Economic Assessment on National Environmental Investments in PRC

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CERTIFICATION OF ORIGINALITY

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it reproduces no material previously published or written, nor material that has been accepted for the award of any other degree or diploma, except where due acknowledgement has been made in the text.

(Signed)

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(Name of student)

Abstract

Environmental issues had been widely debated in recent years throughout the People's Republic of China (PRC). The increasingly industrialization took place in China not only produced new workplaces, a vast increase in society's productive capacity, but also raising population and pollutants. The condition of the environmental quality in PRC was one of the World Bank's most serious global concerns. Neighbours of PRC such as Japan and Korea claimed their acid rains were the result of great amount of SO_2 emissions in China.

Chinese government began to undertake environmental expenditure in the early 1980s. The investment amount was gradually growing from year to year. But the percentage of such investment took in gross domestic production (GDP) has fluctuated from 1980s. The percentage to GDP decreased from 2.5 percent in 1980s to 1.22 percent (CNY 256.6 billion) in 2006.

However, with the increased environmental investment, the environmental quality in water, air and solid didn't achieve significant progress. The pollutant discharge or emission amount from industry and domestic both increased year by year. The increase rate of treated pollutant amount cannot catch up with the increase rate of total pollutant.

Therefore, weather the investment amount is enough and weather the investment is effective should be exam.

This study firstly analysed the environmental pollution and pollution treatment situation in China. Important economic parameters such as GDP, employment rate, industrial production, and energy consumption were chosen to illustrate economic developing condition, and to evaluate the economic capability of investment from Chinese government and the society. Other factors affecting environmental quality were also selected to explicate the interaction between economic growth and environment pollution.

After analysing PRC's environmental and economic level, four countries were selected to compare with China's investment condition, according to the similarities in economy, society, and industrialized level. Comparison conducted between PRC and India, Japan， Germany, and the United State (the U.S.) in environmental investment amount, invested area and their environmental achievements.

It was found that the investment amount took by Chinese government was almost a quarter to a half of developed countries such as the U.S. and Germany. The percentage that investment amount taken in GDP by Chinese government wasn't reach the level from that by Japanese, American and German government. In such countries, the percentage maintained in more than 2 percent form 1980s, but the percentage in PRC was approximately 1.5 percent or less from year 1990. India, had the most similarities with China in the world, had a fiscal budget in environmental

investment which was 20 times more than that of PRC. Suggestions for Chinese government, limitations of this study and recommendations to further research were given at the last part of this thesis.

List of Publications

1. **Zhang B.B.**, He, D., Chua, H., Tsang, Y.F. Shin, S.Y.,2006. "A comparison between China and the United States environmental expenditure", submitted to *Journal of Environmental Management*.

2. **Zhang B.B.**, He, D., Chua, H., Tsang, Y.F. 2008. A brief study on environmental protection management in P.R.C. *Waste Management and the Environment IV*, Granada, Spain, June 2-4, 2008.

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1. Introduction

1.1 Background

It has become increasingly apparent in resent years that pollution problems are becoming more global in nature. That is, human activities in one region have a significant impact on the environmental quality many mils removed from that region (Sawyer, et al. 1994). The quantity of some effluents has overcome the natural, self-cleansing powers of the atmosphere, waters, and earth had exceeded the natural digest abilities.

Industrialization

Industrialization not only produced new social classes, new workplaces, a vast increase in society's productive capacity, increased pollution, and rising population. It is also totally reshaped agricultural production itself. Today, industrial production has enabled fabulous constructions and interventions into natural environments 'the previous generations of people would have considered impossible' (Philip, 2007). Industrialization leads to the increasing separation of human beings from a direct dependence on the natural environment.

Nowadays, industrialization continues, but increasingly it takes place in China, Philippines, Taiwan and India rather than England, the U.S. and the France (Philip, 2007). Because capitalist companies need to make and increase their profitability by using cheap labour in the weaker regulated states such as China. None of the post- industrial societies of the northern hemisphere is immune from

industrial pollution; even planned cities such as Brasilia in Brazil have not been particularly successful in alleviating the environmental problems (Philip, 2007).

Urbanization

By 2000, more than 75 percent of whole world's population of around six billion people lived in urban areas (Philip, 2007).

Air pollutant can be yielded from car and other vehicle emissions, factory smoke and gases or from the infamous 'smog', a combination of smoke and fog. Water pollution can be yield from ocean oil spills, chemical discharges from factories, untreated human waste making its way to watercourses and seas or the marine dumping of toxic and nuclear waste. Land can be contaminated from overuse of pesticides in farming or increased radioactivity from nuclear power production.

Growing populations and particularly expanding urban populations, urbanization, resulted in waste water discharged (Stearns, 2007).

Constant quest for profit

Environmental problems are not just caused by industrialization and urbanization. Alan Schnaiberg (1980) has indicated that environmental damage is also an inevitable problem of competitive capitalist market economies in which profit-making is the driving force. Philip (2007) also stated that 'competitive pressure leads to a constant motivation from more and cheaper production of goods and unavoidably a lack of concern for environmental protection'. The more concern on environmental protection, the more costly and less compete companies will be yield.

Actually, constant quest for profit ultimately induce to industrialization in greater speed. As Bell (2004) described, if the capitalistic production sets environmental on a treadmill to environmental damage, then modern consumerism helps to accelerate the treadmill running speed in this direction. Although consumption is human beings have to engage in to survive, modern mass consumption was very different from all earlier forms (Philip, 2007).

In the last more than half a century, industrial production was moved to developing countries where wage rates and taxes were lower and environmental regulations were weaker. The goods made by factories have to be bought by consumers, though producing and consuming may well be conducted in different locations. Products tend to be produced wherever it is cheapest to do so, but consumed wherever the best price can be gained.

Norway began its environment related expenditure statistics from a Statistics Norway survey of 399 manufacturing enterprises that covered environmental protection investment for 1974 – 1985 (de Caprona and Hansen, 1987). The U.S. conduct the Pollution Abatement Costs and Expenditures (PACE) survey -- the most comprehensive source of information on U.S. manufacturing's capital expenditures and operating costs associated with pollution abatement—in 1973 (Becker and Shadbegian 2007), administered by the U.S. Census Bureau. And Japan treated environmental pollutants at the very begging of developing industrialization in the early 1960s.

However, environmental governance in many developing countries suffers from several political economy problems (World Bank, 1992; Lo, et al., 1997).

According to international experience, environmental pollution can be controlled

only when pollution treatment investment take 1% to 1.5% in GDP; and environment can be improved only when that investment take at least 2% to 3% in GDP (Lu and Gao, 2004; Wang and Chang, 2003).

1.2 Issues

Although some western countries have worked with environmental protection expenditure for years, the accounting bodies applied different approaches and definitions but still didn't synchronize between countries (Hass and Smith, 2002). Since the data originally provided by relative enterprises without clear concept on environmental protection expenditure, data (information) about environmental expenditure are difficult to develop good measurement.

Take Norway for example, although the theoretical concept of environmental protection expenditure has undergone development and refinement, the method of calculating or estimating investment expenditure values hasn't changed a lot from the early 1980s. Hass and Smith stated that 'the biggest problem involves investment in integrated (or pollution prevention) plant and equipment'.

American faced similar problem that they developed survey on environmental expenditure to enterprises since 1973, however, over the years numerous academic studies (including some by the authors) have cast suspicion on the quality of PACE data (Becker and Shadbegian 2007).

1.3 Objectives of this Research

1) Analysis the deterioration of PRC's environment;

2) explore the relationship between economic and social growth and environmental pollution in P.R.C;

3) evaluate if the environmental investment was enough;

4) analysis if the investment direction need to changed or promoted;

5) give suggestions on how to improve environmental protection in PRC.

1.4 Structure of This Thesis

The organization of this thesis is summarized as the following (see Figure 1.1).

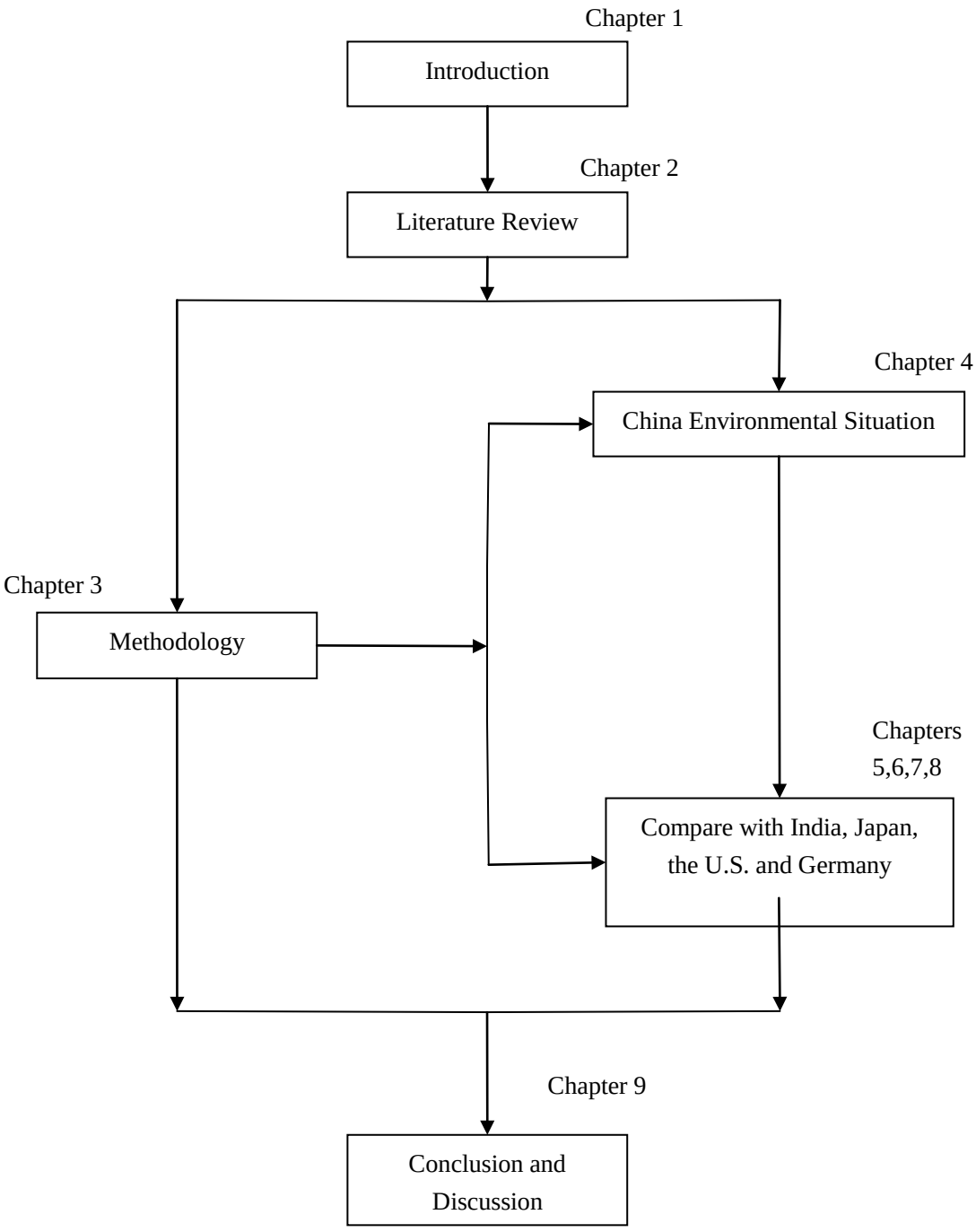
Chapter 1 is an introduction to the research issue and provides information on the current focus on environmental degradation throughout the world. Chapter 2 critically reviews relevant literature on theories in environmental protection investment and provides the research's contextual background. Chapter 3 defined the research scope and methodologies of this study.

Chapter 4 provides environmental conditions in China and the relationship between economy, society and environment. From this chapter, the first two objectives of this study would be solved. Chapter 5, chapter 6, chapter 7 and chapter 8 undertake a contrast between P.R.C. and India, Japan, the U.S. in 1970s and Germany. The four chapters provide developed regions' relevant investment and their legislation framework for the compares conducted on the

remaining chapters. Each chapter will have its own conclusions.

The last chapter, Chapter 9 summarizes the whole research, concludes the thesis and points out the conceivable future directions for research.

Figure 1.4: Organization of the Thesis



2. Literature Review

2.1 Interfaces between Environmental Prevention and Economic Development

2.1.1 Interaction

The most conspicuous environmental impact on social economy is the pollution cost made by environmental problems. Estimates of economic losses in China caused by pollution range from 3.5 to 8.3 percent of GDP based on a study by the Policy Research Center for Environment and Economy of the State Environmental Protection Administration (Lin, 2003).

According to China Statistic Bureau, the average direct economic losses induced by environmental accidents from 2000 to 2006 was 140 Million Yuan, which took about 0.013‰ in the average GDP in due years. Figure 2.1 shows the direct economic losses from 2000 to 2006, where the steep slope induced to a fluctuation line on Figure 2.2.

Figure 2.1 Direct economic loss in China

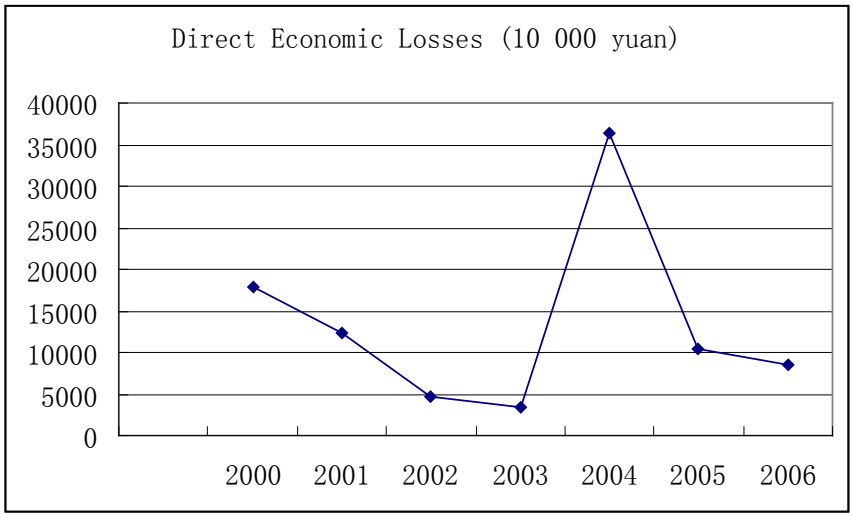
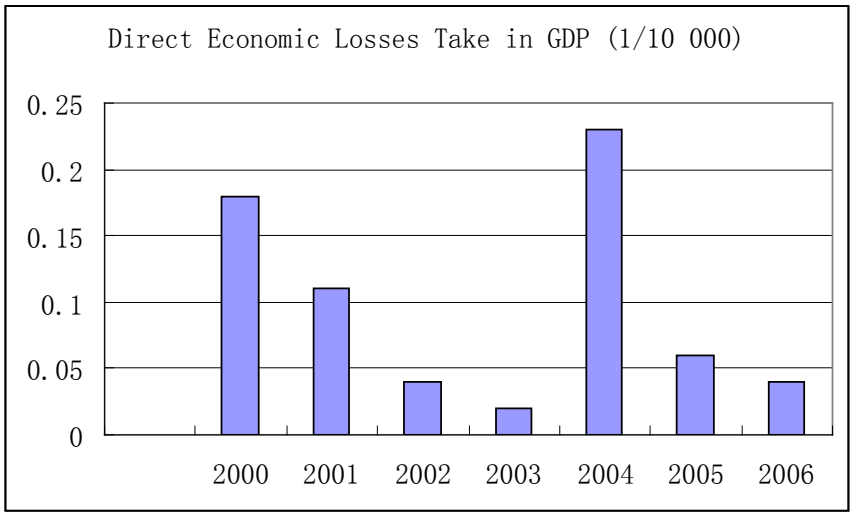


Figure 2.2 Economic loose take in GDP



Although direct economic losses took a tiny percentage in GDP for years as shown in Figure 2.2, the amount of the average losses 140 million Yuan approximately equals to total investment in the primary industry from Hangzhou City, capital of Zhejiang Province in 2005 (Zhejiang Government, 2006).

Environmental problems also influenced (1) health, (2) industrial and (3) recreational aspects of economy as interpreted blow.

One threat to public health is the costly effect of organic pollutants in water. Disease-causing bacteria are present in organic wastes and domestic sewage. The disease menace to public health remains a real ganger in less-developed countries nowadays. One example of public health problems related to water pollution is the periodic appearance of cholera in Africa, Middle-east and Far East countries. The economics effects of organic pollutants are in term of the cost of treatment incurred to avoid the dangerous associated with epidemic diseases.

Inorganic toxins in water also presented considerable dangers to public health. The conventional poison and inorganic toxins are an example of the immediate dangers. Similar with organic pollutants' case, the economic cost incurred to control the levels of inorganic contaminants in domestic water suppliers.

The less easily measured cost is the welfare damage and the potential human health costs. That is the long-term consequences of the human ingestion of the substances and the complex reactions of the substances with human body processes over extended lengths of time. For example, researchers have found statistical significant relationship between cancer deaths and domestic use of Mississippi River (Page, Harris and Epstein, 1977).

Another kind of cost must also be included, which is the treatment of water taste, odor and other esthetic characteristics.

Poor air quality directly affected human fatalities from the recording of environmental problems. Incidents of poor air quality leaded to a great deal of deaths in few days. The higher population density there was, the more deaths

were caused. According to an air quality expert from World Health Organization (WHO) (2007), there are about 656 thousand Chinese people death due to air pollution. The World Health Organization estimated that 800,000 people globally – including 600,000 in Asia – die prematurely each year due to air pollution (Schwela, 2006). Evidence suggested it is more widespread and ultimately more damaging that effects may accompany persistent human exposure to poor air quality over long time periods (Seneca and Taussig, 1984). Lave and Seskin (1977) estimated that over 16 billion dollars in potential health benefits could be realized from significant reductions in sulfur dioxide and particulate levels/

The economic cost, due to air pollution in human health, were mainly included treatment of air contaminants, death losses, and treatment of disease such as lung cancer, asthma, emphysema and bronchitis.

The relationship between economic prosperity and environmental problems is probably most apparent in the area of solid wastes. Waste collection, disposal, and reuse, all solid waste treatment phases need vast quantity of human labors. And all these steps will easily create air pollution and therefore causes human health disease.

The effect of environmental pollution from secondary industry is obviously. Corrosion dangers resulting from a natural high mineral content of water are normal in industrial uses of water (Seneca and Taussig, 1984). Water that meets the quality standards requires treatment in order to remove economically damaging characteristics as hardness, acidity, alkalinity, or salinity. Thus the economic cost is the expenses undertaken to avoid the industrial damages.

Air pollution on the other hand had direct harmful effects on primary industry—agriculture. Its damage involved hundreds of millions of dollars annually for the U.S. economy. In addition, air pollution such as acid rain can injure ecological systems and cause the loss of natural wildlife.

The value of the resulting reduction in outdoor recreational activity is a pollution damage cost, which need to be considered as one pollution effect on the economy.

2.1.2 Interdependence

Economic growth has been accompanied by increasing demands on the state's environmental resources. Water is widely used in manufacturing industry (Seneca and Taussig, 1984). Take electricity demand in China for example. Lin (2003) demonstrated that China's high dependency on coal for electricity generation was expected to continue. More than a half share of the growth in power supply is expected to come from coal-fire power plants during the period. The share of hydro power plants will remain at about 24 percent, the share of nuclear power will be no more than 4 percent, and the share of diesel plants is negligible (Lin, 2003).

Not only in China, was water requirement in urban areas throughout the world increased at an alarming rate. Take Delhi, a city of India for example, water needs met from surface and subsurface. The total requirement was about 3200 liters per day (Subramanian, 2002).

Economic increase also had a numerous demand of population, take population as one natural resource. In one hand, factories built up in few years in order to

produce commodities and make profit to level up factory owners' life. The manufacturing lines cannot help the owners reach their aims without plenty of workers and managers. On the other hand, of more importance, goods need consumers to purchase.

People's participation in outdoor recreational activities such as swimming, skiing, fishing, hiking, sight-seeing, camping, require the use of high qualities of water, air and land. At low levels of dissolved oxygen (DO), water bodies become incapable of supporting fish life (a publication from University of Minnesota, 2008).

2.2 Previous research on environmental investment in PRC

2.2.1 Research on PRC environmental situation

Research on environmental pollution in PRC had done much since 1990s in domestic and much earlier in overseas. Despite the frequent recurrence of environmental problems throughout human history, widespread concern about environmental quality began only in the late 1960s and largely confined to the United States and a few other economically advanced countries.

Rapid growth of the Chinese economy after 1978 was an extraordinary achievement in PRC (Knight and Song, 1999; Cannon, 2000).

Water pollution situation had improved somewhat in recent years in China (Hailu and Veeman, 2000). Most cities were investing rapidly to expand waste-water treatment, so water quality might likely to continue to gradually

improve.

Along with the development of industrialization and urbanization，total mass of wastewater maintain increased in a rate of about 4% during the last 10years. The total wastewater discharge quantity reached near 50 billion tons in year 2004, which is increased by 4.9% than year 2003. The discharge volume of domestic wastewater as well as COD in the wastewater gradually goes beyond that of industrial wastewater in 1999, which take the 54.2 percent in total discharge quantity in 2004.

Air pollution in PRC got a lot of concerns from both domestic and overseas. Environmental quality in China had been improved due to a variety of programs implemented by the Chinese government in recent decades (Yi, Hao and Tang, 2006). Urban air pollution and its impact on urban air quality was a world wide problem (Fenger, 1999). Air qualities in urban area were worsening as the population, traffic, industrialization and energy use increased.

China was the second largest contributor to air pollution in the world (Feng, 1999). The road vehicles were responsible for 70% of the sulphur in Beijing's air (Watts, 2005).

2.2.2 Research on PRC environmental laws and regulations

As in many developing countries, the enforcement of environmental regulations in PRC was considerably more confused than their promulgation (Lo and Fryxell, 2005; Robins, 1990).

The bulk of regulations were not being uniformly implemented across China and

that many of the country's environmental problems appear to be getting worse (Vermeer, 1998; Ma and Ortolano, 2000; McDermott and Stainer, 2002). Two main factors appear to be most responsible for the gap between promulgation and enforcement (Lo and Fryxell, 2005). The first was that increasing levels of economic activity usually more than any offset any gains associated with environmental regulations (Xie, 2001; Xu, 2003). In most government departments, it was possible for the regulations to keep pace with increasing pressure on ecosystems (Lizieri and Palmer, 1997; Zheng and Qian, 1997; Zhou, 1997). Another factor was the problem of achieving effective regulatory enforcement (Ross, 1988; Lo and Tang, 1994; Tang, Lo, Lo, Cheung, 1997; Neller and Lam, 1994; Chan, Wong, Lo, and Cheung, 1995; Sinkule and Ortolano, 1995; Sims, 1999). Numerous reasons had been cited for problems with regulatory enforcement in China (Swanson and Kuhn, 2001). In addition, PRC's fragmented bureaucratic administration created jurisdictions, conflicts over priorities, and insufficient coordination (Lieberthal and Lampton, 1992; Shirk, 1993; Yuan and James 2002).

