increased significantly. From 1980 to 1985, total governmental support for environmental protection was 0.62 billion RMB (US$75 million). From 1986 to 1990, the total amount more than doubled to reach 1.43 billion RMB (US$173 million). From 1992 to 1996, it reached the impressive figure of 20.17 billion RMB (US$2.43 billion)[8]. Most of the money went to projects for a comprehensive rehabilitation of the environment. Even allowing for the high rate of inflation during a part of the period, the local authorities have made a substantial investment in the rehabilitation of the environment.

In 1985, Shanghai started to restructure its economy. In particular, the government strongly encouraged investment in services, which caused the share of secondary sector output in local GDP to decline quite significantly. In 1978, industry accounted for 77.4 percent of the local GDP. Its share dropped to 59.1 percent in 1990 and 48.4 percent in 1999[9]. This restructuring of the local economy, with its emphasis on non-polluting activities, helped to promote and facilitate environmental work in the municipality. Yet, it could not by itself solve the problems inherited from the past. The latter had to be tackled through specific policies that we shall present in the next section.

The Protection of Water Resources

The Huangpu is the major source of drinking water for the Shanghai population (see figure 1). Its increasingly polluted stream therefore required a determined effort. The first stage of the project for water diversion and protection in the upper reaches of river was initiated in 1985. It was completed within two years and benefited four million local households. The second stage of the project, started in 1994, was completed in 1997. The project moved water intake upstream and expanded the capacity of the intake to five million tons per day. At the same time, the government invested 0.2 billion RMB (US$24 million) in 12 giant industrial polluters along the upper reaches of the river, with the view to closing them down or to relocating them away from the area. Eventually, these measures resulted in a 60-percent decrease in pollution.

Suzhou Creek is a tributary of the Huangpu and a major element of the local waterway system. It had been seriously polluted by industrial and residential waste discharge for several decades. To rehabilitate the ecology of the Suzhou Creek, the government invested 1.6 billion RMB (US$193 million) in 1988 in the first stage of the Sewage Confluent Project. This project included a 33.39-kilometer pipeline for the collection and discharge of both industrial and residential wastes in a 70.57 sq. km concentration area along the creek. The pipeline led to a new waste-treatment plant. After thorough processing, the liquid waste from the concentration area is directly pumped into the sea. The project was completed in 1993, and started improving the condition of Suzhou Creek in great measure.

While the project was being implemented, the government set up a " Comprehensive Rehabilitation Office " (Zonghe zhengzhi bangongshi) to deal with the pollution of the tributaries of Suzhou Creek. The objective of the Office is to cleanse the entire water system of Suzhou Creek and to give it a clean appearance[10]. The mid-1990s saw the beginning of the second stage of the Sewage Confluent Project. Six billion RMB (US$723 million) were invested to build a new pipeline system for the treatment and discharge of the industrial waste

that came from the western areas of Shanghai. This waste used to be directly discharged into Suzhou Creek and other rivers of Shanghai.

Comprehensive Control of Air Pollution

By the 1970s, Shanghai had already transformed most of its industrial boilers. It helped alleviate air pollution to some extent, but small-sized industrial and non-industrial boilers were still scattered in large numbers in residential areas. In 1982, Shanghai set itself the goal of making the central city an area free of black smoke. By the end of 1985, 21,508 small-sized industrial and non-industrial boilers had been transformed, and the goal of the municipal government had been basically achieved. In the later 1980s, the SEPB started creating " smoke-and-dust monitoring zones " in the central districts of the city. By 1992, such " smoke-and-dust monitoring zones " covered the whole central area of Shanghai.

Thanks to these measures, the amount of dust in suspension in the air has decreased significantly. In 1995, the average quantity of dust in the air was 14.3 tons per sq. km. per month. It was 1.45 ton less than in 1994. In 1996, it was reduced by a further 0.49 ton and 0.53 ton in 1997. Altogether, over a period of three years, the government has succeeded in reducing dust in the air by 15.7 percent. At the same time, new gas supply facilities were being installed in most residential districts in the city center to ease the pollution that resulted from the use of coal as the major source of energy (cooking or heating) by individual households. Finally, in the mid-1990s, the SEPB turned its attention to reducing fumes from buses and cars. As a result, most taxis in Shanghai have installed LPG equipment.

