24. A STUDY ON THE GLOBAL ENVIRONMENTAL PROBLEMS FROM THE RAPID ECONOMIC DEVELOPMENT IN THE SOUTH CHINA

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ABSTRACT: The rapid development of some developing regions such as the Guangdong province in the south China has drawn much attention from various fields. The urban sprawl in such an area results in the rapid rural-urban land use conversion so that the previous small town has been evolved to a middle city containing more than a million of people. Further, because of its proximity to Hong Kong and Macao, the huge foreign investment increased the industrialization in the Guangdong province. In addition, with the improvement of income and living standard in previous years, the motor vehicles have been increasing. This research aims to meet this urgent need to comprehensively study the consequences of the rapid economic development from the viewpoint of the global environment. Such a study is profitable for the global and local environment as well as to the local economic development.

KEYWORDS: Economic Development, Energy Consumption, Global Environment

1. INTRODUCTION

The rapid economic development of a region such as the Guangdong province in the south China usually accompanies with its urbanization, industrialization and motorization. These changes promote the energy demand and result in obvious environmental issues such as the increase of waste, the loss of cultivated area, air pollution, and the increase of harmful accidents, and so on. Environmental problems are closely related to the energy consumption. This issue is more serious in the developing countries and regions where the fossil fuel may be the main fuel to generate energy. The primary energy consumption in China in 1991 was almost equal to that of South Korea in the early 1970s and Japan around 1950 (Imura et al. 1995). If the economic development in China keeps at its present pace, such gap in energy consumption will diminish rapidly in a few decades. As the energy supply in China is heavily dependent on coal, the emission of air pollution is enormous. Nonetheless, environmental pressure in industrial areas and big cities has surpassed the critical level because major production facilities and population are concentrated there. Energy use is the largest source of greenhouse gas emissions worldwide, and China currently accounts for about 10 percent of the global energy use. Further, among countries with high greenhouse gas emissions, only China is likely to maintain rapid rates of economic growth well into the next century and this expansion will require additional energy. On the other hand, China and other low-income countries are likely to be most affected by climate change because their economies are more dependent on the climate-sensitive sectors such as agriculture. A recent modeling work by the Intergovernmental Panel on Climate Change (IPCC) estimated that the agricultural production would fall by 6-8 percent worldwide and by 10-12 percent in developing countries with a doubling of atmospheric CO_2 concentrations (Johnson et al. 1996). The rapid development in the south China has drawn much attention from various fields. The urban sprawl in that area results in the rapid rural-urban land use conversion so that the previous small town has been evolved to a middle city containing several millions of people. Energy use may well be the engines of modern economies to promote the ongoing increases in gross domestic product (GDP). However, these increases are generally accompanied with the growth of another GDP: Garbage, Dust and Pollution (Newton and Manins 1999).

China is the number one coal producer and consumer in the world, and the only large country using coal as its main energy source. The efficient energy consumption is becoming one distinguishing issue for meeting the high economic development. Guangdong province has been achieving rapid

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economic growth since the early 1980s because of its proximity to Hong Kong and Macao, and has been designed as a window of showing the reform and open-door policies in China. It has drawn much attention from various fields such as sustainable development and global environment (Eng 1997, Liu and Itoh, 1999, Wu 1998). This research aims to study the global environmental problems due to the rapid economic development in the southern China by means of the energy consumption. Such a study is profitable for the global and local environment as well as to the local economic development.

2. ECONOMIC DEVELOPMENT AND ENERGY CONSUMPTION

It has been mentioned that the energy use varies with GDP (Proops et al. 1993). To see whether this assertion is valid for China within the previous development procedure, the energy use against GDP is plotted in Figures 1 and 2 for the whole country of China from 1989 to 1996 and the Guangdong province of the south China from 1989 to 1996, respectively. These data are mainly derived from the China Energy Statistical Yearbook 1991 and the China Energy Statistical Yearbook 1991-1996. It can be found that there is a clear correlation between the energy use and GDP, and the correlation coefficients R^2 are 0.93 and 0.95 for China and the Guangdong province, respectively.