2.2.3 Research on green GDP of China

Davis Pearce and his colleagues outlined an environmental economics approach in their book, published in 1989, Blueprint for a Green Economy. This document and subsequent writings from this 'green' form of economics is characterized by its aim to translate environmental problems into economic problems (Barry, 2007, p224). Professor J.H. Dales (1968) defined waste disposal costs to be the sum of (1) pollution prevention costs and (2) pollution costs.

The simple following equations (Seneca and Taussing, 1984, p13) explore the

method calculating waste disposal costs:

$C_{\text{Waste Disposal}} = C_{\text{Pollution Prevention}} + C_{\text{Pollution}}$ (1)

$C_{\text{Pollution}} = C_{\text{Pollution Avoidance}} + C_{\text{Pollution Damage}}$ (2)

C: Cost

In China, Green GDP was at its beginning, but more and more researchers began to treat its calculation and tried to well form it (Wang, et al. 2004).

2.2.4 The interface between environment and society in P.R.C

Experiences indicated that one of the most important elements in the economic increasing is the development of industry (Shen, 1999; Wan, 1998). If pursue following the traditional means, developing industry entailed the inefficient consumption of limited national resources and generation of industrial pollution.

A new paradigm is now being forced by environmental issues and related matters such as human health, animal welfare and the application of new reproductive technologies to the human species (Dickens, 1992).

Industrial-capitalist system forced landless, homeless peasants having been removes from the land into cities in European history (Barry, 2007, p219)

'Air and water pollution and other environmental problems are as old as the human species' (Seneca, 1994, p5). 'Great Stink' in London of June 1858 was the result of using the Thames River as a common sewer.

China is the second largest electricity producer in the world (Sinton, et al., 1998;

Gao et al., 2004; Lin, 2007) after the United States (Lin, 2003). The installed capacity was 338 gigawattes (GW) and annual electricity generation was 1,446 terawatt-hours by the end of 2001. Nuclear power contributes about only 1 percent of the installed generation, hydropower about one quarter, and thermal power about three quarters (STATISTIC). In the last two decades, demand for electricity has been increasing more rapidly in China than anywhere else in the world (Sinton, et al., 1998; Lin, 2003; Levine, 2005). The averaging 9 percent annually growth rate approximately equals to the rate of annual GDP growth.

To meet rising demand, China must address such issues as how to meet the resulting enormous capital requirements and how to prevent environmental deteriorations.

According to one research conducted by Asia Development Bank, electricity demand will have an increase of over 60% for the period: from 1,446 terawatt-hours in 2001 to 2,362 terawatt-hours in 2010 (Lin, 2003; Lin, 2005).

As demonstrated (Lin, 2003), China's high dependency on coal for electricity generation was expected to continue due to two reason. One is the need to maintain low electricity tariffs and the other is abundant domestic coal supply.

There must be a great concern on the environmental impact of coal consumption because of the rapid growth of power demand in China and high dependency on coal for electricity generation. 138 GW was expected from coal-fired power plants in the total incremental capacity of 187 GW during 2002 to 2010 (Lin, 2003).

Flue gas desulphurization was installed for only about 20 percent of new plants

until 2003. Most of them were located in more developed regions. It was therefore predicted that 50 percent of newly constructed coal-fire power plants would be equipped with flue gas desulphurization before 2010 (Lin, 2003).

It is remain a long way from the science allows people to live in a perfect world, where the world population is suitable and people recycle all waste and generate zero pollution (Gareth, 2004).

Individual actions can make little impact on the environment, preferring instead to concede responsibility for the environment to the politicians in the expectation that they will introduce legislation that will ensure a ‘safe’ environment. However, environmental policy may not be upper most in the minds of political leaders. The economic state of the nation usually takes priority (Gareth, 2004).

The increased level of CO_2 originated from the burning of fossil fuel (mainly coal) (Schneider, 1989; Gareth, 2004).

Land degradation occurs specifically when ‘excessive’ use is made by humans of a part of the landscape. In the process of gaining the things they need for their continuing survival and reproduction, all human change and transforms the natural environment (Philip, 2007). Rather than investing energy, time, and resources into simply ameliorating the worst effect of inequality, green political economy seek to address the root causes of it (Barry, 2007).

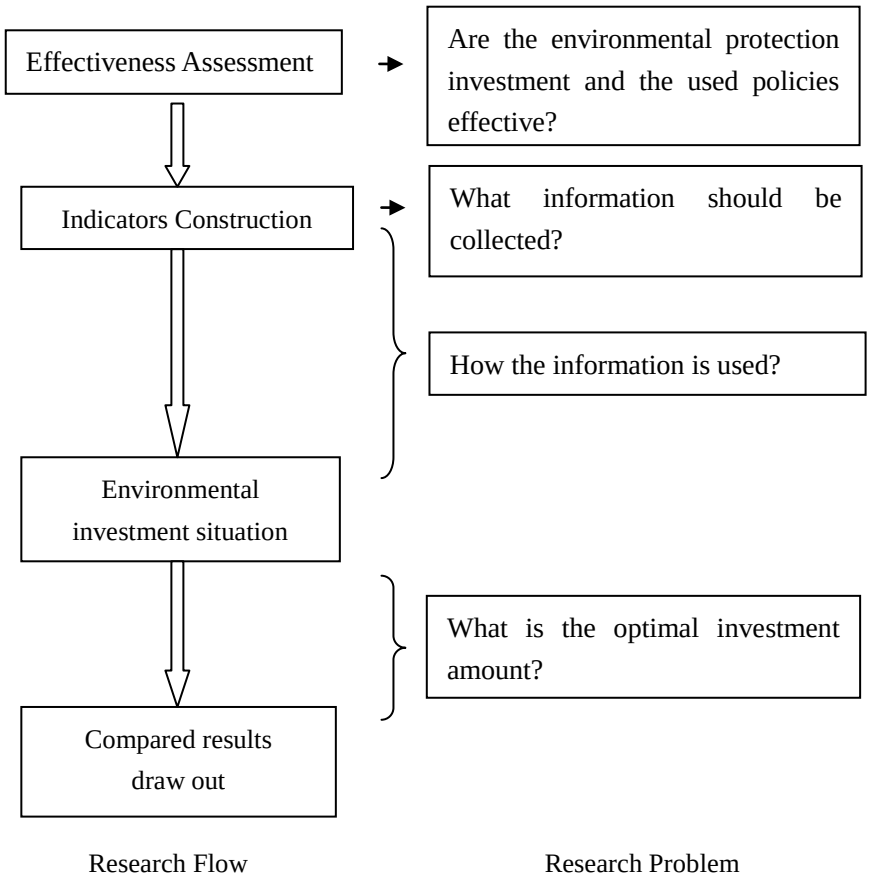
These four aspects of environmental protection were conducted many research. However, few studies conducted on the proper value of environmental investment, by comprising investment amount in different countries.

3. Methodology

3.1 Research Framework

The research problem defined in this study is investigated through the following research flow shown in Figure 3-1. The left part in the Figure is the research flow and the right part is the corresponding research problem.

Figure 3.1: Research Flow and Research Problem



The expatiations for the research method will be given as follows

3.2 Materials and data collection

The website of National Bureau of Statistic of China, Chinese statistics yearbook (Annually, 1973-2006) published by China Statistic Press, China environmental yearbook (Annually 1999-2006) published by China Environmental Science Press, the website of State Environmental Protection Administration of China, the website of the U.S. Environmental Protection Agency, the website of World Bank, the website of Organisation for Economic Co-operation and Development (OECD) and many other investigation reports are useful data sources in doing this study.

One problem must be tackled that data from the above sources is not exactly the same. When there are discrepancies among data, two classes of data have two ways to settle.

For data related to China, ones from the website of National Bureau of Statistics of China have the priorities since this study aims at assess the environmental protection investment in PRC and the National Bureau of Statistics of China has the authorities to publish statistic data and renew in time. The second selected source and thereafter are China statistic yearbooks, China environment yearbooks and the website of State Environmental Protection Administration.

For the other class of data, ones related to western countries and India, each country's website of Statistical Bureau and EPA will be firstly referred. However, not all data are provided in English version in non-English language countries such as Germany and Japan. And sometimes, take India for example, limited authorities to access governmental website hamper data collection. Data in

publications are always corrected with updated information each year and considered to be an authentic source worldwide, thus data from the website of the World Bank and other investigation reports helped to make a choice when select data and act as a important supplement to official published ones.

3.3 Methods used in forming assessment

The literature review is adopted to form an overview first. Parameters such as pollution emission amount, GDP, per capita GDP, population density, and investment amount are selected to illustrate situation of environmental protection investment and economic level.

Any regulations or conducted method of environmental investment made by governments should be based upon the local and national economic situations (Garner, 1996). Thus the economic features of China will be explored firstly by comparing with some representative developed countries. In doing so, we need to analyze the three main factors in evaluating economies – GDP (Gross Domestic Product) or GNP (Gross National Product), employment rate, and inflation (Stiglitz et al., 1992). In these three factors, the value of inflation rate in China has dissensions for a long period, and this rate is not so closed related to the environmental problems. Therefore, the inflation rate will be ignored when calculating GDP and the environmental expenditures thereafter.

Pollution prevention costs involved direct outlays by government, to purchase resources to inhibit pollution. According to this nomenclature, the costs incurred by a local government to treat its sewages before dumping them into a river are

pollution prevention costs.

Pollution costs shown on governments' materials were the aggregate of pollution avoidance costs and pollution damage costs (Seneca and Taussing, 1984, p13). In another words, pollution costs can be broken into two categories: (1) the private or public expenditures undertaken to avoid pollution damage once pollution has already occurred and (2) the welfare damage of pollution.

However, the full welfare costs of pollution damage are impossible to measure exactly (Seneca, 1984, p12). The private expenditures mainly from related manufacturing enterprises hardly can be calculated accurately (Hass and Smith, 2002) either.

Thus in the dissertation, only pollution prevention costs and pollution avoidance costs will be used to forming following contrast between countries. In some cases, the pollution abatement and control (PAC) expenditure will be used to undertake contrast.

3.4 Methods used in determining states or regions for contrast

How to choose proper countries to undertake contrast is a problem of importance in this study. Since environment quality determined by countless factors, such as its own variation and surroundings' complicated effect, the most important ones of them should be selected.

3.4.1 Factors affecting environmental quality

All human societies change and transform the natural environment in the process of gaining the things they need for their continuing survival and reproduction (Philip, 2007, p55). Society's relationship to natural environment have been reshaped by large, density populated urban areas, immensely long road and transport networks, the industrialization of raw material extraction and food production, and the twentieth-century mass consumption of goods.

Population and population density

A positive correlation between population growth and natural resources demand is expected. Population density directly determines pollutants discharge amount.

Energy, conservation of natural resources

The energy consumption will lead to higher demand for energy power. In most developing countries, non-renewable energy sources such as coal and lignite would be chosen. Coal and lignite are just the contributors of CO_2 and other GHGs.

Economic growth

The growth of commodity production has led to water pollution, soil erosion, destruction of fire wood resources and loss of genetic diversity of plant and animals, although it will improve the satisfaction of basic needs (Mohan, 2002, p245).

Structural Changes in the Economy

Heavy industry became the main contributor of electricity consumer in China,

which used up about 60% of the total electricity consumption (Lin, 2003).

3.4.2 Classify countries by factors affecting environmental quality

On the basic of analysing factors affecting environment, an overall comparison can be conducted between China and other countries in economic structure and environmental investment.

First of all, economic situation will be explored because the investment depends on economic strength. Although not all countries have similar economic strength with China, some of economic features of them such as GDP growth rate, and economic structural will be compared with that of China in order to explore comparability. Similar features are the first foundation in choosing comparable countries.

The second phase is according to some of the factors affecting environment, such as population, industrial reliance and pollutant emission volume, to illustrate economic developing level between the two at the very beginning.

Then the environmental conditions and countries' environmental achievements will be compared. From this step, major pollutant sources, objectives of environmental investment of the countries, and weather the investment is efficient will be explained.

3.5 Study's Scope

3.5.1 Definition of environment

There are various definitions and understandings of the environment from

dictionaries and thesaurus. Here hare some definitions of ‘environment’ that can be found.

A computer thesaurus defined environment as ‘surroundings, milieu, atmosphere, condition, climate, circumstances, setting, ambience, scene, and decor’. Roget’s Thesaurus (1988) explained environment as ‘situation, position, locality, attitude, place, site, bearings, and neighborhood’. Environment also delineated by Collins English Dictionary and Thesaurus (1992) as ‘surroundings, conditions of life or growth’.

In this dissertation, environment refer to surroundings closest related to people’s life in atmosphere, hydrosphere and lithosphere. Ambient air, wastewater, and solid waste will be the of most focus issues. Climate change, degradation of rivers and lakes, forest erosion will not be discussed in this thesis.

3.5.2 Environment pollution

Almost anything can be considered as polluting to human societies (Philip, 2007). Noise from neighbors’, stuffy indoor air, nuclear leak, ocean oil spills…… This thesis will narrow the different types of pollution down to those that affect the air, those affect the water and those affect the land. These three main types of pollution were globally widespread concentrated on.

3.5.3 Definition of investment

According to one BPP Press publication, ‘an economist looks at the term from the point of view of investing in the factors of production, particularly capital – new machinery, land and buildings etc.’

Actually, the definition of investment can be provided from two academic aspects – finance and business. From finance point of view, investment can be defined as the purchase of a financial product or other item of value with an expectation of favorable future returns. On the other hand, in business, investment can be defined as the purchase by a producer of a physical good, such as durable equipment or inventory, in the hope of improving future business (Peng, 2005).

Whatever the definitions of investment said, in this thesis, the investment refers to the real expense from government or individuals.

3.5.4 Definitions of Environmental Protection Investment

There are several definitions on environmental protection investment showed up by different researchers based on their research purposes. Generally speaking, environmental protection investment is an investment made by environmental protection investors, such as governments, enterprises, social communities and individuals in order to achieve environmental, social and economic effectiveness. During this economic activity, financial resources were allocated into environmental protection industry to increase capital, to protect surroundings from polluting, to maintain ecological balance, and to obtain a sustainable developing society (Peng, 2005).

The EU Statistic UK describes environmental expenditure on their website as how much has been spent to protect the environment. It includes both investments and current expenditure.

Environmental protection investment can be divided into three main categories

according to investment orientations, investment for pollution treatment, investment for protect and enhance ecology, and investment for management and research and technology (Jiang at el, 2005).

In this dissertation, it will be focused on that environmental protection investment in pollution treatment and in pollution prevention and related environmental protection current costs made by Chinese government.

The environmental protection expenditure calculated the government investment in anti-pollution industry, including the equipment purchase and maintenance fees, waste treatment plants construction and maintenance fees, chemicals for treatment plants and sludge dewatering and related expenses.

However, the social input in China which hasn't been effectively stimulated (compared to the U.S. local expenditures took near 17% total expenditure in 1970s) can hardly be calculated. One reason is there isn't plenty records on social investment in anti-pollution. Another one is the social investment activities haven't been well stimulated (Lu and Gao, 2004; Wang and Chang, 2003), which means social investment takes really a tiny part of the whole investment amount in China.

4. Environment situation in PRC

Environmental problems which appeared during hundreds of industrialization years in western countries presented in less than thirty years in China. China's air pollution for example, caused by use of coal and many other development enquiries as serious today as that which the developed nations faced in the 1950s and 1960s, their worst pollution period (Wan, 1998). Besides the developing enquiries, the high population density in Chinese eastern coast cities made environment itself cannot digest uninterrupted industrial and domestic pollutants. Although Chinese western provinces do not have as high population density as eastern provinces, education there cannot be hoped to include environmentalism for the lack of well-trained teachers to teach and the scarce capital to fund.

According to China Daily, the government of north China's coal-rich Shanxi Province is to spend 1.19 billion Yuan (US$155 million) this year on areas disfigured by coal mining. Northwest China's Lanzhou, known as one of the most polluted cities in the world, plans to spend 130 million Yuan (US$16.9 million) this year to fight pollution in the Yellow River, which runs through the city. However, weather the expenditure is enough need to be assessed because one city in Shanxi province still stand in the top six polluted cities claimed by Blacksmith Institute in 2006, and Lanzhou's environmental quality achieved the lowest level in 2006 according to Lanzhou Daily.

4.1 Environmental pollution in PRC

Pollution levels in many countries outstripped those of western countries and Japan (Stearns, 2007, p235). China contributed 9 percent of total world chemical emissions, compared with 5 percent for Japan, 14 percent for the Former Soviet Union, and a booming 18 percent for the U.S.

4.1.1. Water pollution

4.1.1.1Industrial and domestic wastewater

Water pollution situation had improved somewhat in recent years in China. Most cities were investing rapidly to expand waste-water treatment, so water quality might likely to continue to gradually improve.

Along with the development of industrialization and urbanization，total mass of wastewater maintain increased in a rate of about 4% during the last 10years. The total wastewater discharge quantity reached near 50 billion tons in year 2004, which is increased by 4.9% than year 2003. The discharge volume of domestic wastewater as well as COD in the wastewater gradually goes beyond that of industrial wastewater in 1999, which take the 54.2 percent in total discharge quantity in 2004 (see Figures 4.1 and 4.2).

Figure 4.1 National wastewater discharge trend

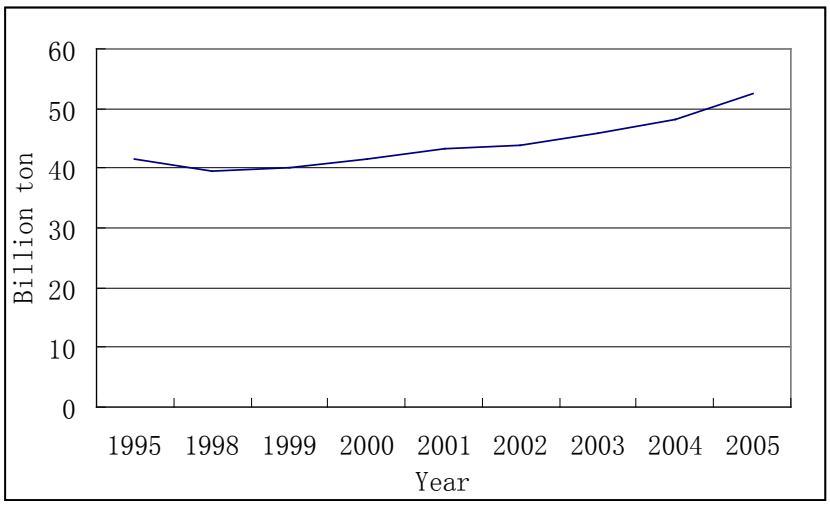
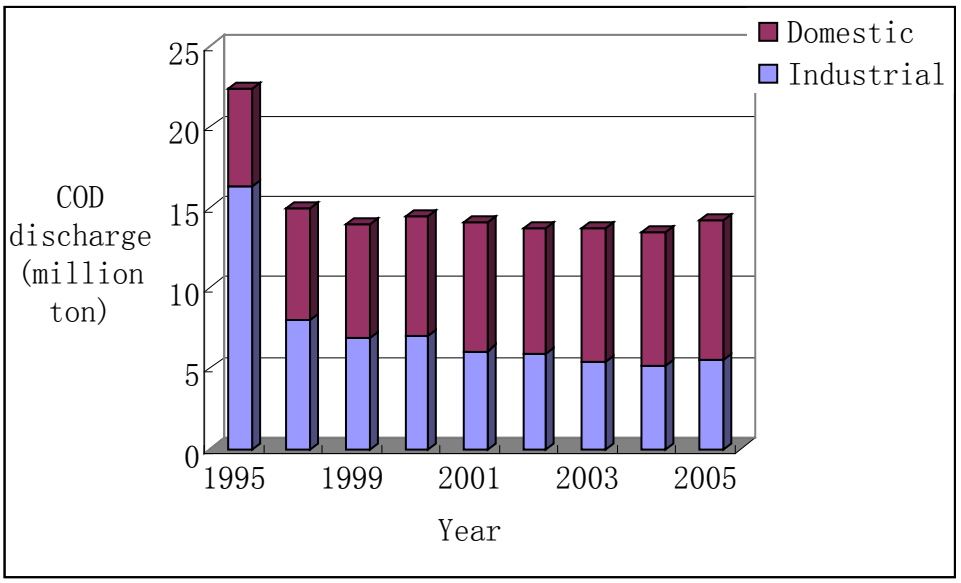
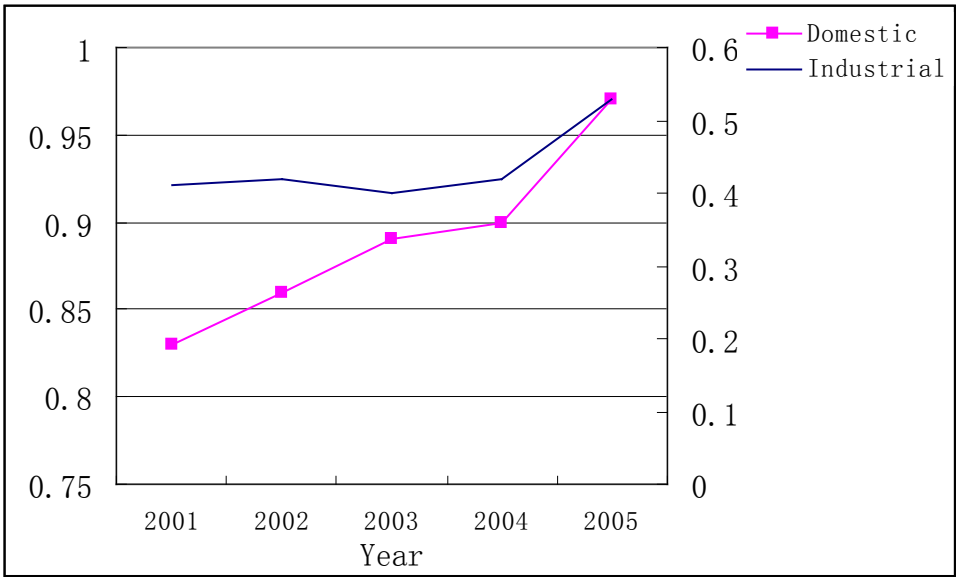


Figure 4.2 National COD discharge trend



However the ammonia-nitrogen discharged volume from domestic growing faster than that from industrial wastewater (figure 4.3). The volume of domestic wastewater was about two times of that from industry from 2001 to 2005.