Noise used to be a serious problem in Shanghai. In the 1980s, the SEPB adopted regulations on noise standards and required enterprises that created noise in downtown Shanghai to improve their production processes and meet the new standards. By 1990, 67 million RMB (US$8 million) had been invested in noise-easing activities, creating 123 quiet residential quarters covering 87 percent of the downtown area.

Comprehensive Treatment of Heavily-Polluted Industrial Quarters

Shanghai harbors the structure of a traditional industrial city. Industrial quarters are actually made up of areas where a high density of factories is combined with an equally high population density. Some areas of Shanghai were seriously polluted by various industrial discharges from this industrial concentration in the city. The Xinhua Road, Hetian Road and Taopu industrial quarters were representative examples of this very unhappy mix (see figure 1).

The Xinhua Road industrial quarter is located in the western part of the central city and covers an area of 2.2 sq. km. Some 110 industrial factories for chemicals, papermaking, metallurgy and medicine, etc. were scattered in the area, which was also home to around 70,000 residents. In 1986, the government invested 0.45 billion RMB (US$55 million) to clean the area. A total of 407 environmental projects were completed, including the relocation or closing down of most of the factories that caused severe pollution. It reduced dust in the air from a monthly 24.5 tons per sq. km. in 1985 to 11.94 tons in 1993. Before this policy was carried out, black smoke and bad odors floated in the air and colored liquid waste covered the surface of the roads. Now, the area has become a beautiful, quiet and clean residential quarter.

The Hetian Road industrial quarter is located in the northern part of the central city and covers an area of 0.85 sq. km. It used to have 50 industrial factories for chemicals, daily consumer goods, electrical machines, industrial instruments and medicine. There were also several thousand households and three middle schools

in the area. In 1987, the government invested 1.08 billion RMB (US$130 million) to help relocate 13 industrial enterprises as well as 2,367 households. Moreover, 233 environmental projects were implemented in 22 industrial enterprises. After eight years of environmental treatment, industrial wastewater discharge has been reduced by 65 percent and exhaust emissions by 62 percent.

The Taopu industrial quarter is located in the northwestern corner of Shanghai and covers an area of 3.1 sq. km. It was built on farming land in the 1950s to the benefit of major pharmaceutical companies. Large-scale " workers' villages " (xincun) were built around the factories to facilitate the movement of employees commuting from home to the workplace. The residential and production functions were therefore intimately mixed in the area. Industrial pollution also had a direct effect on the local residents who had long complained about this unfortunate state of affairs.

In 1987, the government started cleaning the area. Up to 1995, the total investment for environmental rehabilitation reached 38 million RMB (US$5 million). The largest sewage treatment factory in Shanghai, with a treatment capacity of 60,000 tons per day, was built in the area. Four steam boilers with a steam capacity of 20 tons per hour were installed in the area to concentrate the heating supply.

Altogether, from 1980 to 1995, total government investment in the environmental rehabilitation of industrial quarters in Shanghai amounted to 8 billion RMB (US$1 billion),

Challenges and Solutions

Thanks to government efforts since 1985, the environmental situation in Shanghai has improved significantly. The high rate of economic growth and massive urbanization in the city, however, have placed the environment under increasing pressures. To protect it from further deterioration, two issues need to be addressed. They will be discussed in the following section.

Fund Shortage and Focus

Since the mid-1980s, the environmental work in Shanghai has mainly focused on the environmental problems inherited from the past. From 1949 to the mid-1980s, the largest part of government funding went into economic construction, especially in the development of industrial production. Urban infrastructures and environment protection were neglected. Environmental work in the 1980s and 1990s could hardly do more than ease the existing environmental situation to some degree. Many environmental problems still remain or may even develop due to further economic development.