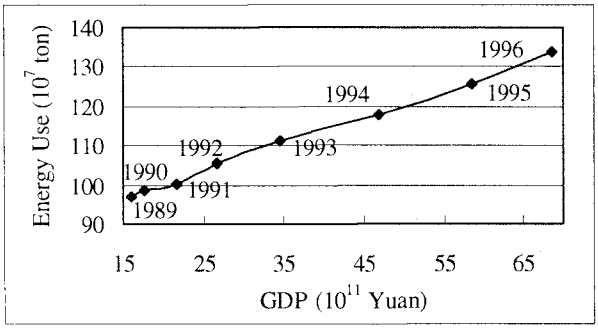

Figure 1: Energy Use versus GDP Growth in China

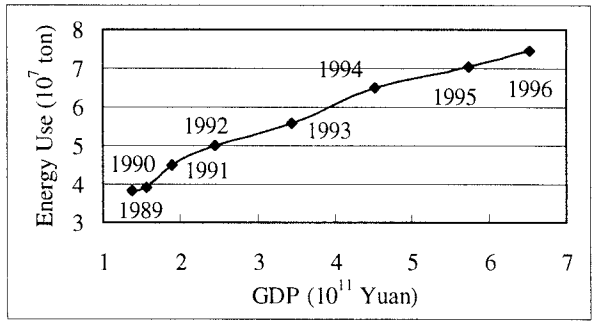

Figure 2: Energy Use versus GDP Growth in Guangdong Province

As shown in Figures 3, it can be noticed that in the previous years the main energy is supplied by the solid fossil fuel coal (China Energy Statistical Yearbook 1991-1996). It may be the fundamental strategy for China to greatly reduce the greenhouse gas emissions by reducing the proportion of carbon-intensive energy source in the energy mix. However, over the short term, there are limits to the extent of substitution for coal because of the long period needed to develop alternative technologies, the abundance of low-cost coal in China, and the magnitude of the energy supply that will be needed to fuel the economic expansion in China. Further, the primary energy demand in China is expected to grow at 3.6% per year by 2020 by the International Energy Agency (1998). This increase is lower than the historical growth rate of 5.5% from 1971 to 1995 because the economic growth will not be so high as before. As a result, the current share of solid fuel will decline by about 10% to be 67% by 2020 as shown in Figure 4. However, the solid fuel still remains the dominant. The main driver of solid fuel demand is power generation.