Figure 4.3 National ammonia-nitrogen discharge trends



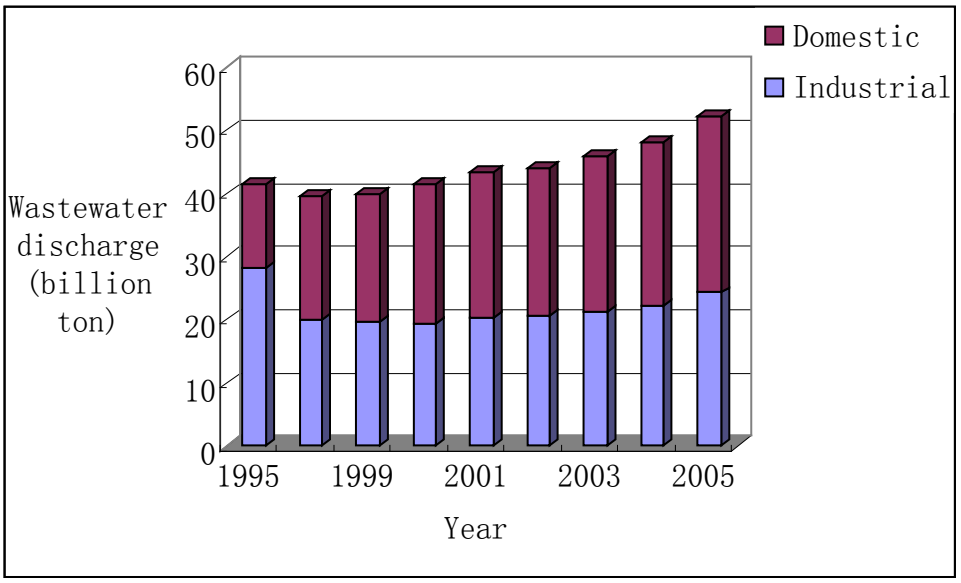
Dollar (2007), the World Bank's Country Director for China and Mongolia in the East Asia and Pacific Region, stated that 'over 90% of industrial discharge is

treated, so that industry is no longer the main source of water pollution. The biggest source is un- or poorly treated household waste (only slightly more than 50% of urban household waste is treated)'.

4.1.1.2 Industrial wastewater

Although the above analysis showed that the main wastewater sources were from domestic, industrialization has had very significant pollution costs for China. And the industrial wastewater still took about a half of total wastewater discharge (see figure 4.4).

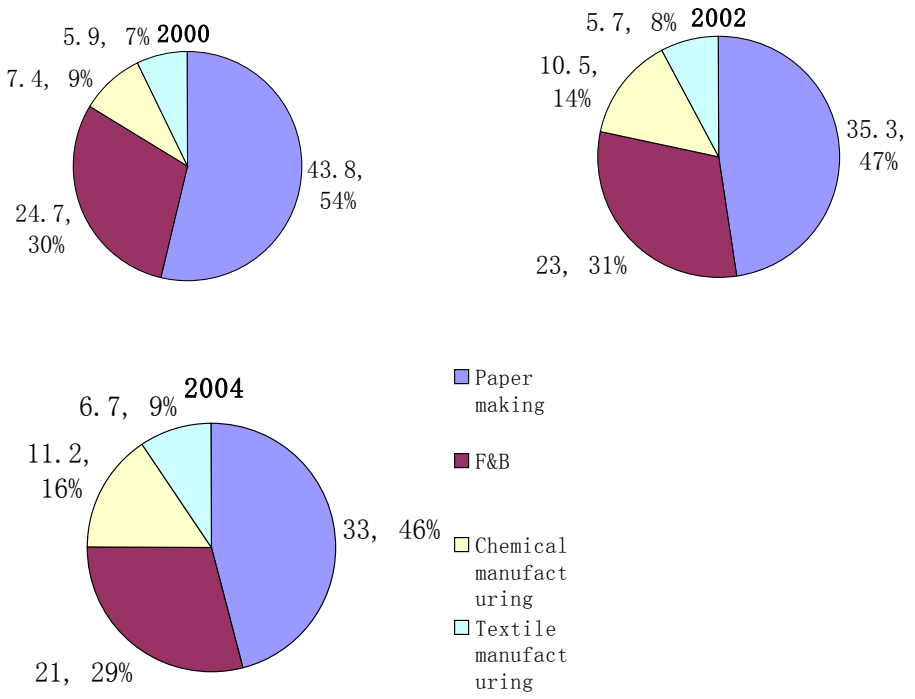
Figure 4.4 Industrial and domestic wastewater discharge



The top four waste discharge sectors whose waste discharge took nearly 80% in the total wastewater discharge were manufacture of paper and paper products, manufacture of foods and beverages, manufacture of raw chemical materials and chemical products and manufacture of textile (see figure 4.5).

Figure 4.5 Ratio of profits to COD discharged of four sectors in 2000, 2002 and

2004



4.1.1.3 Wastewater disposal plants

By the year 2004, there are 637 wastewater disposal plants, which was planned to dispose daily more than 42.55million tons of municipal sewage. The total treated wastewater volume reached 10.14billion ton in the whole year 2004, more than 80% of which equals to 8.58billion ton is domestic wastewater. The actually treated volume is a little more than a half of that is schemed.

Government states that the main problem is the municipal sewerage system, the construction speed of which is left far behind the speed of building wastewater treatment plants. Other reasons reduce the rate of wastewater treatment also be pointed out by the government such as operation system, revenue ordinance, supervise regulations.

4.1.2. Industrial solid waste generation, discharge and utilization

Although the country-wide generation of industrial solid waste obviously grew up in the last ten years, discharge amount sharply reduced and the integrity utilization significantly increased. That means the techniques of treating solid waste improved and on the other hand the investment in treating waste increased.

Table4.1 National total industrial solid waste (million ton)

	Generation		Discharge		Integrity utilization	
	Subtotal	Hazardous Wastes	Subtotal	Hazardous Wastes	Subtotal	Hazardous Wastes
1995	650.00	--	22.27	--	--	--
1998	800.68	9.74	70.48	0.458	333.87	4.28
1999	784.42	10.15	38.80	0.360	357.56	4.65
2000	816.08	8.30	31.86	0.026	347.51	4.08
2001	887.46	9.52	28.94	0.021	472.90	4.42
2002	945.09	10.00	26.35	0.017	500.61	3.92
2003	1004.28	11.70	19.41	0.003	560.40	4.27
2004	1200.30	9.95	17.62	0.011	677.96	4.03
2005	1340.00	11.62	16.55	0.006	770.00	4.96
Increased rate (%)	11.64	16.78	-6.1	-45.45	13.6	23.08

4.1.3. Air pollution

Air pollution in PRC got a lot of concerns from both domestic and overseas. The air quality as showed in Table 4.2 became worse year by year. Only the emission of dust declined a little.

Table4.2 National total waste gas emission (million ton)

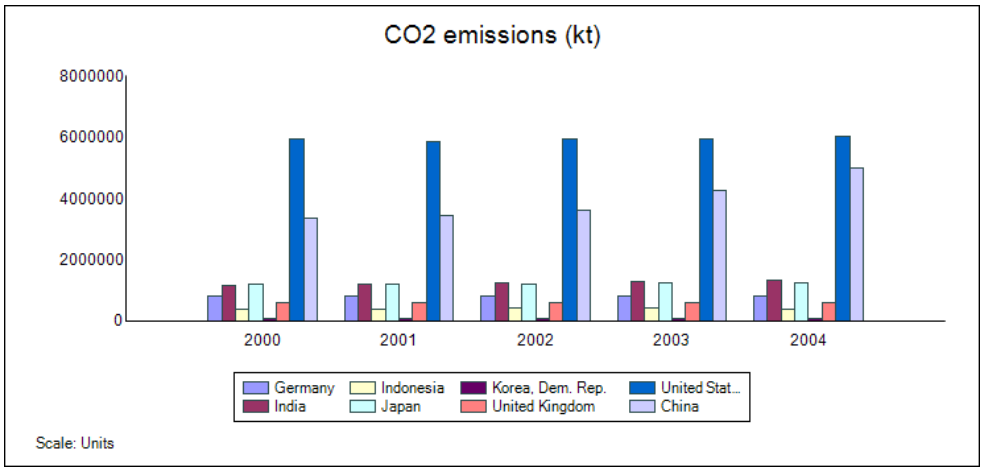
	Emission of SO_2			Emission of Soot			Emission of Dust
	Subtotal	Industrial	Domestic	Subtotal	Industrial	Domestic	
1995	23.70	13.96	9.74	17.44	--	--	17.31

1998	20.91	15.94	4.97	14.55	11.78	2.76	13.21
1999	18.57	14.60	3.97	11.59	9.53	2.05	11.75
2000	19.95	16.12	3.82	11.65	9.53	2.12	10.92
2001	19.47	15.66	3.81	10.69	8.51	2.17	9.90
2002	19.26	15.62	3.64	10.12	8.04	2.08	9.41
2003	21.58	17.91	3.67	10.48	8.46	2.02	10.21
2004	22.54	18.91	3.63	10.94	8.86	2.08	9.04
2005	25.49	21.68	3.81	11.83	9.49	2.34	9.11
Increased Percentage (%)	13.08	14.65	4.96	8.16	7.11	12.50	0.77

4.1.3.1 Use of coal and fuel

The trend of coal and fuel consumption went along a climbing curve during the last decade. Coal consumptions with an average annual growth rate of 8 percent led China became the world's second largest CO_2 emission for more than five years (OECD, 2005) as showed in the figure 4.6 below.

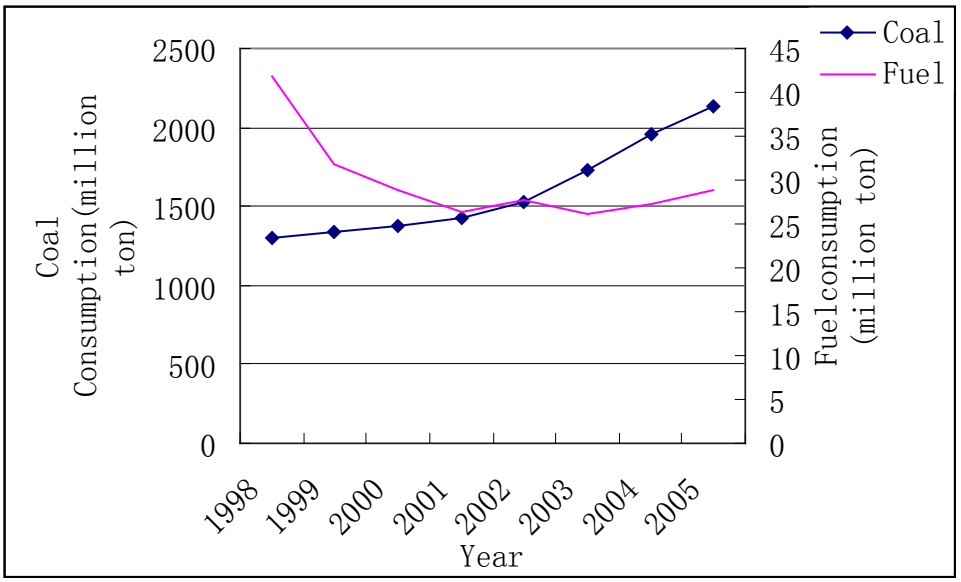
Figure 4.6 CO_2 emissions from different countries from 2000 to 2004



Total consumption of coal was 1.96billion ton, increased by 13.4% than 2003, including 1.26billion tons of industrial consumption. Industrial consumption of coal accounted for about 90%of total consumption, which increased by up to

15% than year 2003. 0.2billion tons of domestic coal consumption in 2004, accounted for 10.2% of the total, maintained the level during last 10years. Total consumption of fuel in 2004 reached 27.34million tons which increased by 4.2% than the year before (see figure 4.7).

Figure 4.7 National total consumption of coal and fuel (million ton)



If the consumption of coal and fuel kept its present increased rate, because of 85% energy in China was from coal burning (Murray and Cook, 2002) which showed on Table 4.3. It is urgent to change traditional production and consumption manner, or the worst environmental period will arrive ahead of schedule.

Table 4.3 Energy use in China

Consumption by Usage	1990	1995	2000	2004	2005	2006
(I) End-use Consumption	60205.9	66156.1	46821.39	59543.75	62154.13	61683.66

Industry	35773.8	46050.3	34122.04	46082.95	48040.74	48006.53
(II) Intermediate Consumption (Consumed in Conversion)	41257.8	69487.6	85178.61	134052.3	154568.4	177532.8
Power Generation	27204.3	44440.2	55811.2	91961.56	103263.5	118763.9
Heating	2995.5	5887.3	8794.07	11546.56	13542.0	14561.43
Coking	10697.6	18396.4	16496.4	25349.58	31667.06	37450.09
Gas Production	360.4	763.7	959.99	1316.43	1276.96	1257.08

4.1.3.2 Industrial and domestic discharges of sulphur dioxide and dust

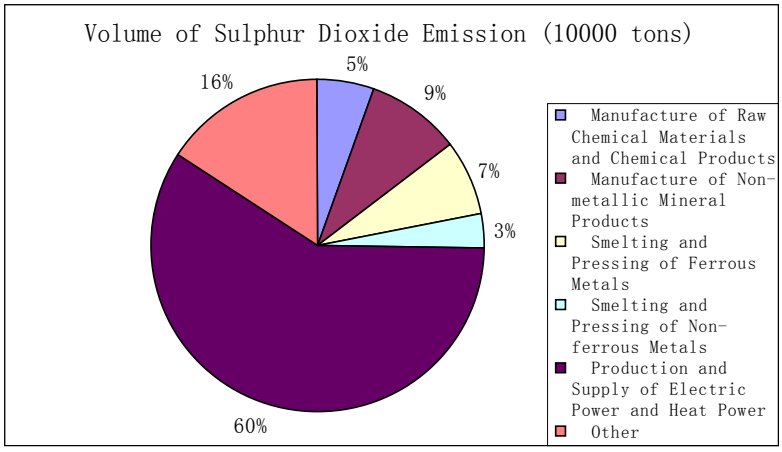
In 2004, country-wide industrial waste gas exhausted 23,769.6billion cubic meter having a considerable increase of 20% than the year before. Total discharge of SO_2 reached 22.55million ton, More than 80 percent of which discharged by industrial production.

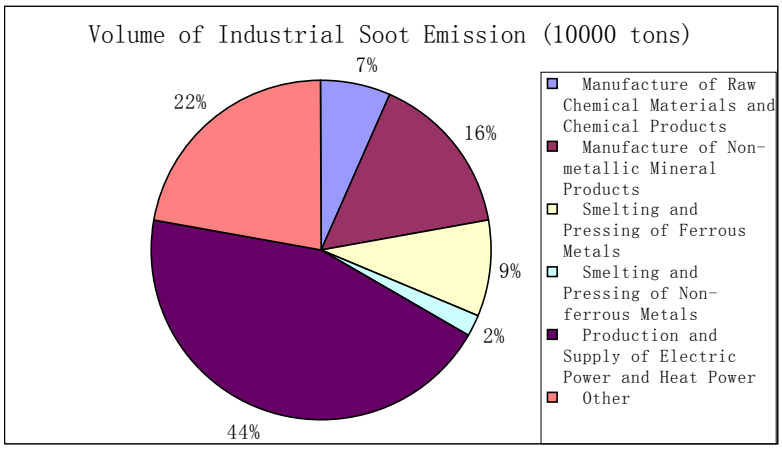
Since the over development of iron, cement and electrolysis aluminum, industrial dust exhaust, industrial discharge of SO_2 and industrial consumption of coal have the obvious increasing trend. Although domestic dust exhaust, domestic discharge of SO_2 as well as domestic consumption of coal have slightly fluctuation because of not widely used of nuclear and oil energy resources. Countrywide discharge of SO_2 and dust also went up year by year. This was resulted from industrial air pollution, which took more than 80% in total exhaust of air pollution.

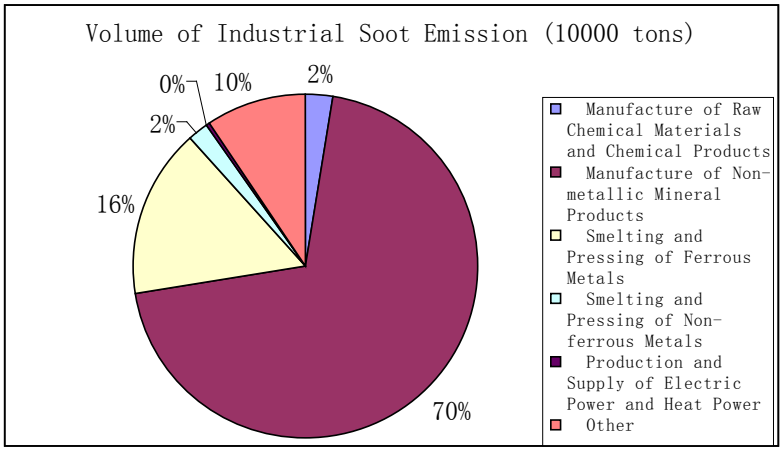
4.1.3.3 Industrial air pollution

As stated above, 80 percent more of air pollutant came from industry. The top five air pollution emission sectors as showed in Figure 4.8, whose discharge took more than 80% in the total waste gas discharge are electric power, manufacture of non-metallic mineral product, smelting and pressing of ferrous metal, manufacture of raw chemical materials and chemical products, and smelting and pressing of non-ferrous metals.

Figure 4.8 Ratios of profits to air pollution emission of four sectors in 2000, 2002 and 2004







The total ratio of profits of these five sectors to economy maintains a little more than 30%. Table 4.4 showed the comparatively high ratio of profits to economic as well as the large amount of SO_2 discharge of electric power industry.

Table 4.4 Ratio profits to economic and SO_2 pollution of electric power industry (%)

	2000	2001	2002	2003	2004
SO_2	43.2	53.5	54.9	61.7	57.1
Economy	6.7	5.7	6.4	5.7	5.2

4.2 The interface between environment and economy in P.R.C.

Industrial growth in China, as in other industrialized countries, brought in new wealth to many people. China policy placed economic growth ahead of the environmental concerns (Stearns, 2007).

After the middle of the 90's 20 century, the insufficient economy times, the real increase rate of the economy mostly determined by the demand fact. At the same time, China has a fabulous economic gain during the last decades.

From industrialization point of view, China now in the middle of industrialization, the economic growth depends on the development of energy consumed and polluted industry. Industrialization and civilization boost China's development just like UK in 100-year before and USA in 200-year before, rural residents flow into cities. The urban residents' percentage changed from three in ten to seven in ten. Thus increased urban population density led greater pressure on city environmental problems.

At the same time, there are 219,463 state-owned enterprises and non-state-owned enterprise above designated size, which reached nearly 1.5 multiple of enterprises amount in 1998. (There are 165080 state-owned enterprises and non-state-owned enterprise in 1998) Including 6086 manufacture of paper and paper products companies, 8282 manufacture of foods and beverages companies, 15,172 manufacture of raw chemical materials and chemical products companies and 17,144 manufacture of textile companies, all state-owned enterprises and non-state-owned enterprise made a Gross Industrial Output Value 18,722.07 billion Yuan, take 13.68% in GDP of 2004. (2004 GDP =136.88 billion Yuan) These data shows that high-polluted industry give a great effort to pull the economic growth.

Table 4.5 showed the GDP growth rate, industrial production, and some data on environmental protection from 1995 to 2004. （http://www.stats.gov.cn）

Table 4.5 Overview of Chinese economy

Year	2000	2001	2002	2003	2004
(1) GDP (1 billion Yuan)	8950	9730	10520	11740	13690
(2) Environmental	101.5	110.7	136.7	162.8	191.0

investment (1 billion Yuan)					
(1)/(2) (%)	1.13	1.14	1.30	1.39	1.40
Direct economic loss due to pollution (1 billion Yuan)	0.178	0.122	0.046	0.034	0.364
Industrial production take in GDP (%)	43.6	43.5	43.7	45.2	45.9
Total Population (1 billion persons）	1.27	1.28	1.28	1.29	1.30

From the table above, it is found that the increased rate of investment in the treatment of environmental pollution was growing faster than that of GDP in China. But the former was still a tiny proportion of the latter. The industrial production took around 40% in GDP which was approximately the same as the percentage in USA between 1869 and 1899. It was prospected in 2020, the population in China would reach 1.4 billion to 1.5 billion, and GDP would increase another time. Besides, there was great populations that have a strong consume ability need a great deal of goods. So, there must be a continual and fast economic rise in the following 5 to 15 years.

Accordingly, China has consume the world's 31%, 30%, 27% and 40% coal, ironstone，rolled steals，cement in 2003, while creating no more than 4% global GDP. Simultaneity, compare with developed countries, the waste water discharge in China is as 5 times per unit GDP as them. And solid pollution produced by Unit Gross Industrial Output Value is 10 times more than developed countries. Last year, the discharge of SO_2 was the most in the world. These data showed the highly increased economy pays for the fearful environmental degradation. And the increase rate of the gross industrial output value mainly pulled by heavy

industry, which was maintained year after year. Therefore, if nothing will be done with the environment, the pollution will add 4 to 5 times, which cannot be afford by the environment.

China as other developed countries went along agricultural society, industrial society, now became stronger in economy. The difference was China hasn't completed its capital accumulation reflects on its GDP per capita was much lower than developed nations (see table 4.6).

Table 4.6 GDP per capita between countries, PPP (Purchasing Power Parity) (current international $)

	1975	1980	1985	1990	1995	2000	2005
CHN	226	412.2	822.7	1303.1	2517.7	3928.0	6571.6
HKG	2935.4	6514.9	10319.6	16512.1	21622.0	26044.5	..
SGP	2498.0	5265.4	7590.9	12040.7	17968.8	23744.3	29921.4
JPN	5456.1	9209.8	13330.9	19241.8	23040.1	26219.8	30821.1
USA	7529.7	12200.1	17532.5	23155.2	27780.4	33970.1	41853.6
DEU	5497.3	9209.6	12664.9	17149.3	21352.1	25480.9	29308.6

Unemployment rate

Another important indicator to evaluate economic policy is unemployment rate. Unemployment rate should be kept in a certain value in order to maintain society stable. China has an unemployment rate around 4% after 2000. However, until 2002, 16.5% employed people work in manufacturing and construction industry which was closed related to industry structure as mentioned before. And this rate

is haven't change a lot from 1978. Table 4.7 make a comparison between China and some developed countries on employment structure. Both the industrial structure and unemployment rate shows China's economy highly depended on heavy industry, and reveals the difficulty China face to treat environment while make people live better.

Table 4.7 Employment by type of industry (%)

Country	Primary industry		Secondary industry		Tertiary industry	
	2000	2001	2000	2001	2000	2001
China		50.0	22.5	22.3	27.5	27.7
United Kingdom	1.5	1.4	25.4	24.9	72.7	73.4
Unites States	2.6	2.4	22.9	22.4	74.5	75.2
Germany	2.7	2.6	33.4	32.5	63.8	64.7

Compare with the developed countries, the primary industry take much more proportion in industrial structure. It seems that the employment by type of industry is another factor affects environmental problems because most developed countries have a similar employment structure and less contaminated environment.

4.3 Environmental investment in P.R.C

The government has gradually increased the proportion of GDP allocated to environmental protection from 0.72 percent in 1989 to 1.33 percent in 2003.