To solve these problems within a reasonable span of time, massive investments will have to be made. According to recent calculations, environmental rehabilitation from 2001 to 2003 will require 50 billion RMB (US$6.5 billion). Government resources will not be able to cover this expenditure. Therefore, beyond technical considerations, the shortage of funds appears as a major challenge for the local authorities. The Shanghai municipal government is currently considering schemes for a diversification of funding for environmental protection. According to these schemes, 35 percent would come from industrial enterprises and district governments, 35 percent from the

central government, investment by overseas governments, and bank loans, 10 percent from government bonds and 20 percent would come from a municipal foundation for environmental protection. Except for funding from the central government and local government, financial support for the environment would rely on non-governmental and overseas funds.

How to attract such non-governmental and overseas capital in the Shanghai environmental sector is a hot topic in government research nowadays. Currently, many sectors of the Shanghai municipal apparatus are facing a situation of fund shortage. Several years ago, some of them started to transform their finance system to attract non-governmental investment. They gradually established market-funded operations. Many municipal projects have been activated with non-government capital. However, the environmental sector in Shanghai has long been supported solely by the government. In recent years, some environmental projects have called for public involvement. For example, to ease air pollution in the Shanghai suburbs, the government banned the burning of wheat straw and encouraged wheat-straw recycling. In 2000, the total investment in the program for wheat-straw recycling reached 4.8 million RMB (US$0.6 million), of which 23 percent came from the central government, 46 percent from the municipal government, and 31 percent from the concerned farmers.

The treatment of the daily output of rubbish is another example of public involvement. Currently, most waste is simply transported to landfills without identifying or removing toxic or useful items. This has caused serious environmental problems, while land shortage is limiting a further expansion of landfills (which would mean sacrificing fertile farmland). To reduce the amount of waste, Shanghai is going to build several incinerators. The Shanghai Jiangqiao Incineration Plant is currently under construction. The project started in 1998 and will be completed in 2002. The total investment is 0.75 billion RMB (US$90 million), of which, the Spanish government has contributed US$32.7 millions. Although there are other examples of diversified fund-raising, the systematic operating system that will ensure long-term funding for environmental work in Shanghai has yet to be designed.

It is expected that, with the transformation of the financial system, the financial sources will eventually diversify and the financial situation in the sector of environment work will gradually improve. At present, the full-scale rehabilitation of the environment is not feasible due to the limited funds available. Shanghai's environmental plan will therefore focus on a few central issues that we shall discuss in the next section.

Water System

Currently, the entire river system in the central part of the city is polluted in various degrees. Some waterways have been soiled by daily rubbish for many years. In 2000, the government has invested 0.5 billion RMB and rehabilitated 1141 waterways for a total length of 2560 km. Yet, there remain 107 areas with dirty waterways in central Shanghai. In 1999, 95.7 percent of industrial wastewater was treated before discharge, while only 50.4 percent of household wastewater were treated. The remainder simply went into the river system without treatment.

In the past, environmental work in Shanghai has focused on industrial wastewater. With the growth of the city and increase in the daily consumption of water, wastewater has become a major burden on the environment. In the rural areas, livestock farms are also becoming a major object of concern. While livestock farms have not received government permission to discharge their wastewater into the river system, many still do so. Finally, water supply is itself another pollutant of the river system in Shanghai. There are 12 plants in the city and their wastewater is directly discharged into the river system without any

treatment. Environmental work on the river system should therefore focus on the above issues.

Quality of the Atmosphere

Coal has long been the dominant primary source of energy in Shanghai. In 1999, the total consumption of coal in Shanghai amounted to 40 million tons that generated 500 billion m^3 of exhaust gas (90 percent of it was of industrial origin). The exhaust gas from motor vehicles and the burning of wheat straw are other air pollutants. Therefore, the environmental plan will pay full attention to the control of the emission from coal burning, especially from desulfurization treatment in power plants, as well as to measures to limit exhaust gas from motor vehicles and the burning of wheat straw.

Solid Waste Treatment in Shanghai

At present, solid waste in Shanghai is moved to landfills without any form of pre-selection of recyclable items or collection of toxic products. While there are a few measures for waste reduction and recycling, there is so far no comprehensive scheme to reduce the harmfulness of certain wastes to the environment. In the outskirts of Shanghai, there is no systematic collection of garbage, a lack of effective measures for the treatment of " white waste " and refuse from construction, and no facility to process toxic or hazardous wastes. This sector should therefore be a major focus of the environmental plan.2.