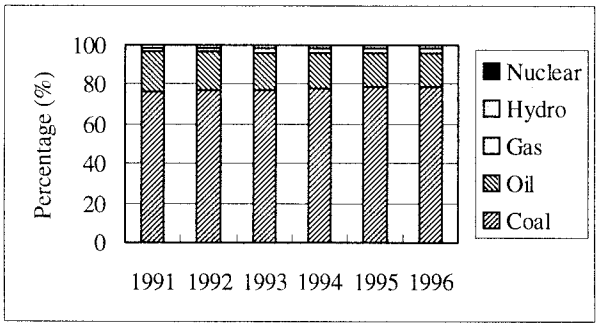

Figure 3: Energy Supply in China

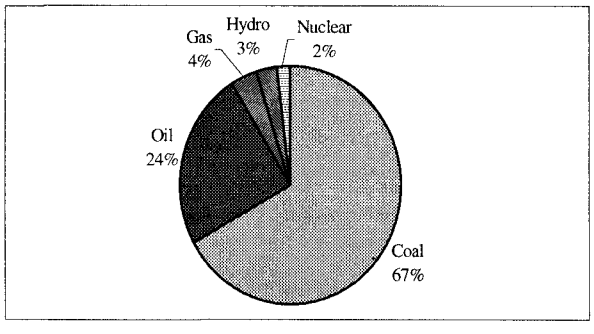

Figure 4: Prediction of Energy Supply in China in 2020

With the development of economics, the energy consumption in the Guangdong province has increased drastically. As shown in Figure 5, the yearly energy consumption in the agriculture, industry and service increased 109%, 74% and 184% respectively within the seven years from 1989 to 1996. Contained in the service sector, the energy demand in the transportation and communication sector increased from 311 tons of standard coals in 1989 to 612 tons of standard coals in 1996, which are more than half of the total energy consumption in the service sector. Figure 6 shows the GDP per energy consumption in the above-mentioned four economic sectors from 1989 to 1996. The economic efficiencies of energy consumption in the industry and transportation sectors are quite low compared to the agriculture sector and the service sector in average. This figure also implies that the elasticity of energy demand increase to GDP growth may change in different years.

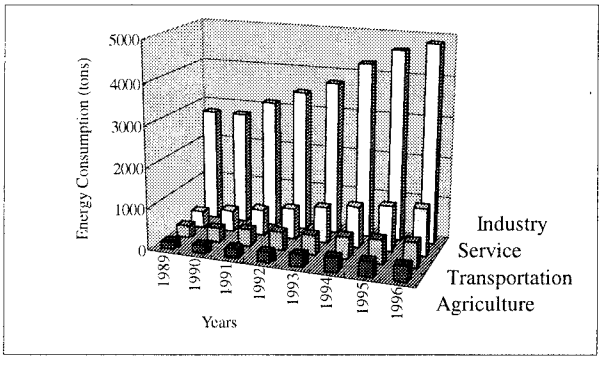

Figure 5: Increase of Energy Consumption in Each Sector in Guangdong Province

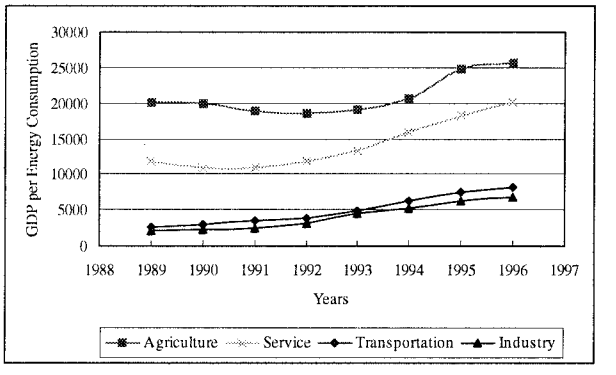

Figure 6: GDP per Energy Consumption Sector in Guangdong Province (unit: Yuan)

3. AIR POLLUTIONS FROM ENERGY CONSUMPTION

As shown in Figure 7, in 1990, the global anthropogenic CO_2 emissions were nearly 5.7 billion tons, of which China accounted for about one tenth (World Resources 1998-1999). Per capita CO_2 emission from China was 0.6 tons of carbon (tC), compared with 5.3 tC of the United States, 2.3 tC of Japan, and 3.7 tC of the former Soviet Union. Figure 8 shows the comparison per capita CO_2 among several countries from 1990 to 1995. Compared to other countries, the per capita CO_2 is still rather low. However, the increase speed is the highest.