Between 1998 and 2002, 580 billion yuan was invested in environmental protection and ecological construction across China, In 2003, 136.34 billion yuan was invested in treatment of environmental pollution, 23.2 percent more than in 2002. Of the total investment, 78.53 billion yuan was used in construction of environmental infrastructure in urban areas, 18.84 billion yuan in treatment of sources of industrial pollution, and 38.97 billion yuan in environmental protection in new construction projects （SEPA, Ministry of Environmental Protection of the People's Republic of China）.

So far this century, China's environmental protection industry has grown at an average annual rate of 17 percent, far out-stripping the general economy. In 2002, the output value of China's environmental protection industry reached 220 billion yuan, compared to 4 billion yuan in 1992. At present, China's environmental protection enterprises are located mainly in more developed areas along the coast and rivers of eastern China, 6 percent being large enterprises with fixed assets worth more than 50 million yuan. Some authorities predict that this industry will maintain its fast momentum.

Table 4.8 Investment Completed in the Treatment of Industrial Pollution (billion yuan)

	Investment Completed in the Treatment of Industrial Pollution this year	Treatment of wastewater	Treatment of waste gas	Treatment of solid waste
2000	23.94	10.96	9.09	1.15
2001	17.45	7.29	6.58	1.87
2002	18.83	7.15	6.98	1.61
2003	22.18	8.74	9.21	1.62
2004	30.81	10.56	14.28	2.26

The declined trend of both ratio of profits to discharge and economic can be the result of the industrial transform policy.

Table 4.9 Government environmental protection funds (100 million yuan)

	2000	2001	2002	2003	2004	2005
Investment in Anti-pollution Projects of the Year by Source of fund	234.7	174.5	188.4	221.8	308.1	458.2
State Budget	33.1	36.3	42.0	18.7	13.7	7.8
Special Funds for Environmental Protection	6.7	8.3	6.8	12.4	11.1	20.6
Investment in Environment Protection Components for "Three-simultaneity" Construction Projects	260.0	336.4	389.7	333.5	460.5	640.1

4.4 Environmental plan in PRC

Being as the largest developing country, along with the economic prosperity in mainland of China during the last 20 years, environmental problems have attracted more attention from the government. The government has mentioned a grandiose target that constructs an overall affluent society by the year 2020, at the meantime, make the favorable environment a important content in this goal.

A decision about enhance environmental protection issued on Feb.3rd, 2005, by the State Department, point to strengthen the environment technical basis platform construct, and the momentous research program of the environment has the priority to list in the state technology plans.

It is became the ultimate goal for the development of environmental protection industry in the 10th Five-Year Plan period that providing the environmental

protection with technological guarantee and material basis so as to adapt to the increasingly strict environmental protection requirements for the environmental protection industry and making it become a new point for economic growth. In this important plan issued by Chinese government, three key goals for the development of the environmental protection industry were raised, which aims to accelerate the development of environmental protection technologies.

5. Comparison and contrast between India and PRC

The beginning of 20th century saw the levels of industrial activities increasing in India compared to the 19th century (Subramanian, 2002). Local media highlighted the topics on environmental protection and economic development in recent years. The environmental issues became the focus in India since the global concerns on their GHGs emissions (Xinhua Net, 2007).

One report from world bank said that along with India's economic booming, especially the increasing investment on construction industry, manufacture of mineral product, and smelting and pressing of ferrous metal, air and water qualities got a great declined.

There was a continuous impact of various types of human activities on India environment in one form or another (Subramanian, 2002).

Definitely, India can be credited with having made an important contribution to the concept of planning in applying it to a developing country with a mixed economy (Bagchi, 1970; Mahan, 2007).

5.1 Why choose India for comparison

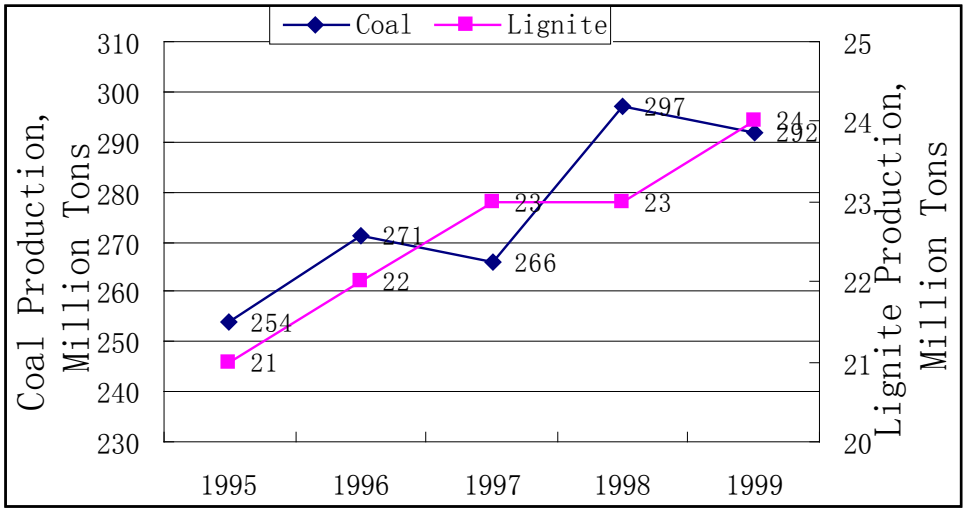
5.1.1 From environment point of view

Studies showed that the concentrations of various green house gases were very much time dependent since the traffic density varies at different times of the day

(Subramanian, 2002).

The two most important sources of energy in India is coal and low quality lignite. Figure 5.1 shows the production trends from 1994 to 1999 for these two energy sources. Both these two fuels were considered as 'non-renewable' energy (Joosten, 2007) and both of the two were sources of acid rains.

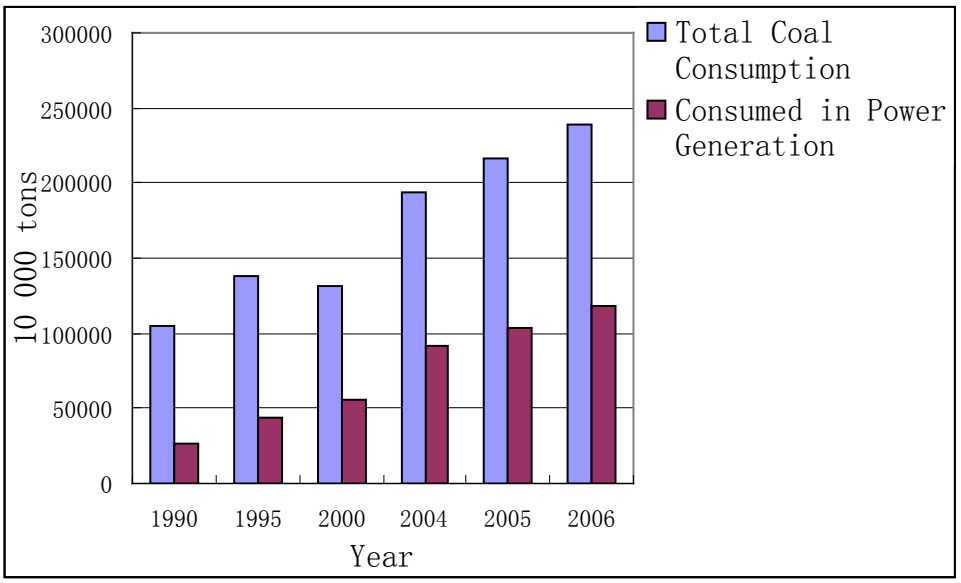
Figure 5.1 Production of coal and lignite in India from 1995-1999



Is it expected that the requirement for coal in India would increased from 285 million tons per year in 2002 to about 500 million tons per year in the year 2010. 70 percent of them would be used in power sectors (Subramanian, 2002).

Similarly, in China, the coal consumption grew another time from 1990 to 2006, reached nearly 250 million tons. The amount of coal use was about 60 to 70 percent of India. And the percentage of total coal use was about 50 percent, which didn't catch up with that in India as showed in Figure 5.2.

Figure 5.2 Coal consumption in China



Coal mining, production and its use achieved many concentrations both in China and India not limited because of following reasons. Mining of coal will result in water quality problems such as acid mine drainage. When ground water react with mineral pyrite in the coal, sulphide-FeS_2, the production H_2SO_4 thereby acidifying the water body. In addition, mining areas undertook land use changes and fertile soil cover lost, affecting the roots of various plants growing thereafter diminishing the green cover (Subramanian, 2002). Burning of coal for generating energy will release enormous amounts of ash, which contains a number of heavy metals at high level since coal contains a number of trace elements such as Hg and Cd. Coal burnt will also cause air pollution because steam particulates such as CO_2, SO_2 and NH_3 will be released.

The great energy demand for using coal caused the consumption of coal cannot be diminished in a short time by government regulations. Because the energy use leading by economic and social activities, which depended on economic

developing objectives and people's energy use for maintain their daily life.

Therefore, one way to alter coal consumption conditions was select a clean energy take the place of coal. The other way may be raise up the efficiency of coal consumption. But the latter method will not change the increased coal use from basic level.

From this viewpoint, both China and India faced the task of improve clean energy technologies and control the use of non-renewable fuels, in order to minimize continuously heavily air pollution.

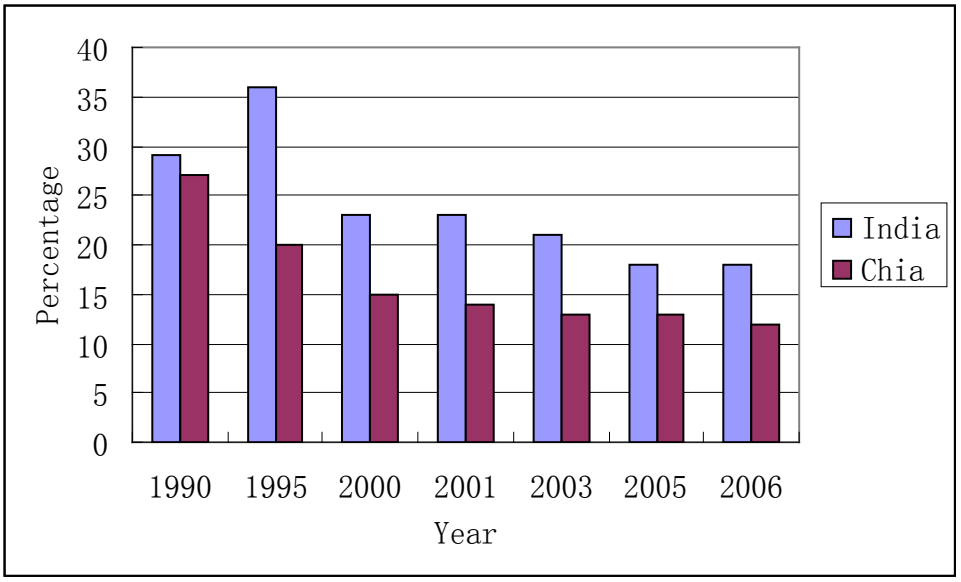
5.1.2 From social point of view

According to Indian Developing Planning 2000, the growth of commodity production had lead to water pollution, soil erosion, and destruction of firewood resources and loss of genetic diversity of plant and animal stocks.

Generation and disposal of liquid and solid wastes clearly evidenced the anthropogenic signature (Subramanian, 2002). In India, according to their Central Pollution Control Board, 23 major cities generate on an average of 1300 tons of solid wastes every day per city, and about 0.475 kg of waste was generated per person per day. Such a vast quantity of garbage means that its disposal became a problem not just for the authorities but for each one of citizens as well (Hindustan Times, 25 September, 2000).

Both India and China were ones of world's largest agriculture exports countries. The value added of GDP from agriculture well illustrated this point. Figure 5.3 showed GDP dependency on agriculture in India and China.

Table 5.3 Comparison of value added of GDP from agriculture between India and China



Although the agriculture took in GDP gradually declined these years according to the figure 5.3, millions of peasants needed to be feed by agriculture industry both in India and China. Urbanization had been caused city's industrial and domestic pollution. No more peasants can be allowed to immigrate into cities, thus this part of people cannot enter factories as early and easily as people in cities.

Thus waste from agriculture had been considered into this study.

The use of pesticide in agriculture was one major impact of human activities that had strong bearing on environment (Subramanian, 2002). Pesticides stay in environment for very long time since they are mostly non-biodegradable.

Total pesticide applied onto agriculture land in India amounted to nearly 85,000 tons, where more than 75 percent is organochlorine pesticides and insecticides which were banned in many western countries. And the number is increasing at the rate of about 3000 tons each year (Gupta, 1986; Subramanian, 2002).

In China, although the pesticide consumption cannot be searched, the fertilizer use amounts were shown in the figure 5.4 and figure 5.5. The continuously increased consumption of fertilizers would have the same result of using pesticide. Because the N, P and other element contains in fertilizers could be changed to water pollutants. One of the main water pollutant resources from agriculture was the great deal of chemical fertilizer use (Chen, 2007).

Figure 5.4 Chemical fertilizer consumption in China

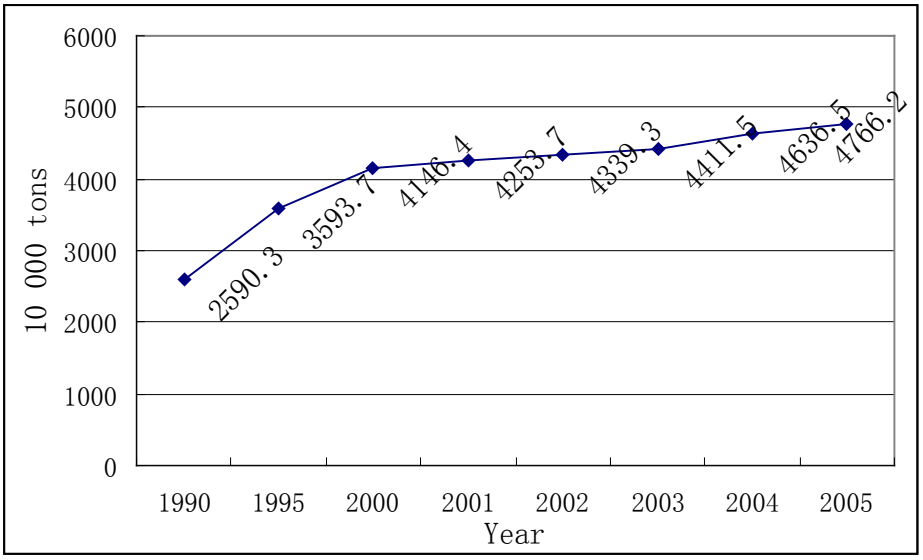
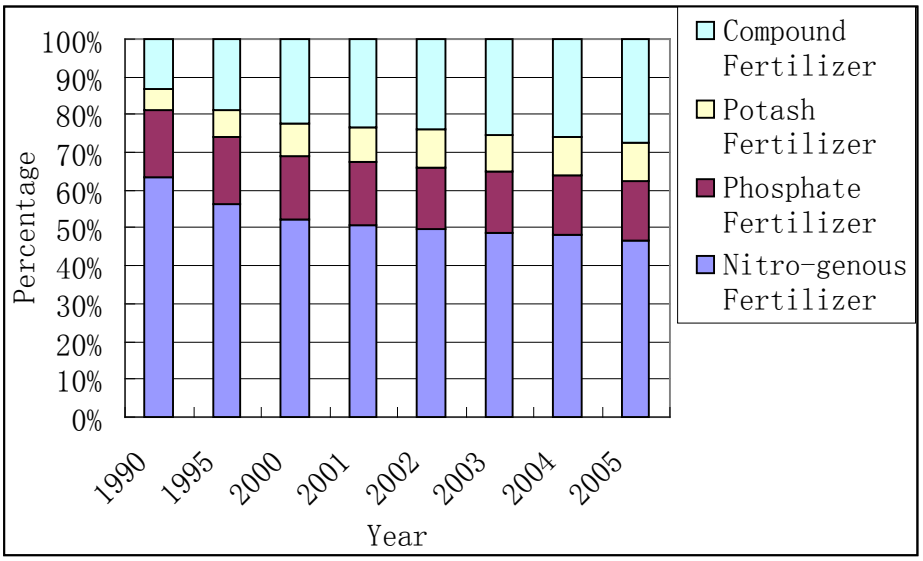


Figure 5.5 Consumptions of different kinds of chemical fertilizer



Subramanian (2002) defined that ‘soil degradation is any added substance or unnatural loss or alternation that makes soil less productive or usable than it was before the change.’ Any changes in the soil-nutrient losses, compaction, or additions that cause reduced plant growth or that make the soil less satisfactory for use can be defined as a kind of soil degradation.

Population density is a parameter has significant impact on environmental quality as stated in methodology. India is the forth crowed countries in the world following Singapore, Bangladesh, and Korea. The population density was 363 people per km^2 which is over twice of that in China.

India’s population reached 1027 million in 2001 and predicted to approach 1.6 billion by 2051. Use its land area 3287 km^2 to undertake a simple division, population density was 312 habitants per square kilometers.

India’s level of urbanization is schemed to rise from about 28 percent in 2001 to 36 percent by 2026—when the total urban population could number about half a billion (Dyson et al, 2004).

Pattern of planning in India have some similarities with that in China. India insisted that it needed stimuli and directions from the political process reflecting the aspiration of its people (Mohan, 2007). Chinese political making always processed from raising political plans by National People's Congress deputies. After group discussions on the plans, National People's Congress made the final

decisions (Tibet Information, 2006).

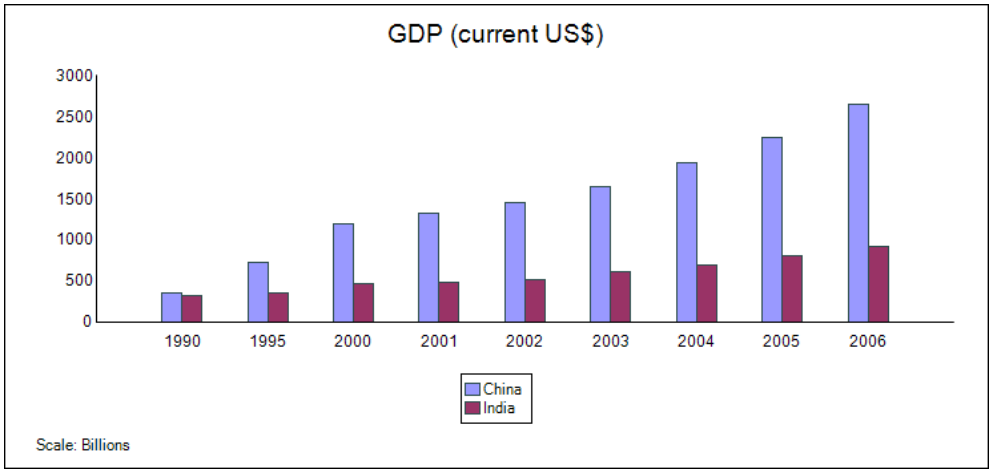
The path chosen for economic development in India was neither entirely capitalist in nature nor completely a strict controlled one, while China had an economic reform from a planned economy to a market economy and in a market-decision supplement with political-leading economy.

Structural adjustment shifted the burden of welfare from the state to individual families in India, which was the same as one of expected results of Chinese economic transform. One of the objectives of China economic transform was transfer state-owned capital to individuals or communities.

5.1.3 From economy point of view

By the early twenty-first century, India economic growth got a record high point, 9 percent per year, closely following China growth rate (Figure 5.6).

Figure 5.6 GDP in India and China

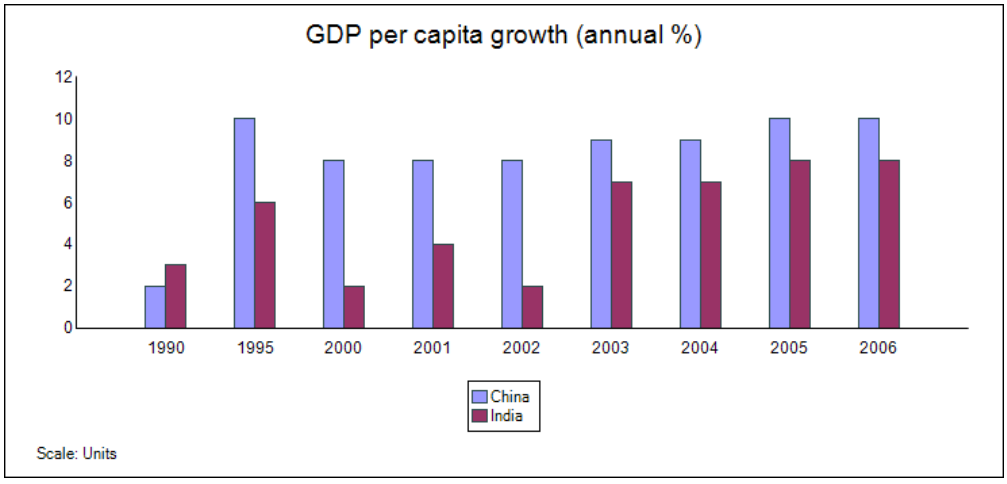


Both Chinese and Indian economy growth depended heavily on cheap labor and policy change (Stearns, 2007). As stated in the chapter above, this kind of labor sources might bring in developing countries' investment in industries but not

high-tech IT industries.

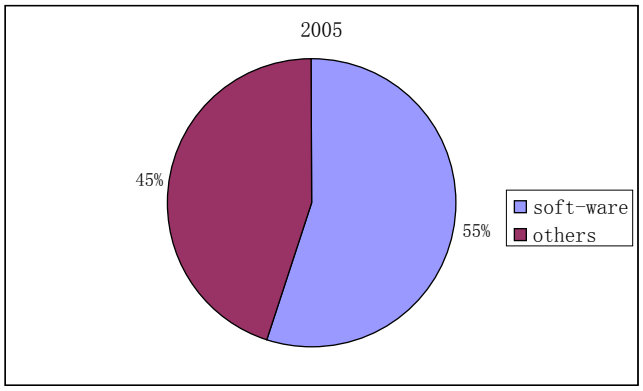
To take an overlook of India and China's economic growth, GDP per capita was chose to show the average people's living condition. From figure 5.7, the economy growth in India was steadier than that of China, but still got a high level of about 7 percent.