Efficiency of Environmental Work and Public Involvement

As mentioned above, Shanghai has set up a three-tier network for environmental management to ensure the enforcement of the legislation on the environment. In practice, we found that there was an overlapping of responsibilities in the system, which has led governmental organizations to " pass the buck " among one another and to low efficiency in environmental work. Organizational restructuring and the enhancement of law enforcement by the local executives are urgent tasks to be undertaken.

From the history of environment protection in Shanghai, it appears that the government has long been a dominant force of the sector. It was considered that the protection of the environment was a responsibility of the government. Although the government has in recent years encouraged public involvement in the sector, it has actually failed to make more than a symbolic move in that direction. The public awareness of environmental protection is very weak, leading to widespread irresponsibility about the environment among enterprises and residents. To ensure the success of environmental work in Shanghai, the government should explore legal means and harness the public education system to raise the public awareness. The following measures are suggested:

1. Environmental training for the administrative staff of government organizations and enterprises;
2. The introduction of environmental education into the teaching materials in primary schools to raise environmental awareness from childhood;
3. Starting an environmental protection column in the newspapers to give more prominence to environmental concerns in the media;
4. Encouraging local communities to organize voluntary groups for environmental work in neighborhoods.

At present, although several national and local regulations on environment are in force in Shanghai, there is still a lack of detailed measures for their implementation in many sectors. In particular, the following regulations are urgently needed:

- Regulation on the management of environmental sanitation, especially for daily waste management;
- Regulation on sewage management;

- Regulation on the conservation of drinking water resources;
- Regulation on the prevention of air pollution, especially by exhaust gas from motor vehicles;
- Regulation on the management of green areas and forest growing;
- Regulation on the reduction of package waste;
- Regulation on a comprehensive rehabilitation of the environment;
- Regulation on the management of solid-waste recycling.

Conclusion

Since the mid-1980s, the municipal government has made repeated and decisive efforts to protect the environment from further deterioration in Shanghai. This has improved the environment to some degree. Yet, environmental work in Shanghai still has to match the level of development of the local economy. With the urbanization process underway in Shanghai, environmental problems will become more acute. If the government remains the only investor in the environmental sector, the shortage of funds will become a crucial issue in the near future.

Currently, public awareness of and involvement in environmental issues are being encouraged. However, public involvement in Shanghai has not yet been included in a clear agenda. Therefore, the mobilization of the public about environmental issues and a change in behavior need to be part of the government's agenda.

Notes:

1. *Shanghai jingji nianjian* [Shanghai Economy Yearbook], (Shanghai: Shanghai jingji nianjian bianjibu, 2000), pp. 28-41
2. *Shanghai huanjing baohuzhi* [Historical Gazetteer of Shanghai Environmental Protection] (Shanghai: Shanghai shehi kexueyuan chubanshe, 1998), pp. 192-215
3. *Shanghai huanjing baohuzhi*, pp. 158-168
4. *Shanghai huanjing baohuzhi*, pp. 168-170
5. *Jiaqiang shanghai huanjing baohu he jianshe de jueyi* [Decision on the Enhancement of Environmental Protection and Construction in Shanghai] (Shanghai: Shanghai shizhengfu, 1999), p. 3
6. *Shanghai gaige kaifang 20 nian* [Twenty Years of Reform in Shanghai] (Shanghai: Shanghai renmin chubanshe, 1998), pp. 506-525
7. Shanghai keji lishiguan, *Shanghai huanjing baohu fagui daquan* [The Complete Regulations of Shanghai Environmental Protection] (Shanghai: Shanghai keji lishi ziliao, 1995), p. 183
8. *Shanghai tongji nianjian* [Shanghai Statistics Yearbook] (Shanghai: Shanghai tongji nianjian bianjibu, 2000), p. 102
9. *Shanghai jingji nianjian*, pp. 55-56
10. *Shanghai huanjing baohuzhi*, p. 168