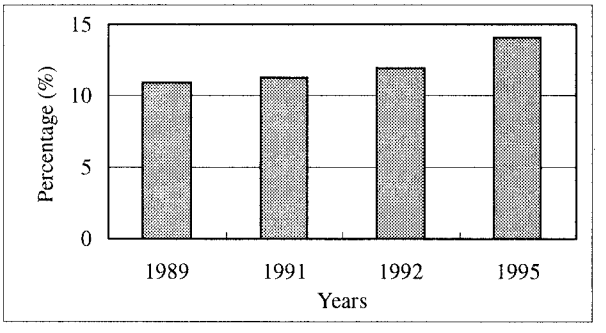

Figure 7: Changes of Percentages of CO_2 Emission of China versus the World

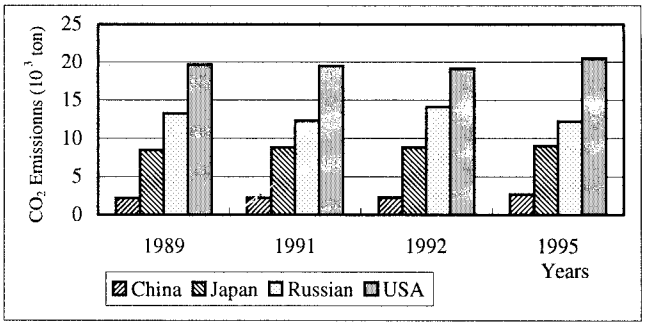

Figure 8: Changes of Per Capita CO_2

The burning of fossil fuels and other human activities are changing the balance of CO_2 and other heat-trapping gases in the atmosphere. The greenhouse effect has the potential to alter the climate of the earth in a relatively short span of time dramatically. At current emission rates, global atmospheric CO_2 concentrations will double by the middle of the twenty-first century. This will result in a warming of the atmosphere of the earth by 1.5 to 4.5 degrees C and cause global mean sea levels to rise by 0.25 to 0.50 meters. Figure 9 shows the distribution of carbon dioxide from three dominant sources of fuels in several countries in 1995. The representative of these types of

fossil fuels are coal, oil and natural gas, respectively. In China, the widespread use of coal and the fact that coal has a higher carbon content than oil or gas create large emissions of carbon dioxide. The combustion of fossil fuel was responsible for 95% of the carbon dioxide emissions, of which 80% originated from the use of coal. Further, the annual increase rates of energy consumption in both China and the Guangdong province are shown in Figure 10.

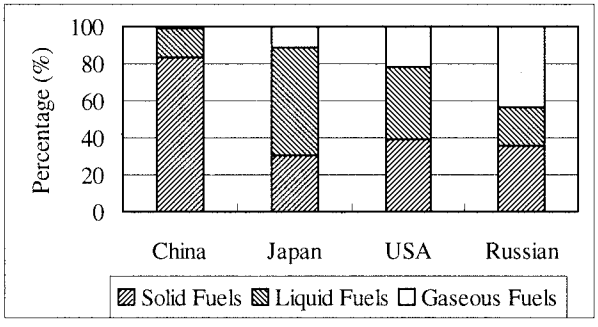

Figure 9: CO_2 Emission from Various Types of Fossil Fuels

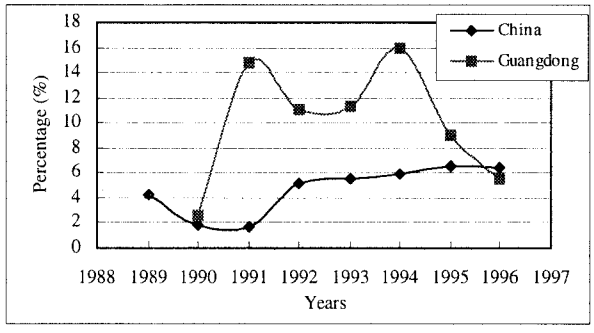

Figure 10: Increase Rates of Annual Energy Consumption

China has an abundance of coal and a relative lack of petroleum and natural gas reserves. Therefore, coal is the major source of carbon dioxide emissions in China. Unlike developed countries, where coal is used mainly in power generation, in China the power sector accounts for only about a quarter of total coal consumption as shown in Figure 11 for 1995 (Johnson et al. 1996). Most coal is consumed directly by industry for steam generation and by the residential sector for cooking and heating. This situation is expected to change a little bit with the development of power plants in the following years. Figure 12 shows the estimated distribution of CO_2 emission from energy consumption in China by 2020. The power sector will increase to 31% and the industrial sector decreases by 46%.