Figure 5.7 GDP per capita growth rate



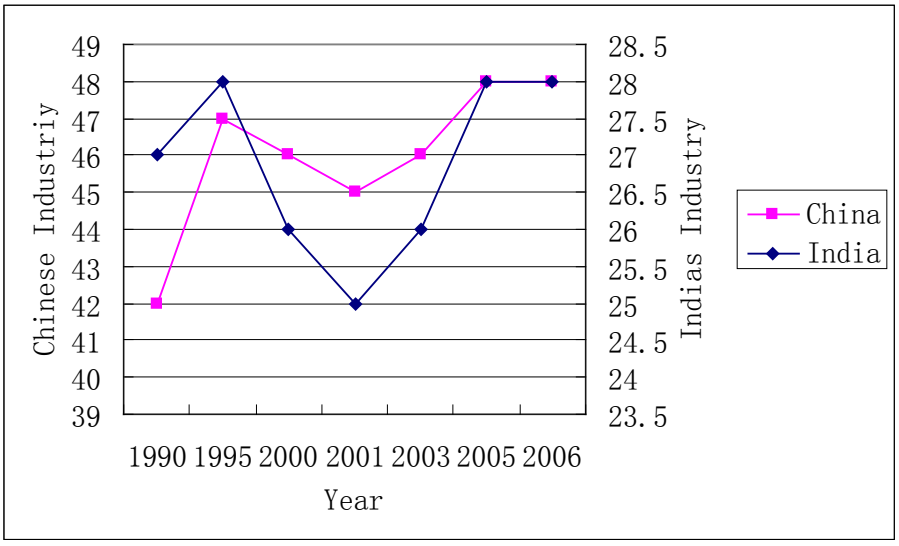
After 1992, India increasingly added high-technology products, particularly software (as showed in figure 5.8), exporting to both the industrial countries and Southeast Asia. In year 2005, output of software took over a half of total GDP and became the leader industry in India. However, high-tech industries had difficulties in employing low level labors without higher education.

Figure 5.8 Soft-ware industry's contribution of GDP from industry's sector



India's industrial growth trend and percentage were about the same as that of China's as showed in Figure 5.9. However, factory development was focused above all in each Five-year plans (Stearns, 2007) in India. Thus India seems to have more challenges that China. As stated in Chapter 4, Chinese policy, similarly, placed economic growth ahead of all, but officially stated control the developing speed of heavy industries.

Figure 5.9 Industry growth trend in India and China



Large chunk of this country's population is still suffering from an under-level living (Mona, 2007). India government expected their industries improves to a higher standard in order to eliminate poverty. Thus the leading development

direction turned to build another ‘world’s factory’ as China (CE, 2007).

5.2 Overview of Indian environmental degradation

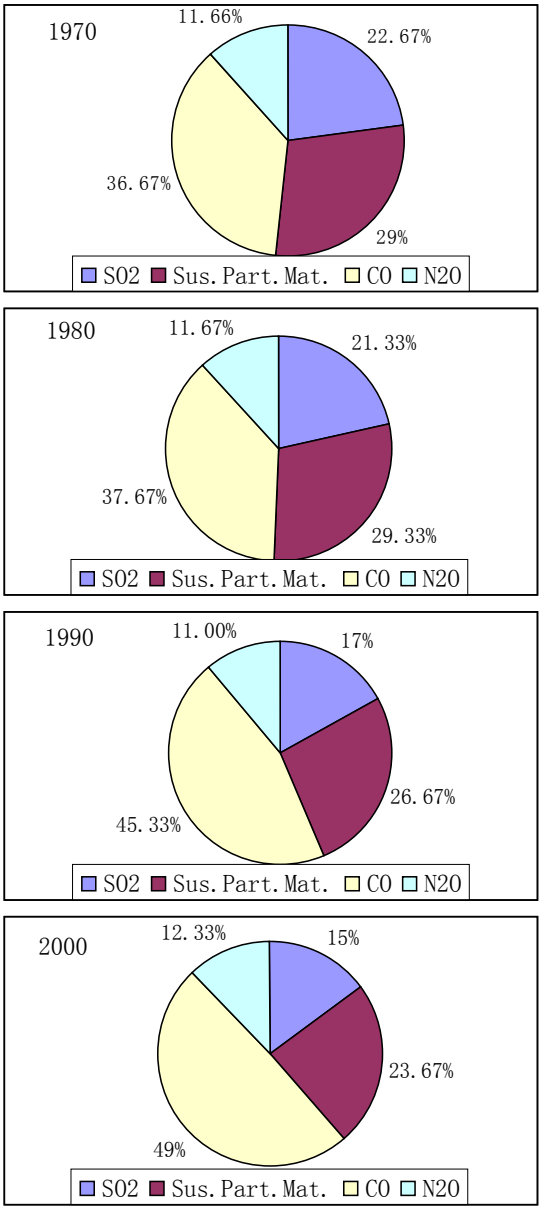
5.2.1 India Air:

‘India becomes the world’ s third largest emitter of carbon dioxide by2015. It ranked fifth in 2005. Two thirds of India’s emissions come from burning coal, mainly in power stations. This share will increase slightly by 2030. Per capita CO2 emissions double over the Outlook period, but, in 2030, are still well below those in the OECD today’ (WORLD ENERGY OUTLOOK 2007: FACT SHEET INDIA, p1).

The green house gases in the atmosphere had increased due to industrial activities (Subramanian, 2002). In India, CO_2 levels in the atmosphere have been increasing at the average rate of 0.4% every year during the last one hundred years of industrialization. Many places in India had SO_2, NO_x and SPM values far in excess of those that can be classified as healthy (Subramanian, 2002).

Figure 5.10 shows the average properties of various gaseous pollutants in three cities in India over a three decade time scale, and it can be seen that CO is the dominant factor of air quality observations in India from 1970s to nowadays.

Figure 5.10: Decadal variation in pollutants in the atmosphere in India (Average data in Delhi, Mumbai and Calcutta).



To contrast with China, the main air pollutants were SOx accounted for 58 percent, soot accounted for 24 percent, and dust accounted for 18 percent. The main contaminants need to be treated in India and China was about the same, thus the technologies improvement directions should be about the same. From this point of view, China and India could learn each other in air pollution abatement both from techniques and investment aspects.

5.2.2 Water in India

Water scarcity in India was an incessant topic from 1970s. The water withdrawal rate excess of recharge rate caused continuous fall in the water table in India.

Water scarcity in India was generally seen in those regions of the countries where there are no large rivers, diversion canals or storage facilities or intensive rainfall (Subramanian, 2002).

In recent years, about from 1990s, besides the water scarcity, water pollution came up to the government's agenda.

India faced to an increased great pressure on water for two reasons. (1)The annual requirement of water in India for various users was 634 km^3 and is expected to more than double within the first half of 21^{st} century (Subramanian, 2002). Domestic water consumers, such as agriculture and households, were expected to increase 70 percent in 2025. Industrial consumers, such as manufactory and energy, were predicted to achieve an average 5 times growth during the next 20 years.

The Figure 5.11 showed wastewater sources in India. The food industry contributed the most to wastewater discharge. The same as China, the first contributor of wastewater was food industry (see figure 5.12).

Figure 5.11 Wastewater sources in India

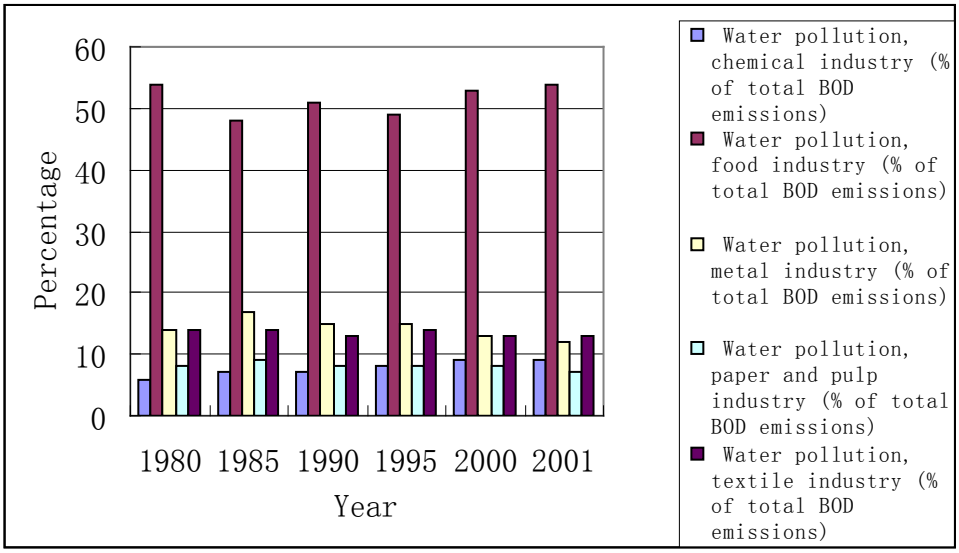
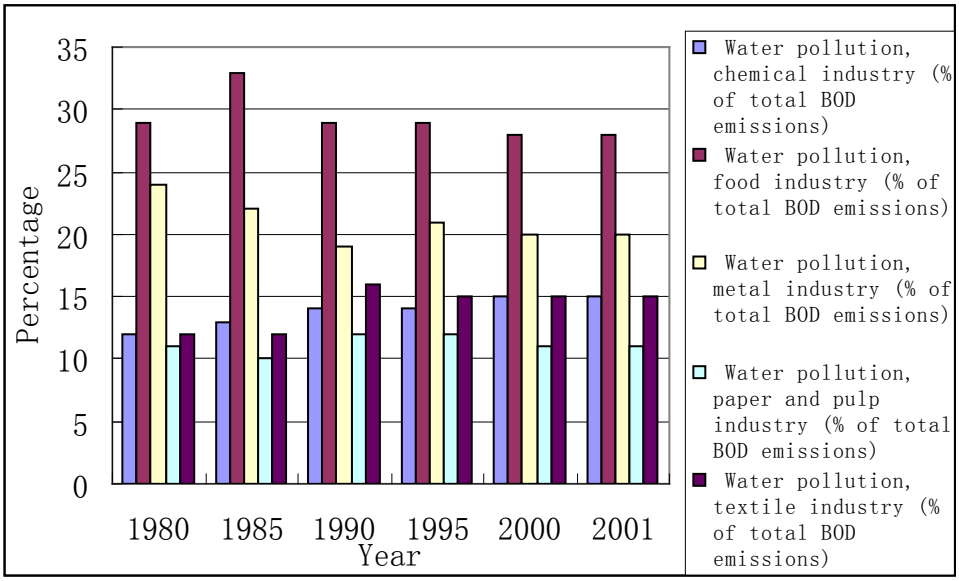


Figure 5.12 Wastewater sources in China



5.3 Environmental investment in India compared to China

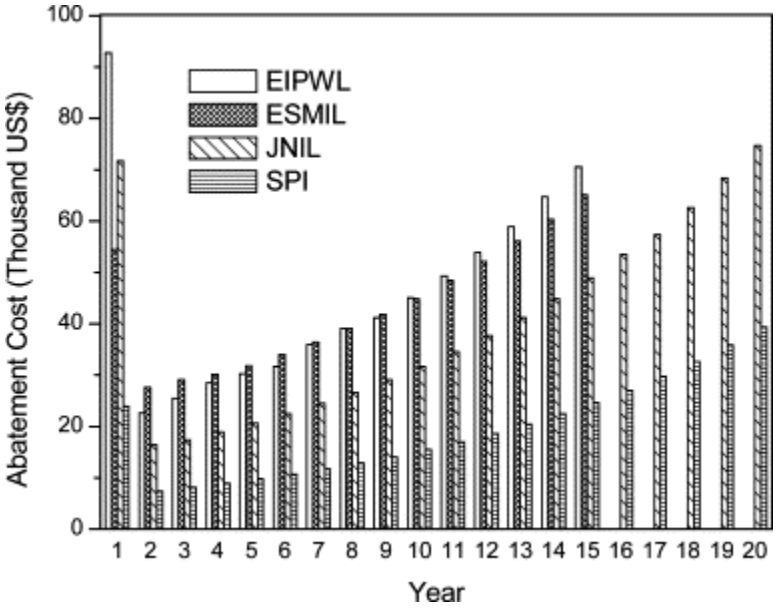
Because of the unavailability to access the statistical data of India, publications would be the only resources.

The OECD predicted that from now to 2030, India needs to invest about $1.25 trillion (in Year 2006 dollars) in energy infrastructure – three quarters in the

power sector. Gross power generation capacity additions exceed 400 GW – equal to today's combined capacity of Japan, Korea and Australia. Attracting electricity investment in a timely manner will be crucial for sustaining economic growth.

Only investment on wastewater could be found when this thesis conducted. The private cost of abatement of various water pollutants consists of capital and operation costs of the pollution control equipment. The operation cost data are summarily presented in Figure 5.12. The yearly total abatement costs, the values were shown in Figure 5.15.

Figure 5.13 Yearly total abatement cost of ETPs (Effluent treatment plants) for the JNIL, ESMIL, EIPWL and SPI over the lives of their ETPs.



(i) Jenson & Nicholson Ltd. (JNIL), a large-scale paint industry;

(ii) Eastern Spinning Mills & India Ltd (ESMIL), a large-scale textile industry;

(iii) East India Pharmaceutical Works Ltd. (EIPWL), a medium-scale pharmaceutical industry;

(iv) Samson Processing Industry (SPI), a small-scale textile dyeing industry.

Source: Malik, P.K. and Datta, S.(2004). Financial sustainability of environmental investment under an empirical pollution abatement policy instrument in India: the case of

wastewater treatment. Environmental Science & Policy, 8(1), 67-74.

The total investment of these four industries gradually increased for 20 years. Although data in China didn't have the exactly comparable ones, the tendency of environmental investment was found as showed in Figure 5.14. The increased rate was about the same with India.

Figure 5.14 Investment Completed in the Wastewater Treatment of Industrial Pollution

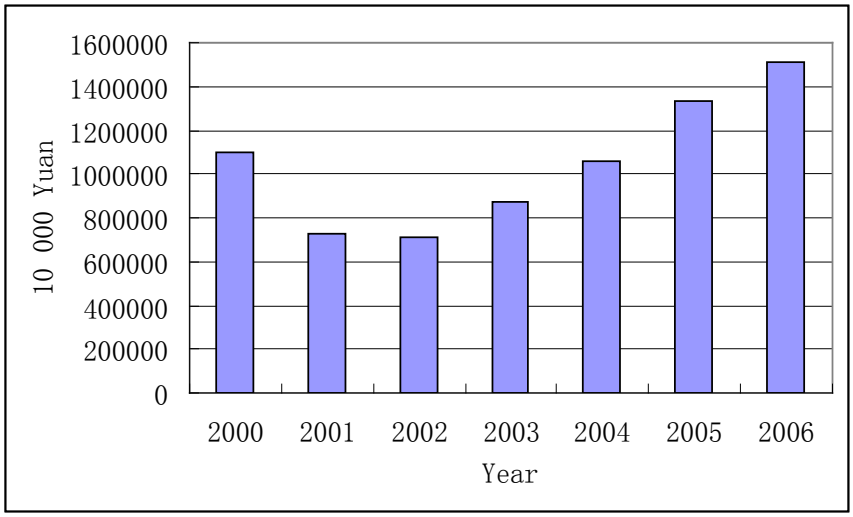
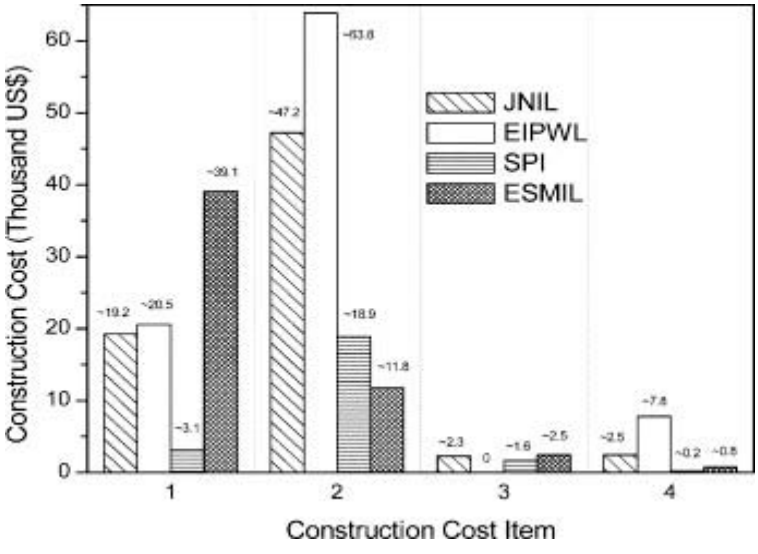
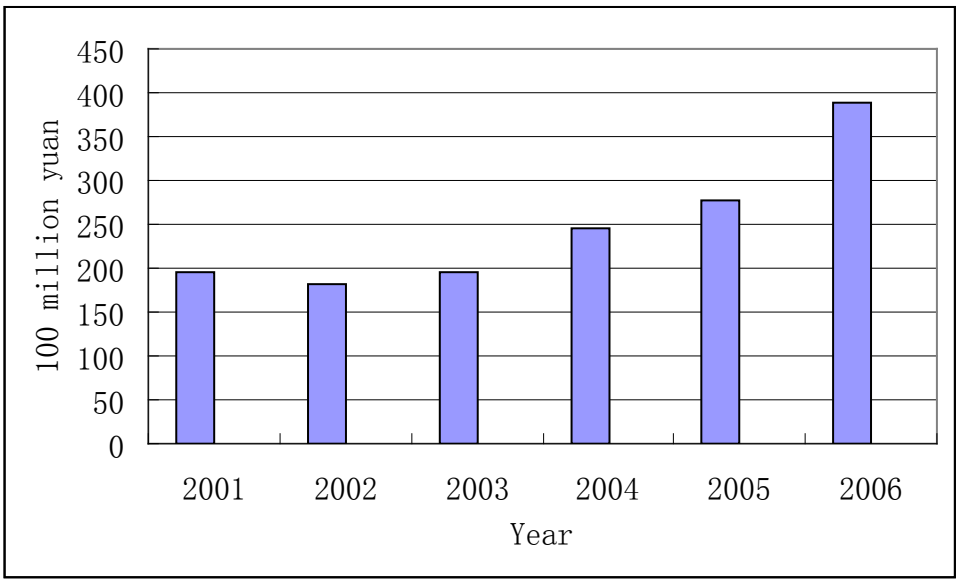


Figure 5.15 Installation/construction cost summary of ETPs for the JNIL, ESMIL, EIPWL and SPI. Construction cost item: (1) equipment; (2) civil work; (3) consultancy and (4) others.



The investment in equipment construction in China as showed in Figure 5.16, were statistic by National Statistical Bureau for many years. However, construction investment in ccivil work and consultancy were not available.

Figure 5.16 Annual expenditure for wastewater equipment construction



5.4 Conclusion

India was one of the most similar countries with China throughout the world. However, India has also the low environmental quality, demand for boost economy, and industry structure that cannot be altered easily.

Research done by Pargal et al. (1997) on industrial plants in India, showed that the existing regulation regimes in India have no effect on controlling industrial pollution. Industries are still operating without proper safety and pollution control measures (Parikh et al., 1999).

The environmental investment in India got little achievement, as their environment didn't progress a lot. Thus lessons from India should be claimed.

First, the investment amount should be continued to increase, but the direction should alter to technology parts. Second, the investment sources should be enlarged to private and communities. Third, environmental issues should be included in public education.

One of the important point should be learnt from India was the energy sources alteration. Stronger policies that the Indian government was now considering could yield large energy savings according to OECD. Coal savings – mainly in power generation – were the greatest in both absolute and percentage terms, because of the lower electricity demand growth, higher power generation efficiency and fuel switching in the power sector and in industry.

Besides, Chinese government need to classify the statistical data as detailed as possible. And this may need investment for labour employment.

5.5 Limitations of choosing India

Capital industry –led growth model was no longer relevant in Indian economy nowadays (Mohan, 2007, p189). China on the contrary, encourages developing capital industries in order to minimize the environmental pressure.

Although India had some achievements on raising environmental quality, there was still a long way to reach well standard environmental quality.

Social investment amount were unavailability in India's statistical database (Malik and Datta, 2004). Thus further research will have impact on contrasting

private environmental investment.

6. Comparison and contrast between Japan and PRC

'Japan was faced with a wide variety of problems during the postwar period, particularly during the period of rapid growth' (Kohama, 2007). During 1970s to 1990s, Japan suffered heavily from environmental by-products of its rapid industrial surge and the attendant growth of its cities.

6.1 Why choose Japan for comparison

Japan as an developing industrial society were far more eager for growth than for environmental preservation, and their leaders argued that they lacked the funds to afford types of controls (Stearns,2007). The first and foremost on the government's agenda in Japan was the same as that in China as explicated in Chapter 4. The priority in economy boost to environment protection led Chinese government and societies ignore environmental issues at the begging of their development. However, Japanese government and societies began deal with environmental problems in 1960s when they began to enlarge material production.

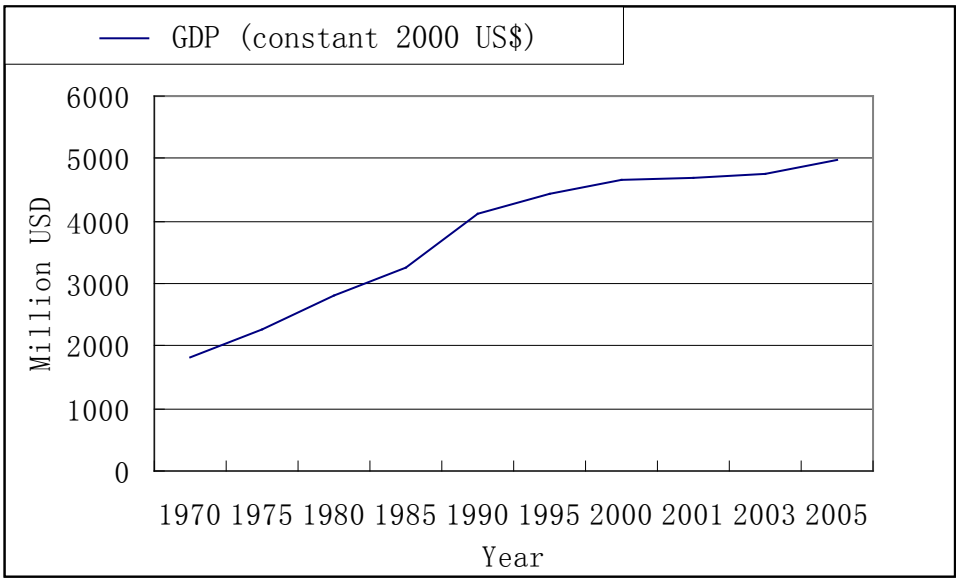
6.1.1 From economic point of view

First of all, Japan the same as China, needed to grow first and cleaned up later. In this sense, the Japanese model may be exactly suitable for China to draw lessons from (Inui and Kato, 2002).

The Japanese economy was one of the largest in the world with a per capita GDP

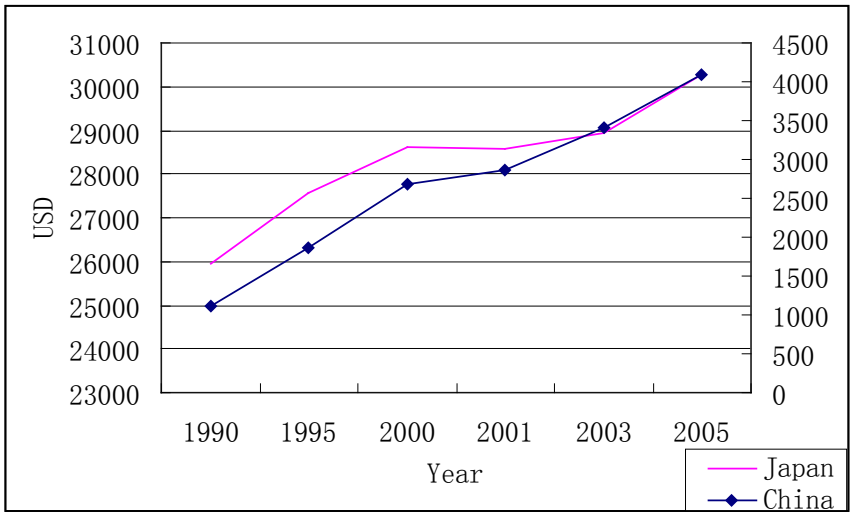
USD 24 700 in 2000. As figure 6.1 illustrated, after growing 140% over 1970 to 1990, GDP rose only by 14% in the 1990s.