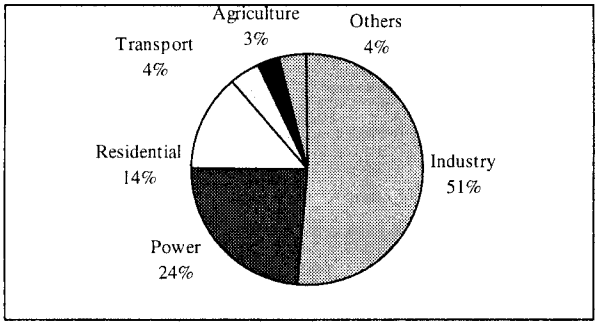

Figure 11: CO_2 Emission from Energy Consumption by Sector in China in 1995

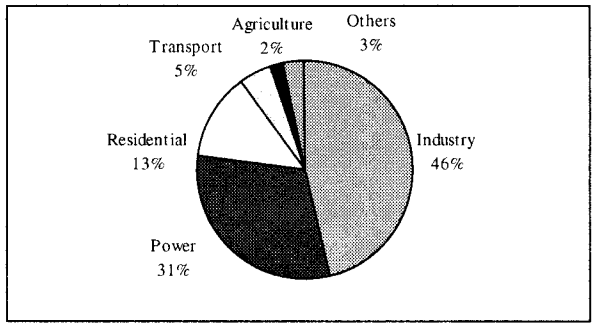

Figure 12: Predicted CO_2 Emission from Energy Consumption by Sector in China in 2020

Further, the average sulfur content of consumed coal in China is 1.35% by weight. In 1996, the total sulfur dioxide emission is 13.6 millions tons, which increased from 12.93 millions tons in 1993. Responsible for such large sulfur dioxide emission is not only the high sulfur content of the coal, and the fact that coal plays such a dominant role in the energy supply but also the inefficiency of the majority of power plants in China. Since a large number of Chinese power plants are located on the east coast, 45% of sulfur dioxide emissions originated on only 8% of the total land surface. Figure 13 shows the geographic distributions of sulfur dioxide emissions in all provinces of China. In addition, many homes in the northern half of China are heated by coal for several months of the year which creates additional sulfur dioxide emissions. Figure 14 shows the sulfur dioxide emissions by sector in China in 1996 according to the China Statistical Yearbook (1997). By sector, the electric utilities is the largest emitter accounting for about 53 % of the total sulfur dioxide emissions in China.

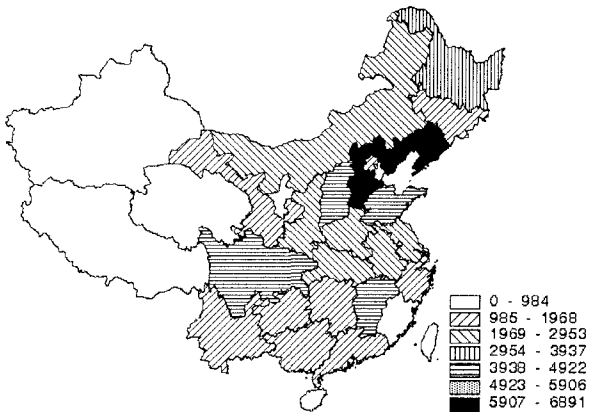

Figure 13: Geographical Distribution of SO_2 Emissions in China in 1996

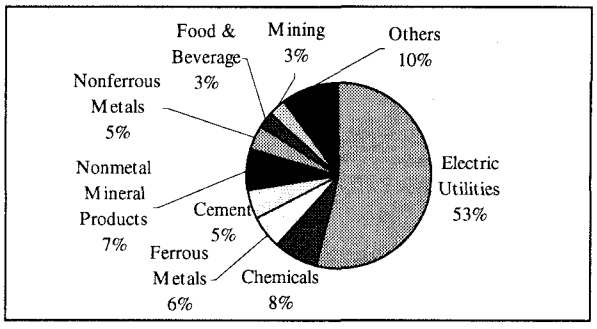

Figure 14: SO_2 Emissions by Sectors in China in 1996 (Total: 13.6 millions tons)