Figure 6.1 Japan GDP growing trend from 1970s



At the beginning of the 21st century, the economy was still unstable, sliding into another depression. Figure 6.2 showed a comparison between Japanese and Chinese per capita gross domestic product from 1990 to 2006. Although Japanese people earned almost 20 times of Chinese people, the growth trend of GDP per capita followed approximately the same tendency.

Figure 6.2 GDP per capita from 1990 to 2005 in Japan and China



Except GDP as an indicator showing one country's economy situation, employment was one of the three main objectives of governments as explicated. Figure 6.3 showed the employment by three strata of industry in Japan from 1980 to 2005. By contrast, figure 6.4 introduced the employment in China in the same period.

Figure 6.3 Number of Employed Persons at by Three Strata of Industry in Japan

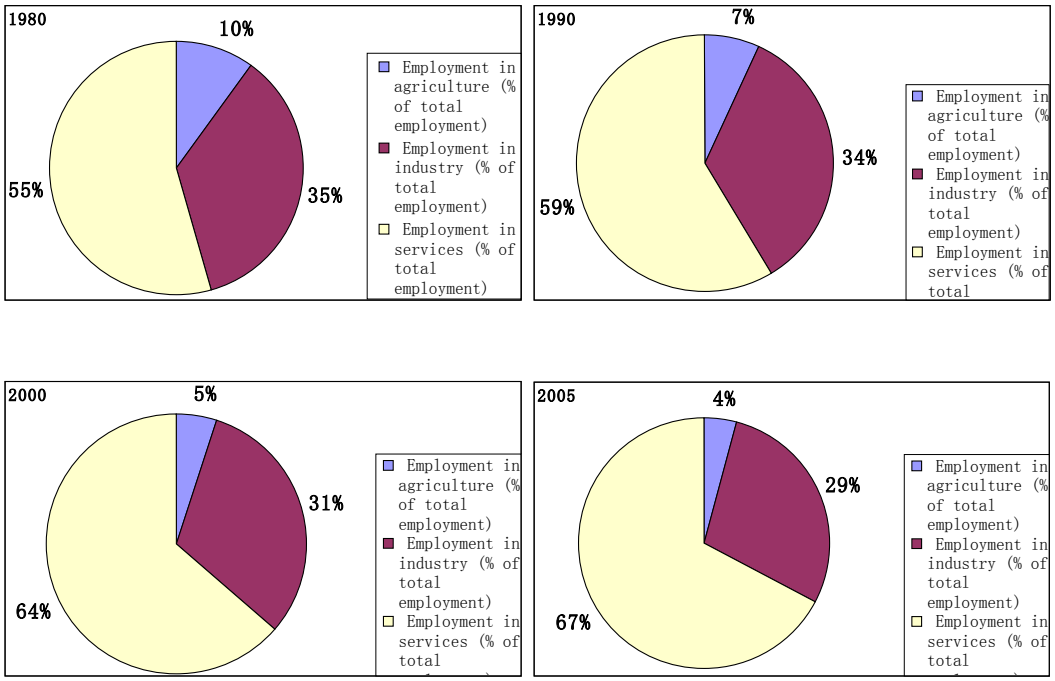
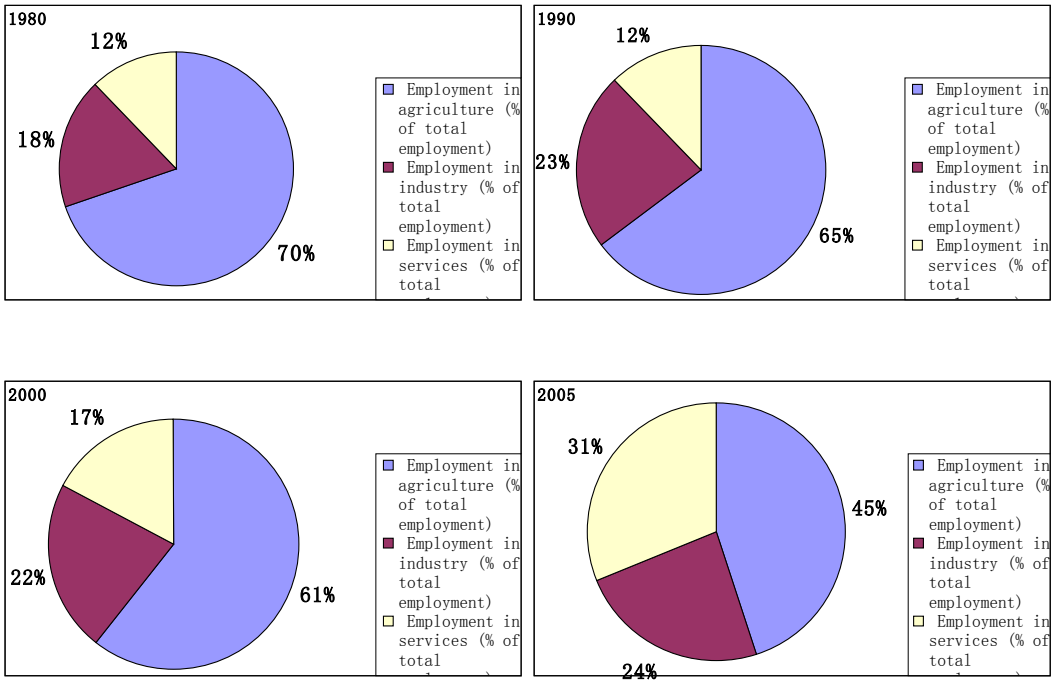


Figure 6.4 Number of Employed Persons at by Three Strata of Industry in China



According to these two figures, the employment distribution had an important similarity between Japan and China. That is, both the two countries' industry employed 20 to 30 percent work force.

In agriculture, nitrogenous and phosphate fertilizers decreased by 22% and 19%, while agriculture production fell by just 8%. The pesticide decreased rate was about the same as agriculture production fell. By contrast, Chinese use of chemical fertilizers increased every year, the nitrogenous and phosphate fertilizers increased by 36% and 61%, while agriculture production increased about 2 times.

6.1.2 From social point of view

Japan has a population of about 127 million in 2005, with 351 inhabitants per square kilometer on average. Its population density is closely following India

among the highest in the world, which is about three times of China's population density. Meanwhile, the unequally population distribution, most Japanese lived at much higher density coastal plains, had a great resemblance with population distribution in China. The east costal regions had 1.5 percent of China total area, lived more than 1060 million people, which took about 8 percent of total population. This kind of population distribution made intensively pollutants discharge and emission, therefore, asked for an advantage pollution treatment skills and more investment in equipment, chemicals and research improvement in equipments, chemicals and research improvements.

Japan had high quality environmental information. Their white papers on the quality of the environment had been published every year for nearly 40 years since 1969. Public had a more easily access to environment-related information nowadays than previous years. As the pioneer in collecting and disseminating environmental statistics, the data on air and water pollution in Japan were comprehensive, detailed and provided frequently. Although Chinese people can access the statistics as easily as Japanese people, the statistical data published by government were not as detailed and well-categorized as Japan's information.

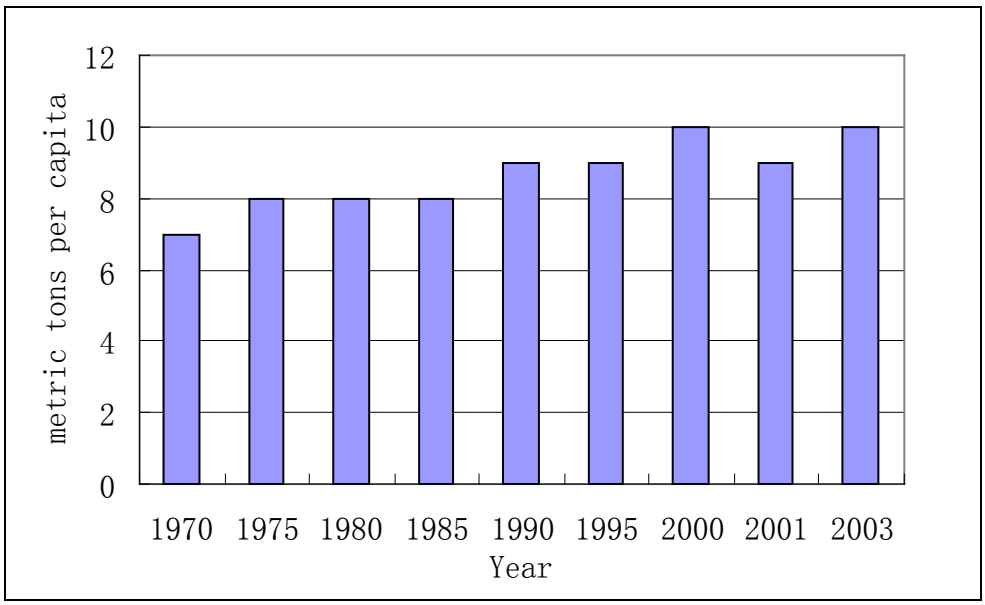
Environmental education in Japan had been part of the Japanese school curriculum for decades. In order to improve environmental education, the 1998 revision of the Courses of Study described the national standard curriculum fro primary and secondary schools (OECD, 2002).

6.1.3 Energy use

Energy intensity increased significantly by 5 percent in Japan in the 1990s with

the lower economic growth of the 1990s. Investment rates in construction and industrial sectors lowered down while energy use grew faster than GDP in transport and residential. The increasing trends in energy use led CO_2 emission increased by 26 percent in transport and 14% in residential sectors. See figure 6.5.

Figure 6.5 CO_2 emissions per capita in Japan from 1970



Japan's electric power industry had turned to the emerging global problems associated with climate change (Tsunoda, et al., 2002). A great achievement had been gained on drastically declined SO_x emissions, low NO_x emissions, and the world's lowest CO_2 per unit of GDP emissions. One solution in Japan was to switch from coal to other energy sources that have a less harmful impact on the surroundings. However, this may not be a practicable method to reduce air pollutions in China, since there were large coal reserves and it was economical to use coal.

Industry in Japan focused on technology development as well as operation ad

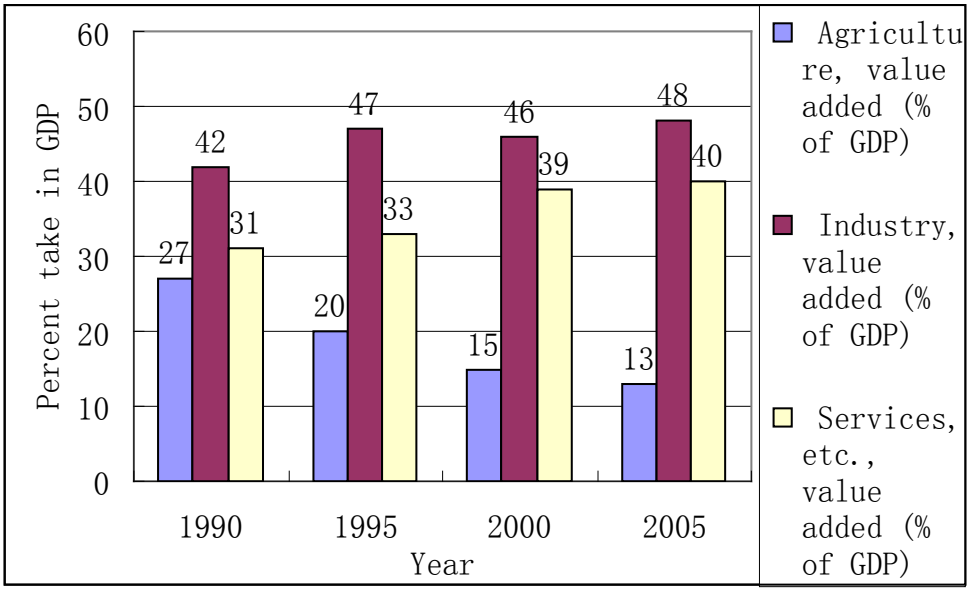
management, making Japan was one of the highest energy efficient countries. Therefore, it catered country's energy demand with less fuel consumption. And pollutants such as SO_x, NO_x, CO_2 and particulates all got a decline. More other experiences should be explored for improving China's air pollution control.

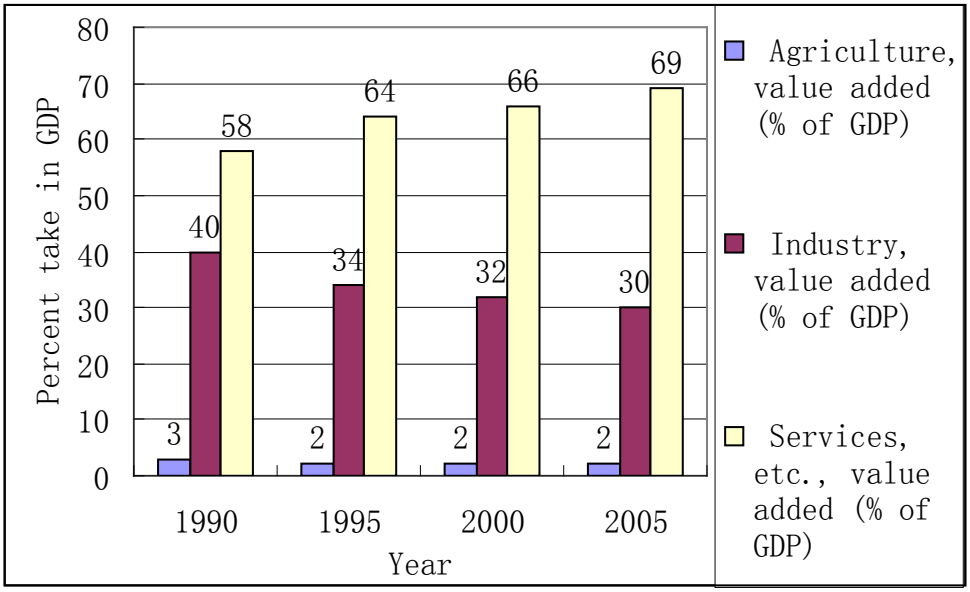
6.1.4 From industrial viewpoint

The share of GDP held by energy-intensive industries decreased from 1980s, meanwhile the proportion held by high-tech industries increased.

The economic structural development will obviously reflect environmental quality as stated in Chapters 1 and 2. In Japan, the share of industry in GDP decreased by 4%, to 37% of GDP in the 1990s. The share of services rose by 4.8% to 61%. Agriculture maintained its share of about 1.7% of GDP. High value-added industries and highly technological industries like India hold the largest shares. Industrial structure change in Japan and China was showed in the figure 6.6.

Figure 6.6 Industrial structural in China (Up) and Japan (Down)





From this comparison, we can find although Chinese economic structural was different from Japanese in primary and tertiary industrial, the percentage of income and employment in secondary industry is approximately the same.

Besides, heavy industry, defined as industries except the food, textile, apparel, wood production, and furniture industries in Japan, accounted for no more than 60 percent of total revenues produced by the manufacturing sector in the 1950s (Kohama, 2007). By 2002, that share had increased to 84 percent total income in

Japan. Which means, both China and Japan faced to an equally pressure on treating industrial pollution.

6.2 Overview of Japan environment achievements

Resulting from efforts made by the central and local governments as well as private companies, Japan's environment had improved substantially (Inui and Kato, 2002).The average Japanese citizens by the early 1990s were contributing over 90 percent less to environmental degradation than the U.S (Stearns, 2007). Generation of municipal waste increased by only 2% in the 1990s and almost stood at the same level in the early 21st century, after rising by 17% in the 1980s.

One of the significant achievements of Japan's environmental expenditure was the decoupling from GDP in 1990s (OECD, 2002). There were two main reasons for the decoupling of pressures on water resources from GDP in the 1990s.

The first was the progress in investment for municipal wastewater treatment. The other was the changes in agriculture production and the intensity of use of nitrogen and phosphors fertilizers.

Weak decoupling of CO_2 and GHG emissions from GDP was also achieved, which reflected the important role of fuel switching and coal import. Emissions of GHGs continued to rise from 1.22 billion tons to 1.31 billion tons in 1990s, an increased of nearly 7%. Emissions of CO_2 rose by about 9 percent while GDP increased by 13%.

The average annual ambient air qualities gained a great improvement. SO_x emissions decreased by 3% in the 1990s and NO_x emission increased by 8% somewhat less than GDP. This achievement was remarkable as Japan had

already been the lowest NO_x emission per unit of GDP of any other countries (OECD, 2002).

In the late 1990s' Japan, emissions of water pollutants such as heavy metals and toxic chemicals had been abated almost completely, while organic pollution of water hadn't improved substantially. BOD and COD in waters had not improved much.

6.3 Environmental investment in Japan compared to China

Environmental expenditure in Japan was estimated to have been nearly 2% of GDP in 1999, which including PAC expenditure together with that for water supply, storm water sewerage and nature protection. The total amount of compensation paid in 2000 was around JPY 74 billion (about USD 740million).

PAC in the public and private sectors accounted to about 1.4% in 1999. Public expenditure (expenditures made by government) was mostly related to water pollution abatement and control, while private PAC expenditure included relatively little investment.

Budget outlays on programmes promoting environmental protection and agri-environmental measures (reducing the adverse environmental effects of agriculture) were increased from USD 160 million in fiscal 1999 to USD 350 in fiscal 2000.

6.4 Conclusions

1) As stated in earlier paragraph, one of the Japan experiences that can be learnt by China was their effective energy production, which will need a great deal of investment in renewing equipments. Table 6.1 below showed thermal efficiency enhancements and the associated cost. Table 6.2 showed the cost composition of pollution control environmental equipment at a coal-fired power plant in Japan.

Table 6.1 Thermal efficiency enhancements and the associated cost

Equipment	Retrofitting activity	Relative increase in thermal efficiency (%)	Cost (yen/kW)
Boiler	Modify boiler structure & burner	0.2 to 0.4	4100
	Increase the number of soot blowers	0.1 (approx.)	200
Turbine	Replace the steam passage parts	3 to 4	3000
Auxiliary	Install gas recirculating fan	0.1 to 0.3	150
	Recovery in degree of vacuum	0.7 to 1.3	400
	Axial flow FDF	--	600
Combined effect		4.1 to 6.1	8450

Source: Electric Power Development Company

Table 6.2 Cost composition of pollution control environmental equipment at a coal-fired power plant

Equipment	Effect of equipment before/after use	Cost composition of equipment as a percentage of the total plant cost
Wet-type limestone-gypsum desulphurization unit	1000/50ppm	10.5
Denitrification device (dry-type ammonia selective catalytic reducer method)	300-600/45ppm	3.0

Combustion improvement (Low-NOx burner)	300-600/150-200ppm	0.6
Wastewater treatment equipment		2.2
Electric dust precipitator	10000-30000/300mg/m^3N	3.1
Major equipment of plant		80.6

2) Renewed pollutant treatment technologies in Japan which could stand in the first group in the world contributed great effort to its environmental protection programmes.

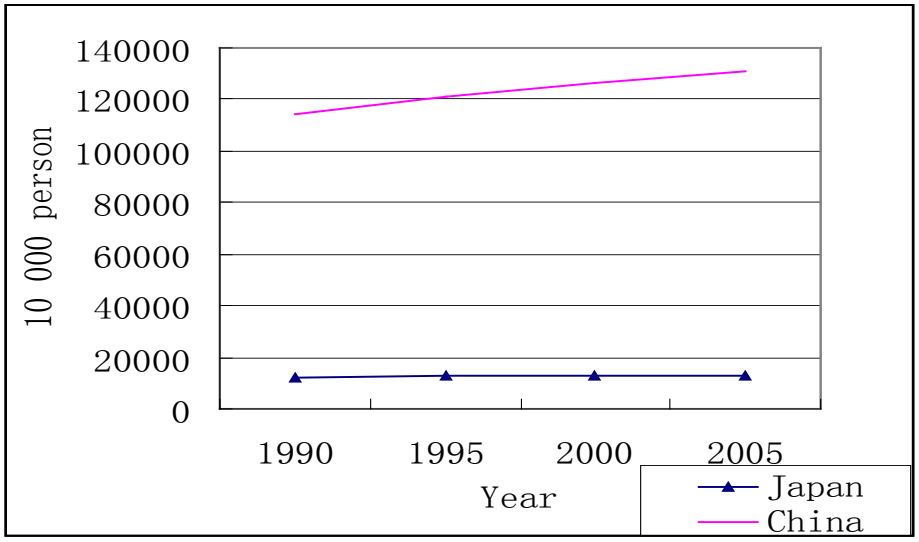
3) Changes in agriculture production and intensity of the use of nitrogen and phosphors fertilizer did great help to Japan reducing domestic wastewaters. But this change asked government or research institutions reduce the new chemical fertilizers' average cost. In the other word, it need technique renew once again. Therefore, more investment required for research and development in chemical fertilizer.

4) Since the Japan began its environmental protection from 1960s, its statistical data were among the most detailed in the world from over 40 years experience accumulation. PRC needed to develop statistical classifications for exactly further research.

6.5 Limitations for choosing Japan

The population increased in Japan only by 2.6% during 1990s, which is 10% from 1143million in 1990 to 1257million in 1999 as showed in figure 6.7.

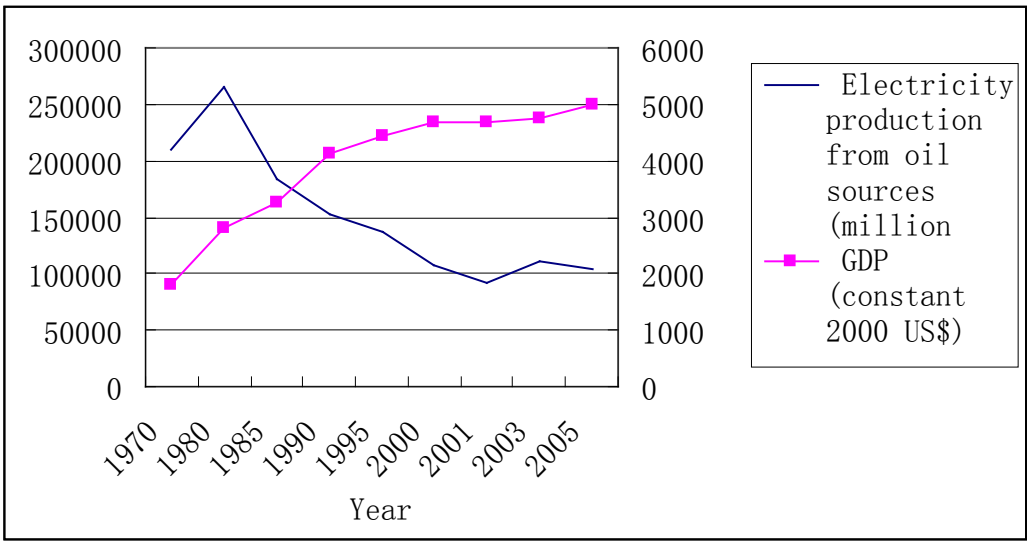
Figure 6.7 Japan and China population growth tendency



China faced environmental issues such as pollution control, energy conservation, natural resource preservation, and global environmental issues at the same time, whereas Japan was able to face them one by one (Inui and Kato, 2002). The feature made environmental protection problems in China more complicated than that in Japan. Environmental protection needed more detailed legislations as well as more amount of investment and more demand for higher techniques. In this point of view, China didn't stand at the same level with Japan when consider environmental expenditures.

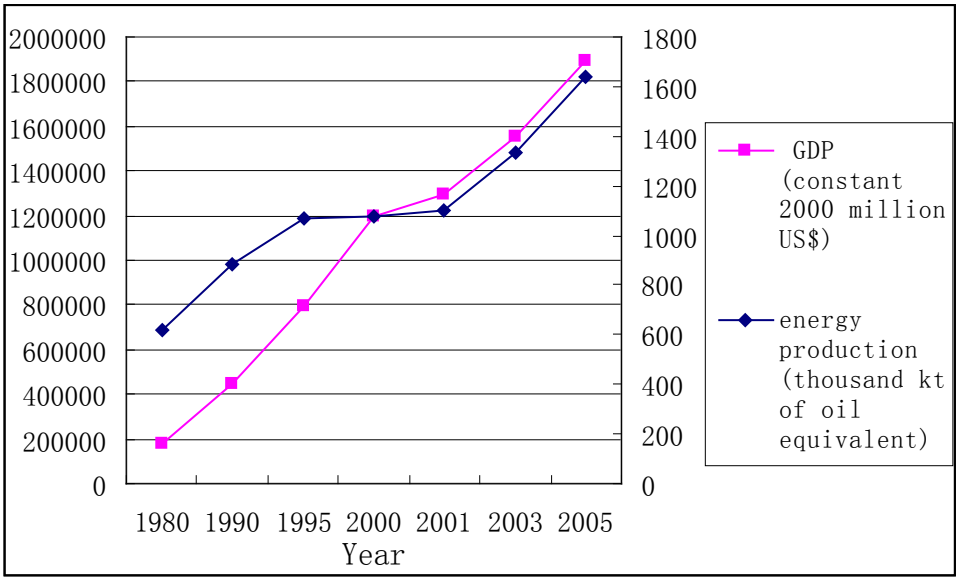
The leading fuel was oil in Japan but Coal in China. Besides, total energy consumption in Japan increased by 90 percent (from 270 million tons of oil equivalent to 510 million tons of oil equivalent) between 1971 and 1996. At this time, Japan's real GDP increased by about 200 percent (from USD1358 billion to USD3316 billion) as showed in figure 6.8.

Figure 6.8 Energy consumption and economic growth in Japan



The energy use and economic growth were on a contrary trend. However, during this period, China's energy consumption and GDP growing trend went along the same curve as Figure 6.9 showed.

Figure 6.9 Energy production and GDP in China



7. Comparison and contrast between the U.S. and PRC

This chapter is compared the environment expenditure in China and the U.S. Assume the base economic indicators in the two regions are in two separated level, the expenditure amount can hardly be told which region invest more than the other. Thus we confirm one factor, the GDP per capita first, which reflects the citizens living level, before undertaking the comparison.

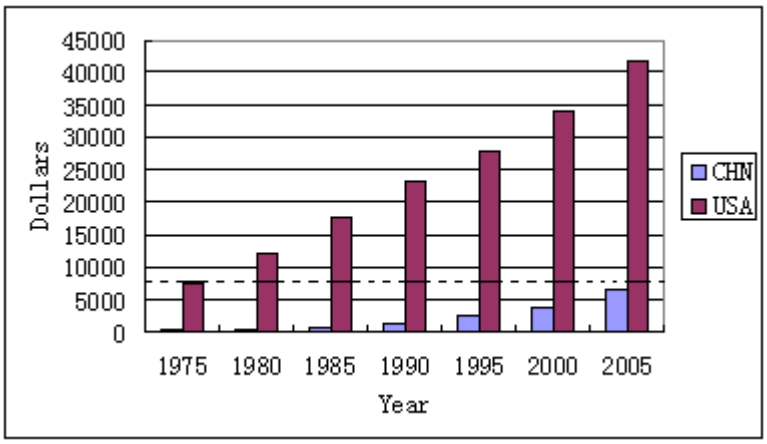
7.1 Why chose the U.S. for comparison

7.1.1 From economy point of view

As claimed in an international conference hold in Brussels in 2007, GDP is the best-recognised measure of economic performance in the world, often used as a generic indicator of progress. However, the relationship between economic growth as measured by GDP and other dimensions of societal progress is not straightforward.

In 2005, Chinese GDP per capita (PPP) reached 6571.6 dollars. From the World Bank database, we find that the U.S. GDP per capita (PPP) was 7529.7 dollars in 1975, which is a little bit more than Chinese level in 2005 (see figure 7.1). Thus, we choose the U.S. in 1970s environmental expenditure as a comparative body.

Figure 7.1 GDP per capita of the U.S. compared to that of China



7.1.2 From the relationship between industrial and economy

The employment rate is another important indicator when we evaluate economy performance. Especially, the 'employment in industry' demonstrates people's life dependence and the economic growth power. Employment in industry (% of total employment) is 30.5 in year 1980 in the U.S. While in China, the employment in industry (% of total employment) maintained a little bit more than 20% from 2000 to 2005. This pair of data means both the U.S. in 1970s and China nowadays has the similar reliance on industry. The two need industry to settle the employment problems in approximately 30% of total people. If industry stopped production, both the two will have a nearly 35% unemployment rate (30% plus the original 5% unemployment rate).

7.1.3 From social aspect

U.S. had the third greatest populations in the world following China and India (see table 7.1). Population will be a pressure in environment, the more

population there is the more municipal waste will be dispose.

Table 7.1 Population and Population density in 2005 (selected countries)

Regions	Population	Population Density
	(10 000 people)	(inhabitants/km^2)
World Total	**643778**	**49**
P.R.C	130756	139
Japan	12795.6	351
India	109458.3	363
Germany	8248.5	236
Russian Union	14315.1	9
U.S.	29649.7	32

The two countries' total land area is about the same from the table 7.1, 9 million square kilometres. This feature interrupts their legislations and laws enforced as fast and efficient as smaller countries like European countries. At the same time, the large amount of people and land area will also pretend to be a hamper in environmental expenditure effectiveness. In recent years, U.S. Total consumption of fuel is the largest in the world. And China is the second largest consumer of coal.

The political problems should be raised in this chapter because the implementation of the investment and environmental legislations usually became problems hamper the efficiency of environmental programs. In the U.S. political problems are (1) the state environmental protection agency often lacks authority vis-a-vis important industrial ministries, (2) fragmented bureaucratic complexity delays implementation, (3) funding for enforcement is inadequate, (4) corruption too often provides counterproductive options to compliance (Fryxell and Lo, 2002). As a result of all these factors, government decrees and

regulations alone have less impact on some environmental problems (Fryxell and Lo, 2002).

In China, the problems came up from the law system. China central controlled law system is well known by the whole world. Whatever this system is good or not, in environmental protection industry, this system result lack of investigation on legislations. The only way to reflect a satisfaction on a rule is waiting for governments' officer to find the ineffectiveness of the rule. The finding period may be at least one year, because the officers need to promulgate the rule into real life and waiting for its effect. During this period, although scientist and citizens can give advice, no risk management and environmental impact assessment will be done by government.

7.1.4 From energy consumption aspect

Although in China, the energy grew only half as fast as overall economy (Sinton et al., 1998; Gao et al, 2004), air pollutants from energy use took a large percentage of total pollutants emission.

As we know, clean energy will not cause serious pollution as coal and oil. In recent years, U.S. Total consumption of fuel is the largest in the world. And China is the second largest consumer of coal.

Following figures introduced the electricity production from coal sources in Figure 7.2, which again illustrated that the dependency of coal in energy consumption in China urgently needed to be reduced; and Figure 7.3 showed the similarly increased tendency of energy consumption per capita in the U.S. and China. although energy consumption per capita in the 1970s' U.S. were 7 or

more times than that in China, the growing trend can be treated and prediction of further development direction. Thus China need to avoid further increase of energy consumption.

Figure 7.2 Electricity production from coal sources (% of total)

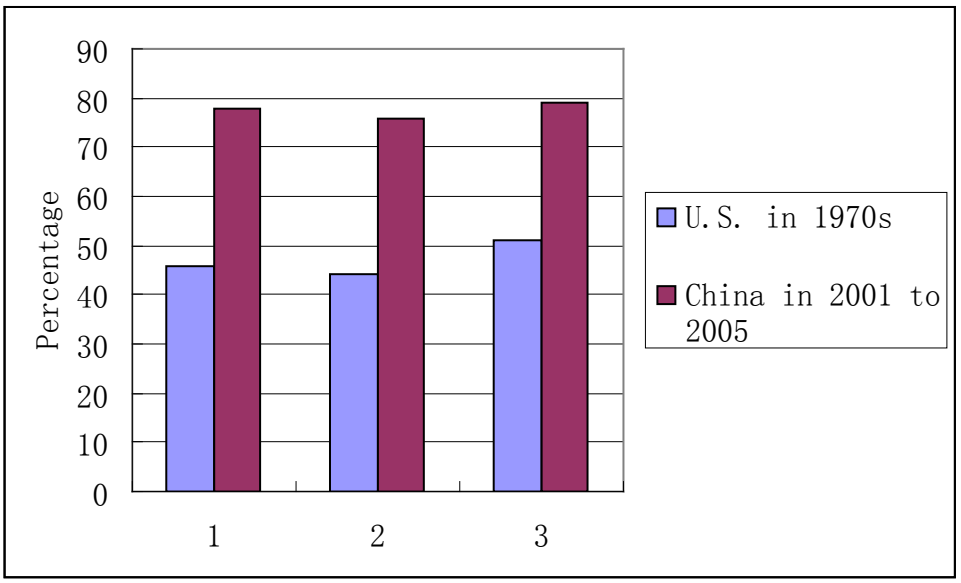
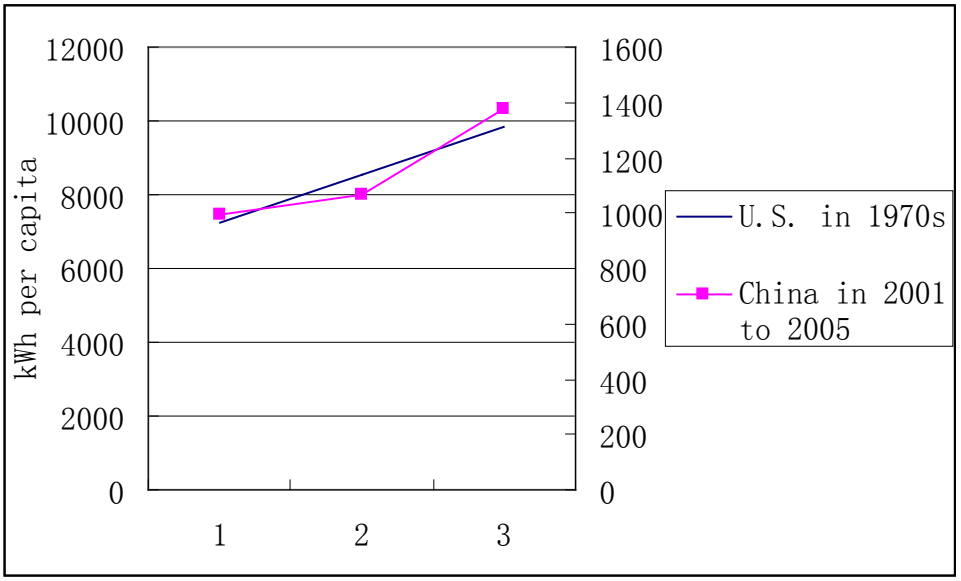


Figure 7.3 Electric power consumption (kWh per capita)



7.2 Overview of the U.S. environmental degradation

During the 1970s, the focus was on basic air and water quality.

7.2.1 Ambient air quality

National Ambient Air Quality Standards for suspended particulate matter, sulfur dioxide, oxidants, carbon monoxide and nitrogen dioxide were firstly set by EPA in April, 1971. Non-federal suspended particulate sampling stations increased from approximately 800 in 1969 to over 3,700 in 1974. Data from these stations are periodically submitted to EPA's National Aerometric Data Bank for summarization in annual reports on the nationwide status of air quality.

There is a table named 'Air Pollutant Emission,' found from Monitoring and Air Quality Trends Report, wrote by U.S. Environmental Protection Agency in 1974. From this table, we can find that the emission volume of carbon monoxide, sulfur oxide, hydrocarbons and particulate had a drop after environmental expenditure and related legislations.

7.2.2 Water conditions in 1970s

We found the expenditures on the equipments and the construction charges grown up both in municipal and industry aspects as shown on the Table 7.2.

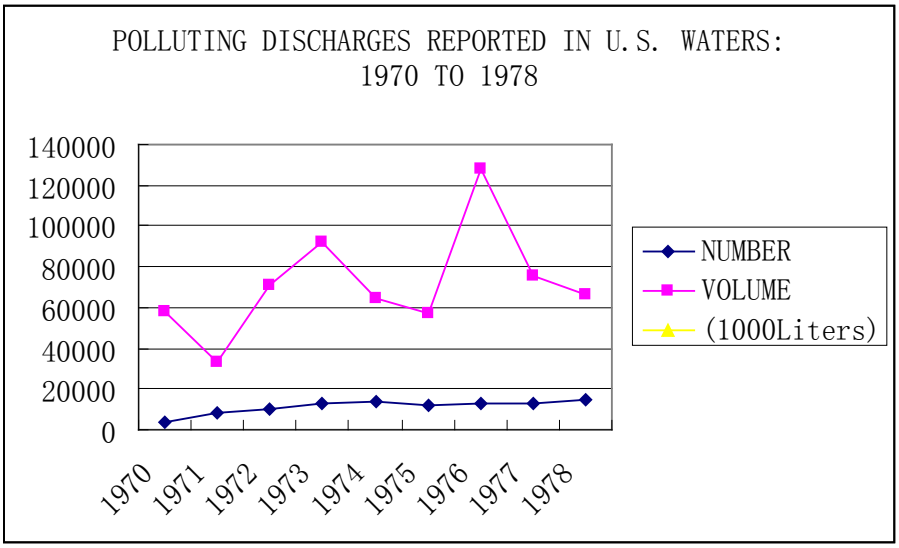
Table 7.2 Water Equipment—Construction Expenditures and Shipments: 1970, 1972, and 1974

ITEM	1970		1972		1974	
	municipal	Industry	municipal	Industry	Municipal	Industry
EXPENDITURES	1650	800	1878	1300	2844	1253
Distrib. And collection systems	1064	NA	1202	NA	1772	NA
Treatment plant	586	NA	676	NA	1072	NA

SOURCE: 1970 and 1972, U.S. Bureau of Domestic Commerce, Construction Review, Oct./Nov. 1971, and unpublished data; 1974, BEA, unpublished data.

However the wastewater discharge volume hasn't shown a steady decreased line but fluctuate heavily. The reason may be the gradually climbing up polluting discharge number.

Figure 7.4 Polluting Discharges Reported in U.S. Waters: 1970 to 1978



SOURCE: U.S. Coast Guard, Polluting Incidents In and Around U.S. Water, 1974; U.S. Coast Guard, Polluting Incidents In and Around U.S. Water, 1978

7.2.3 The U.S. Solid

Along with increased of both gross waste generated volume and the steady

resources recovery volume, the net waste disposal fluctuated in the range of 12% can be calculated from the Figure 7.5.

Figure 7.5 Solid waste generation, recovery, and disposal from 1970 to 1978

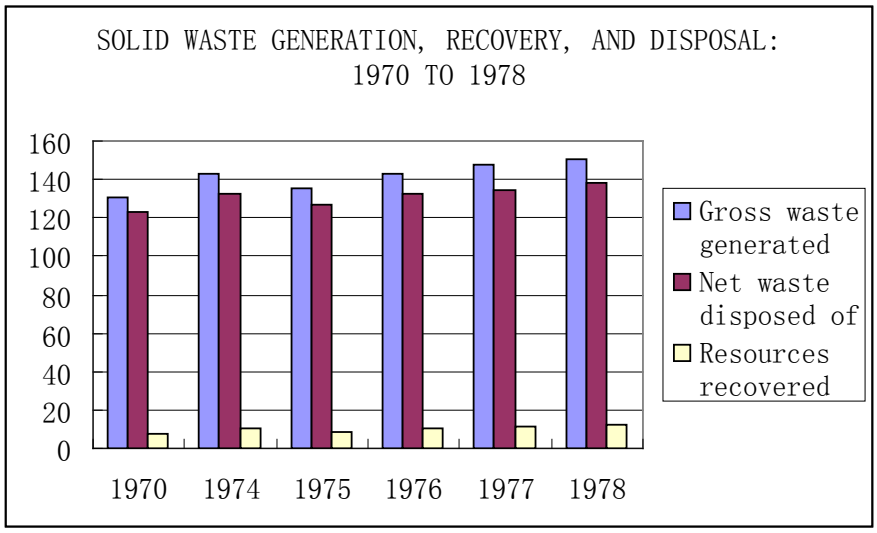


Table 7.3 SOLID WASTE GENERATION, RECOVERY, AND DISPOSAL: 1970 TO 1978 (In millions of tons. Covers post-consumer residential and commercial solid wastes which comprise the major portion of typical municipal collections only.)

Percentage of gross discards	1970	1974	1975	1976	1977	1978
Paper	16.0	16.3	15.5	16.1	19.8	20.1
Glass	1.3	2.5	2.7	2.7	3.4	3.3
Metal	1.2	3.4	4.4	4.5	2.5	2.5
Aluminum	1.3	5.0	6.7	9.2	7.1	13.3
Rubber	8.2	6.1	6.9	3.9	3.4	3.3

Source: U.S. Environmental Protection Agency, unpublished data from Franklin Associates, Ltd., Prairie Village, Kans.

Although paper waste cannot be well controlled during the 1970s in the U.S., which induce the gross waste generated have a small range increased, the other

pollutants are all have an decrease or at least maintain the level.

7.3 Environmental investment in the U.S. compared to P.R.C

A substantial regulatory framework was in the U.S. in place to manage the environmental problems, starting with the Clean Air Act of 1970 (Elliott et al., 1994).

The U.S. conduct the Pollution Abatement Costs and Expenditures (PACE) survey -- the most comprehensive source of information on U.S. manufacturing's capital expenditures and operating costs associated with pollution abatement—in 1973 (Becker and Shadbegian, 2007), administered by the U.S. Census Bureau.

According to international experience, environmental pollution can be controlled only when pollution treatment investment take 1% to 1.5% in GDP; and environment can be improved only when that investment take at least 2% to 3% in GDP (Lu and Gao, 2004).

Table 7.4 Federal obligations for pollution control and abatement 1970 to 1980

(In millions of dollars) Fiscal Year Calendar

MEDIA OR POLLUTANT	OBLIGATIONS (liabilities, contracts and other commitment entered into requiring the payment of money by the government.)							
	1970	1973	1974	1975	1976	1978	1979	1980
Total(1)	1070	4545	4176	6103	6465	5370	7961	8701
Water	677	3730	3455	5179	5492	3922	6212	6597
Air	189	461	490	348	334	456	517	576

Land	35	61	40	57	66	132	122	141
Living things, materials, etc.	169	293	191	519	573	860	1110	1287
GDP (2,billion $)	NA	NA	NA	159.6	NA	NA	NA	276.7
(1)/(2)				3.8%				3.01

Source: U.S. Office of Management and Budget, Special Analyses, Budget of the United States Government, annual.

Table7.5 Chinese Investment Completed in the Treatment of Pollution (billion yuan)

MEDIA OF POLLUTANT	OBLIGATIONS (liabilities, contracts and other commitment entered into requiring the payment of money by the government.)				
	2000	2001	2002	2003	2004
Total(1)	101.5	110.7	136.7	162.8	191.0
Industrial Water	10.96	7.29	7.15	8.74	10.56
Industrial Air	9.09	6.58	6.98	9.21	14.28
Industrial Land	1.15	1.87	1.61	1.62	2.26
GDP (2,billion $)	8950	9730	10520	11740	13690
(1)/(2)	1.27%	1.28%	1.28%	1.29%	1.3%

The Chinese government has gradually increased the proportion of GDP allocated to environmental protection from 0.72 percent in 1989 to 1.33 percent in 2003. Between 1998 and 2002, 580 billion Yuan was invested in

environmental protection and ecological construction across China, 1.8 times the total investment in this area for the 48 years between 1950 and 1997. In 2003, 136.34 billion Yuan was invested in treatment of environmental pollution, 23.2 percent more than in 2002. Of the total investment, 78.53 billion Yuan was used in construction of environmental infrastructure in urban areas, 18.84 billion Yuan in treatment of sources of industrial pollution, and 38.97 billion Yuan in environmental protection in new construction projects. However, the proportion governments' investment in China is still far from that of the U.S. government.

Table7.6 Investment Completed in the Treatment of Industrial Pollution (billion yuan)

	Investment Completed in the Treatment of Industrial Pollution this year	Treatment of wastewater	Treatment of waste gas	Treatment of solid waste
2000	23.94	10.96	9.09	1.15
2001	17.45	7.29	6.58	1.87
2002	18.83	7.15	6.98	1.61
2003	22.18	8.74	9.21	1.62
2004	30.81	10.56	14.28	2.26

(1)/(2) (%)	----	----	----	----	----	1.02	1.01	1.14	1.20	1.19

The government has gradually increased the proportion of GDP allocated to environmental protection from 0.72 percent in 1989 to 1.33 percent in 2003. Between 1998 and 2002, 580 billion Yuan was invested in environmental protection and ecological construction across China, 1.8 times the total investment in this area for the 48 years between 1950 and 1997. In 2003, 136.34 billion Yuan was invested in treatment of environmental pollution, 23.2 percent more than in 2002. Of the total investment, 78.53 billion Yuan was used in construction of environmental infrastructure in urban areas, 18.84 billion Yuan in treatment of sources of industrial pollution, and 38.97 billion Yuan in environmental protection in new construction projects.

7.4 Conclusion

It cannot be explicated that the U.S. environmental expenditures in 1970s was successful as the pollutant were not decreased obviously.