4. INDUSTRIAL WASTE EMISSIONS

The industrial air and water pollution in China has been major concerns for the past two decades. A recent assessment by the Chinese Research Academy of Environmental Science has identified industrial pollution as the source of approximately 70% of China's total environmental pollution. Current estimates of human health damage from urban air pollution are very high for some areas. Such high levels of damage are primarily due to the rapid growth of pollution-intensive industries. The pollution intensity of output in certain key emission categories has dropped sharply since 1985, at least in factories, which are regulated by the environmental agencies. Continued rapid decline in pollution intensity will be necessary just to stay even with the pace of industrial growth. Moreover, recent findings on pollution related health damage suggest that considerable improvement in ambient quality would be necessary. In fact, it is very difficult to face with the simultaneous need to reduce pollution and increase industrial output and employment, especially in the developing regions due to the limitation of the fund, equipment, labor capacity, and technology, and so on. Figure 15 shows the changes of related indices of several types of industrial wastes including the waste water, waste gas, SO_2, and dust by taking the values in 1987 as 100.

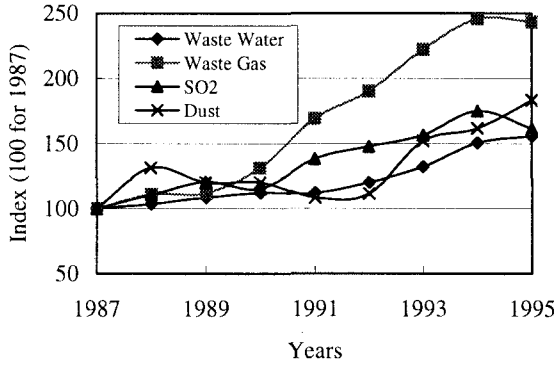

Figure 15: Changes of Waste Emissions

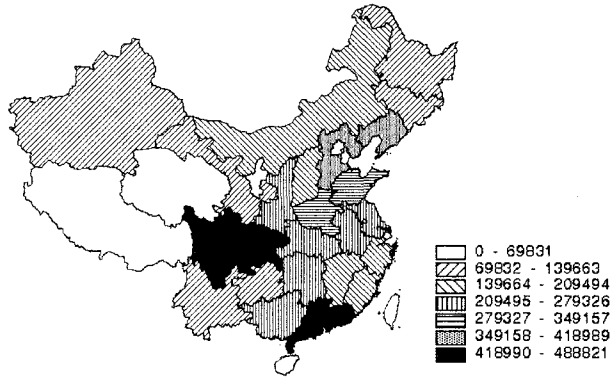

Figure 16: Industrial Dust Emission (unit: ton)

By taking the advantages of GIS in data visualization and analysis, a waste management system is being under development to study the geographical distribution and relationship of waste emissions. Figure 16 shows the industrial dust emission in 1996. The industrial dust discharged refers to the total weight of solid dust discharged by industrial enterprises in the production process such as dust of refractory materials from iron plants, dust from coke-screening system or from sintering machines of cooking plants, dust from lime kilns, cement dust from building material enterprises, etc., but excluding smoke and dust discharged by power plants. A great deal of dust in the urban area is generated from the construction sites of the civil infrastructures and the particle emissions from motor vehicles.

5. CONCLUSIONS

This research aims to study the global environmental problems due to the economic development in the developing countries and regions by means of the energy consumption. The following conclusions can be stated from this paper:

1) In both China and the Guangdong province of the southern China, the energy demand increased with the growth of GDP. In China, the energy supply is highly dependent on the solid fuel of coal. Nearly 80% of energy supply is derived from coal.

2) At present, more than 10% of CO_2 emissions of the world is generated in China, of which about more than 80% is due to the burning of coal. About 90% of coal is used for industrial production, power generation, and residential. Further, the emissions of sulfur dioxide is also mainly due to the coal burning in China and a high portions are in the eastern and northern parts of China.

3) The emissions of wastes including the waste water, the waste gas and the solid waste have increased more than 50% in China with its industrialization and economic development. Particularly, the waste gas increased near 2.5 times from 1987 to 1995.

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