Following conclusions can be gained from this chapter. Under the same economic level, the percentage of environmental investment take in GDP in China is about 1/4 to 1/3 of that in U.S. The constant dollars expenditure in China in recent years is less than that in the U.S. The amount of particulates and SO_2 in China, 2005 is approximately the same as the amount in the U.S. in 1975. Sources of environmental expenditure have differences between China and the U.S.

In China, government input is take the most part of total expenditure and seldom public investment put into environmental protection. However, the public input

in the U.S take 1/6 in 1972 and continued to increase.

7.5 Limitations of contrasting the U.S. and China

As showed in table 7.7 The employment distribution in three types of industries which showed the people living dependence had obviously difference between China and the U.S.. Most work force involved in the third industries, which will not have more pressure on environment than the secondary industries, in the U.S. in 1970s until now.

Table 7.7 Employment in agriculture, industry and services (% of total employment)

	1980	1990	1995	2000	2001	2003	2005
U.S.							
Employment in agriculture	4	3	3	3	2	2	2
Employment in industry	31	26	24	23	23	21	21
Employment in services	66	71	73	74	75	78	78
China							
Employment in agriculture	69	53	48	46	45	49	44
Employment in industry	18	19	21	17	17	21	24
Employment in services	12	10	12	13	13	29	31

Although the U.S. in 1970s had similarity with percent China in economic level, some definitions of investment and other indicators altered with time went. Thus caused comparison cannot be done detailed. Besides, data availability was not enough about the U.S..

8. Comparison and contrast between Germany and PRC

8.1 Justification for choosing Germany as studied country

8.1.1 From the environment viewpoint

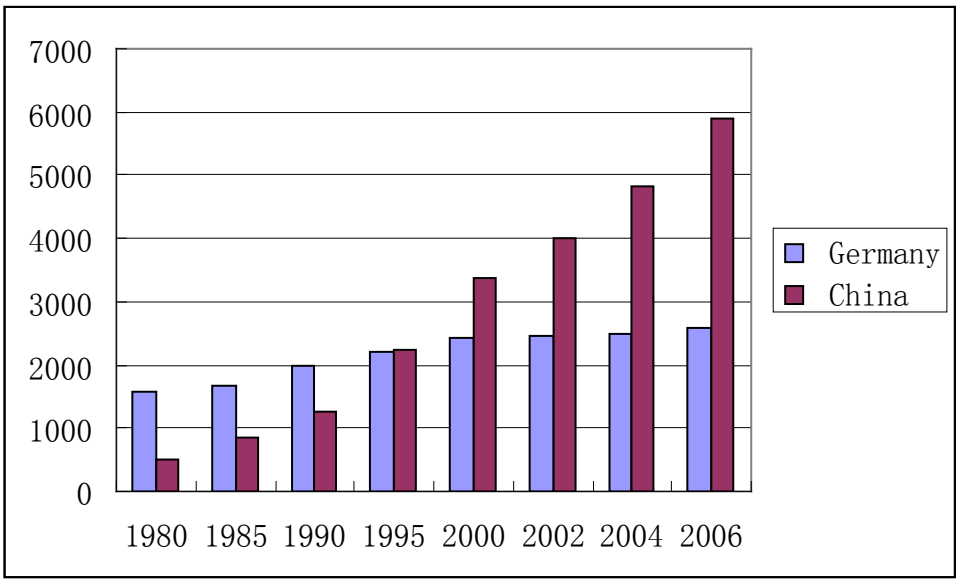
Germany environmental protection pressures were still created by agriculture, changes in consumption patterns and increased mobility. In western Germany, further improvement will probably require greater expenditure, while in New Lander, new pressures were to be expected due to industrial production recovery, continuously changing of consumption pattern and increased car use (OECD, 2001).

Just as Dr. Dollar said, ‘in the case of water pollution the situation has improved somewhat in recent years. Over 90% of industrial discharge is treated, so that industry is no longer the main source of water pollution. The biggest source is un- or poorly treated household waste (only slightly more than 50% of urban household waste is treated).’

8.1.2 From economy viewpoint

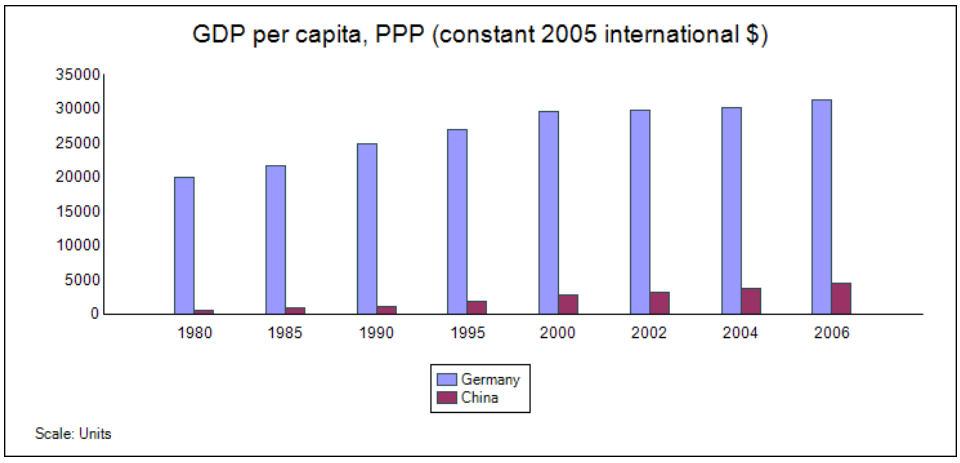
Germany was one of the most developing countries in the world. Its GDP maintained the top five for many years. China caught up with Germany in the year 1995 took the third place in the world. (see figure 8.1)

Figure 8.1 GDP, PPP (constant 2005 international $)



But distance between China and Germany in GDP per capita cannot be fulfilled in 50 years as showed in figure 8.2. That means the people living level cannot be compared between the two countries. Therefore, the two governments should have different level of anxious when consider investing in environmental protection.

Figure 8.2 GDP per capita in China and Germany



Germany economy experienced a deep recession after a boom in the early 1990. Production growth was modest between 1991 and 1998. GDP growth rate during

this period was 10%, which approximately equaled to the average annual GDP growth rate in China. the GDP per capita increased by 7%, unemployment rate reached record levels in 1997 (International Finance Crisis) about 10 percent.

8.1.3 From the relationship between environment and society viewpoint

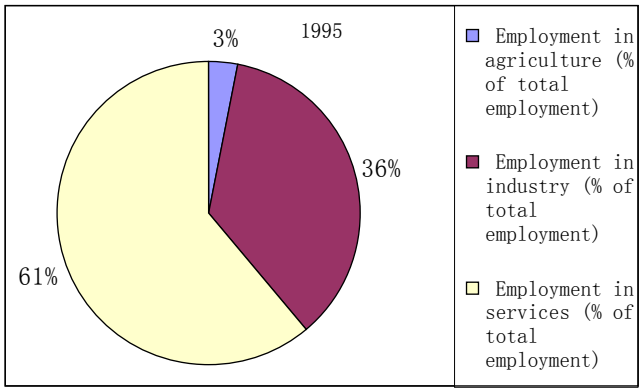
Germany is one of Europe's more densely populated countries with 230 inhabitants per square kilometers. China had the average population density of 139 inhabitants/km^2, and even higher density in east costal regions. The environmental pollution was spatially concentrated in Germany because of the population distribution was unevenly (OECD, 2001). And the east costal regions were also the main objective areas in PRC on pollutant treating.

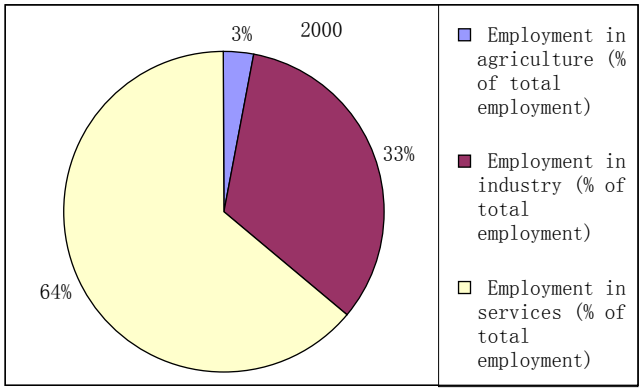
8.1.3 From industrial structural point of view

The main reason in choosing Germany for comparison was because of its industrial contribution to its GDP.

The employment distribution was raised again to illustrate the workforce living dependence in the two countries. Figure 8.3 showed the employment in three strata in Germany and Figure 8.4 showed that in China.

Figure 8.3 Number of Employed Persons at by Three Strata of Industry in Germany





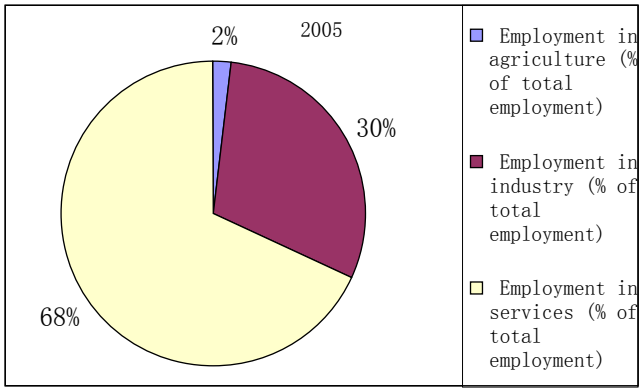
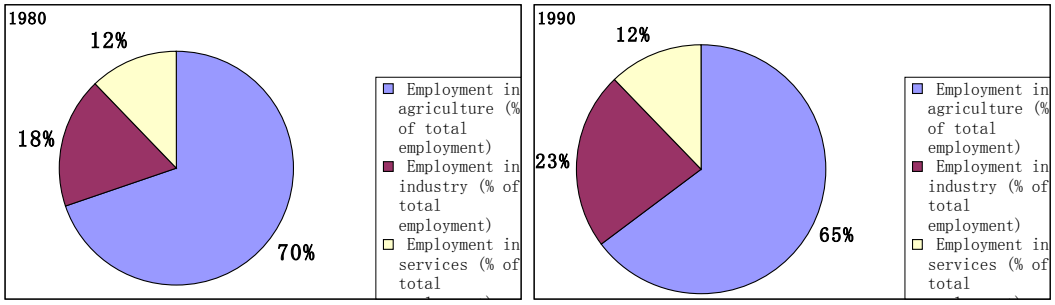
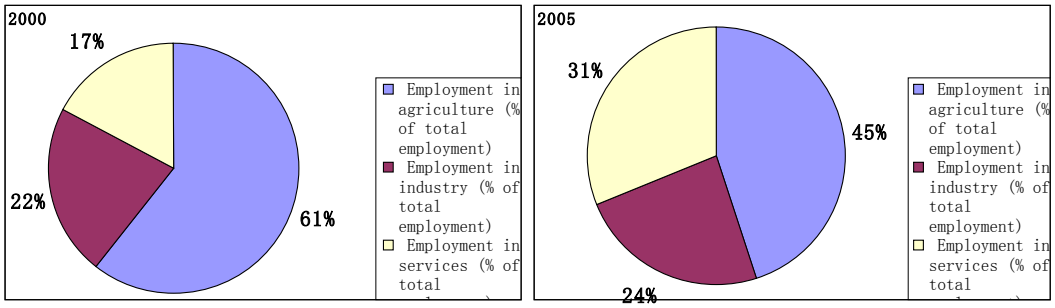


Figure 8.4 Number of Employed Persons at by Three Strata of Industry in China





The two figures indicated that although employment in third industry in Germany was much more than that in China, the employment in secondary industries in Germany was a little bit higher than that in China. And there was a small part of employment in first industry in Germany.

On the other hand, the electricity consumption per population (kWh/capita) reached 7111, which was about 6 times more than China's electricity consumption 1781 kWh/capita. There was about 50% electricity in Germany produced by coal and 79% in China. The reliance of power production on non-renewable fuel was not as high as China, but still took in a great part compared to that of Japan.

8.2 **Overview of Germany environment progress**

In the 1990s, Germany made further achievement in progress in decoupling economic growth from resource use and environmental damage, primarily with respect to traditional air contaminants such as SO_x, NO_x, CO_2 emission and organic pollutants discharges into waters. In particular, considerably improvement was accomplished in industrial emission control (OECD, 2001). The following years until now, in spite of growing economic performance, total

environmental pollution has fallen in Germany stated by official website.

This achievement on environmental protection in western Germany has been largely due to implementation of environmental policies. In New Lander, where over 80 percent of Germany's total reduction of SO_2 emissions has been achieved, the achievement has mainly resulted from economic restructuring and the closing of many production sites.

Germany Statistic Bureau pressed that between 1995 and 2006 emissions of carbon dioxide (CO_2) decreased by 4.7%. Over the period 1995 to 2005 emissions of nitrogen oxides (NO_X) fell by 33.5% and those of sulphur dioxide (SO_2) by as much as 67.6%.

Emissions of air pollutants have decreased to a considerable extent and a smaller quantity of water and raw materials has been consumed. However, the continued strong increase of land use for housing and transport purposes disagrees with these downward trends.

Between 1995 and 2006 energy consumption slightly increased by 1.4%. However, taking the effects of weather-related oscillations into account, we can take it for granted that energy consumption actually stagnated over the period considered. The consumption of raw materials decreased by 5.3% over the time span mentioned. This was mainly due to the impact of market fluctuations for building materials.

Withdrawals of water from nature as well as disposals of water in the natural environment recorded a remarkable 17% decrease between 1995 and 2004. This decrease can be explained, in particular, by a market reaction to changes in the provisions pertaining to the use of water and by a strong rise in water and sewage

prices.

A comparison of trends between withdrawals and disposals in the natural environment shows: the results achieved in reducing pollutant releases into the natural environment (for example by using improved filter equipment) were better than those achieved in reducing the amount of resources extracted from nature.

8.3 Environmental investment in Germany compared to China

Different from China, environmental investment in Germany includes two parts of sources. In addition to government aid (government expenditure), an increasing number of foundations in Germany support environmental research, development and investment. The Germany Federal Environment Foundation (DBU) established in 1990, with the capital of nearly 1.53 billion* EUR is one of the largest foundations in Europe. During the 1990s, DBU supported over 3300 projects spent at least 0.77 billion EUR.

On the other hand, since the mid-1980s, Germany annual expenditure on pollution abatement and control (PAC) has been reached 1.5% of GDP. About a half of total PAC expenditures relates to water pollution, 40 percent to solid wastes and the left 10 percent to air pollution.

The table 8.1 gave an overview of Germany environmental investment both from government and private. Compared with investment in China, the total investment in waste management in 2005 was about the same. However, Germany declined their investment but China increased their investment year by year. On the water and air treatment investment aspect, China invest much more

than that of Germany.

Table 8.1 Environmental investment in Germany

Environmental domain	1995	2000	2002	2003	2004
	EUR mn (at current prices)				
Waste management	1,680	1,380	1,550	1,360	1,280
Waste water management	2,950	2,490	2,490	2,740	2,420
Protection of ambient air	4,130	3,020	3,010	2,930	2,790
Government	14,110	9,550	8,530	8,360	8,490
Waste management	5,480	4,170	3,770	3,630	3,490
Waste water management	8,440	5,220	4,600	4,560	4,790
Protection of ambient air	50	30	20	20	20
Privatized, public, enterprises	12,460	16,080	17,250	17,940	19,240
Waste management	6,420	7,540	8,340	8,520	8,850
Waste water management	6,040	8,540	8,910	9,430	10,390

8.4 Conclusion

As showed in Figure 8.5 the renewable energy was used more and more in recent years in Germany. Besides, the energy productivity and raw material productivity increased either (see Figure 8.6). Thus Germany could develop its industry in using clean energy instead of coal and lignite. And the environmental quality could be maintained to a stable level. And the GHGs emissions declined step by step.

Figure 8.5 Renewable energy use tendency in Germany

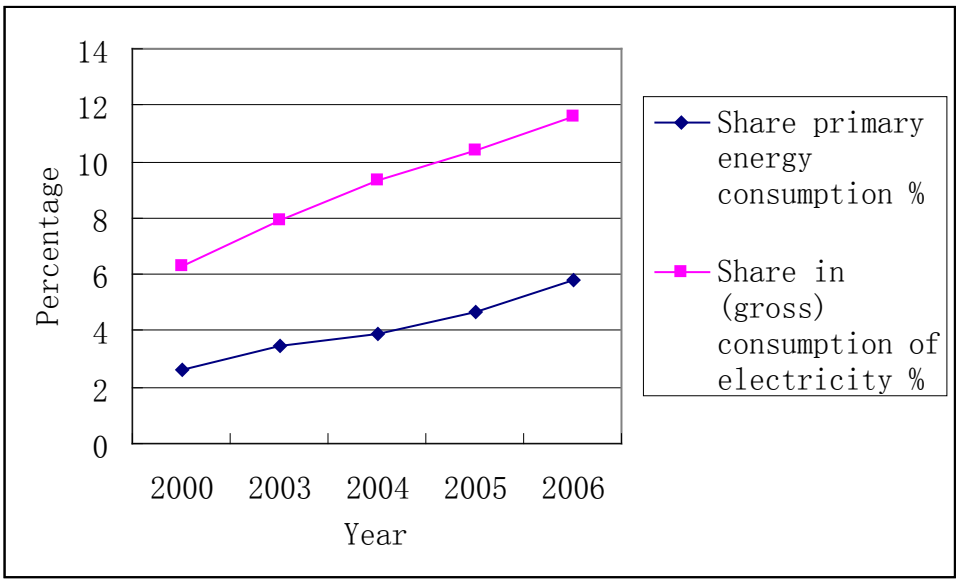
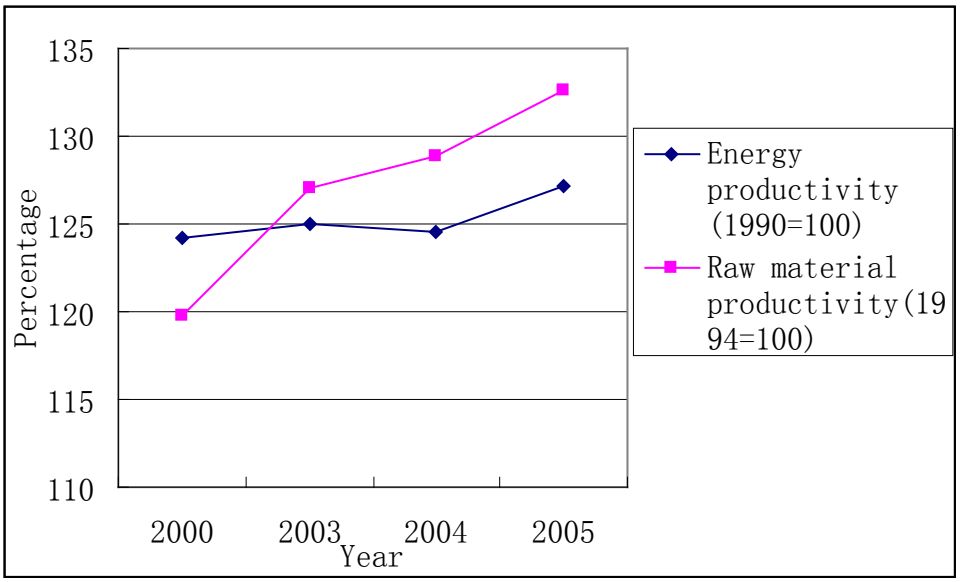


Figure 8.6 Energy and raw material productivities in Germany



2) The investment amount was an important factor in reducing environmental pollutions. However, as Germany showed, treat the pollution sources was more important than treat effluent pollution, and will be more efficient.

3) Private investment took the most part of environmental investment in Germany.

8.5 Limitations of contrasting Germany and China

Environmental education has been a key concern for many years in Germany. Environmental education in schools has advanced importantly. Most subjects in schools include environmental issues. By contrast, Chinese schools haven’t offer environmental related courses and even environmental issues, and universities offered such courses only for colleges majored in environment-related disciplines.

Besides schools and universities, many establishments and institutions offer environmental education. The German environmental education institutions included adult education, nature and environment centers, consumer councils, conservation and environmental protection organizations, biosphere reserves, museums, and zoos. All these institutions in China won’t offer environmental education frequently, and remind and request citizens do not destroy environment.

China made their effort to make public well informed about environmental matters. Information on a wide range of environmental topics is available from a number of sources, such as media and internet. It is of more importance that environmental information was available to public, which covers not only on the status of the environment, but also on activities and measures that impact on environment.

9. Overall Conclusions and recommendations

9.1 Conclusions

After analysing the Chinese environmental and economic conditions and comparing the investment situation between PRC and India, Japan, the U.S. and Germany, the following conclusions have been drawn.

1) Investment amount should be raised up to about 2% of GDP

Under the same economic level, meaning US in 1970s and PRC in 2000s, the percentage of environmental investment take in GDP in China is about 1/4 to 1/3 of that of U.S. The constant dollars expenditure in China in recent years is less than that in the U.S.

Lessons from India, Japan and Germany showed that the investment amount in environmental protection should be continuously increased, to about 2 % of GDP to meet the contemporary challenges.

As shown, Germany treated the pollution at sources than at discharging points. This is shown to be more efficient.

2) Higher investment to environmental technology research and development

The energy productivity and raw material productivity in these two countries increased either. The benefit for enhance energy productivity was the less amount of energy consumption. And reduce pollution as well.

Stronger policies that the Indian government was now considering could yield

large energy savings according to OECD. Coal savings – mainly in power generation – were the greatest in both absolute and percentage terms, because of the lower electricity demand growth, higher power generation efficiency and fuel switching in the power sector and in industry.

3) Investment sources should be enlarged by involvement of private sections and the communities.

In China, government input is take the most part of total expenditure and seldom public investment put into environmental protection. However, the public input in the U.S take 1/6 in 1972 and continued to increase. And in Germany, the private investment took the most part of its total investment in environment.

4) Energy sources in China should be altered to clean energy as soon as possible.

The renewable energy was used more and more in recent years in both Germany and Japan.

5) Environmental education should be enhanced

Environmental education has been a key concern for many years in Germany. Environmental education in schools has advanced importantly. Most subjects in schools include environmental issues. By contrast, Chinese schools haven’t offer environmental related courses and even environmental issues, and universities offered such courses only for colleges majored in environment-related disciplines.

6) More statistical employees required

Chinese government need to classify the statistical data as detailed as possible. Since the Japan began its environmental protection from 1960s, its statistical data were among the most detailed in the world from over 40 years experience accumulation. The detailed data offered future research on environment could be conducted more accurate. And this may need investment for labour employment.

7) Changes in agriculture practices and reduction of nitrogen and phosphors fertilizer. This helps to Japan reducing domestic wastewaters. But this change asked government or research institutions reduce the new chemical fertilizers' average cost. In the other word, it need technique renew once again. Therefore, more investment required for research and development in chemical fertilizer.

9.2 Recommendations

This work provided how much total environmental investment amount should reach and the further investment directions.

Further research could be done on how much investment should be undertaken in each direction of environmental protection.

Moreover, when the environmental quality becomes better in PRC, weather the environmental investment should be increased or not in order to balance the economic development.

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