A Sustainability Analysis of China

Sponsoring Agency: Hong Kong Institute of Education

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Date: 15 December 2010

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Executive Summary

The recent waves of rapid economic growth across much of the developing world have brought about many changes, both positive and negative, for developing nations, inciting calls for more environmentally sustainable and responsible development. Given the somewhat nebulous nature of the term “sustainable”, though, it is important to understand what it means for an entity—be it a corporation, a city, or a country—to be sustainable. According to Robert Goodland (1995), environmental sustainability is a set of practices designed to “improve human welfare by protecting the sources of raw materials used for human needs and ensuring that the sinks for human wastes are not exceeded, in order to prevent harm to humans” (p. 3). Striving for sustainability has become much more important in recent years, due to an increasing human population and subsequent demand for resources. This growth in population and consumption has become a significant burden on many of the planet’s ecosystems. The collection and use of natural resources also presents significant environmental issues, such as pollution and excessive generation of waste. At this time, China stands as perhaps one of the most important countries in considering the issue of environmental sustainability.

Over the past twenty years, China has risen to become a major international power, controlling one of the largest economies in the world. Due to the demands from national and local governments for increased economic growth, protecting and maintaining the environment has until recently been ignored almost completely (Zhang, Wen, & Peng, 2007). Even now, while China is working to clean up both its environment and perceptions of its environmental record, significant barriers still exist to making the country even close to sustainable. According to He, Lu, Mol, and Zhang (2009), regulation is lacking in many key areas and, in the areas where regulation does exist, it is often ineffective due to poor implementation of regulatory

programs (p. 1650). The *laissez-faire* environmental regulatory policies of Hong Kong Special Administrative Region (HK SAR) have contributed significantly to high levels of air and water pollution in the region as well, resulting in extensive environmental degradation for both Hong Kong and other nearby areas.

The aim of this project is to identify legislative and business practices significantly impacting Hong Kong and Mainland China's environment and natural resources, and from this recommend measures which may be taken to improve the environment of the region. To do this, we plan to identify unsustainable development policies and practices within Hong Kong and Mainland China that are causing environmental degradation, quantitatively assess levels of environmental damage in Hong Kong and Mainland China, and determine alternative policies that may lead to a more environmentally sustainable region.

We intend to use literature reviews to analyze the effects of resource exploitation and pollution in the years following Hong Kong's handover back to China, as well as the past and current environmental regulatory policies of Hong Kong and China. Quantitative data regarding environmental damage—particularly resource exploitation and pollution—in Hong Kong and China will also be gathered and analyzed. This will provide us with data to substantiate recommendations we will make regarding environmental policy in the region.

In addition to literature reviews and data analysis, we plan to conduct interviews with scholars in Hong Kong whose expertise lie within the fields of China/East Asia, environmental science, and environmentally sustainable development. Scholars will have a deep understanding of the intricacies of China and Hong Kong's successes and failures regarding the achievement of environmental sustainability in the region, and so will be of great help in our research. We also

plan to conduct interviews with business representatives to learn more about the environmental perspective of businesses operating in Hong Kong, and surveys of private citizens to learn about their role in shaping the regional environment.

The environmental problems facing Mainland China and Hong Kong are widespread and severe. While there has been progress in improving the environment of the region, further action is needed to repair the damage that has been done. By combining the aforementioned methods, we intend to be able to recommend actions that may be taken by regional governments or businesses to improve the environmental state of Mainland China and Hong Kong.

1. Introduction

The recent waves of rapid economic growth across much of the developing world have brought about many changes, both positive and negative, for developing nations, inciting calls for more environmentally sustainable and responsible development. Given the somewhat nebulous nature of the term “sustainable”, though, it is important to understand what it means for an entity—be it a corporation, a city, or a country—to be environmentally sustainable. Development which is environmentally sustainable, according to the United Nations (1987), progresses in a fashion which “meets the needs of the present without compromising the ability of future generations to meet their own needs” (sect. 2.I). Striving for sustainability has become much more important in recent years, due to an increasing human population and the subsequent demand for resources. This growth in population and consumption has become a significant burden on many of the planet’s ecosystems. The collection and use of natural resources also presents significant environmental issues, such as excessive pollution and generation of waste. At this time, China stands as one of the most important countries when considering the many challenges of achieving environmental sustainability.

Few countries have seen the benefits—and drawbacks—of rapid economic development as quickly and intensely as China has in recent decades. Over the past twenty years, China has risen to become a major international power, controlling one of the largest economies in the world. Due to the demands from national and local governments for increased economic growth, protecting and maintaining the environment has until recently been ignored almost completely (Zhang, Wen, & Peng, 2007). Even now, while China is working to clean up both its environment and perceptions of its environmental record, significant barriers still exist to making the country even close to sustainable. According to He, Lu, Mol, and Zhang (2009), regulation is lacking in many key areas and, in the areas where regulation does exist, it is often ineffective due to poor implementation of regulatory programs. For example, China’s Environmental Information Disclosure Decree, which seeks to increase transparency in reporting environmental

issues, has been fraught with organizational problems that have rendered it ineffective in some regions (p. 1650). In Hong Kong SAR, home of one of the freest markets in the world, high levels of air and water pollution stand as some of the most prominent negative effects of rapid development in the region.

As a result of lax regulation and relentless economic growth, many of the resources the people of China use have either been polluted or stretched to their limits. From overuse of water resources for agriculture in the North to air quality degradation due to industry in the South, China has put its natural environment into a very dire state (Organisation for Economic Co-Operation and Development, 2006). Hong Kong SAR, too, has become both the culprit and victim of environmentally unscrupulous practices. Hong Kong-based manufacturing companies, many of which have operations in Mainland China for economic reasons, have become significant contributors to high levels of air and water pollution in Southern China (Cheung, Wilford, & Hills, 2009, p. 252).

The increased visibility of China on the world stage has prompted other countries to take a much harder look at the country's environmental actions. Because of this, China has been facing increasing international pressure to limit the breadth and severity of its resource usage and pollution. Such pressure has come from within the nation's borders as well: many people within China have started to vocalize their opposition to what is seen as excess environmental exploitation in the name of economic growth (Merth, 2009, p. 3). These demands present a pressing need for research to be done into how the Chinese government, the nation's people, and businesses operating within China can alter their practices with the goal of environmental sustainability in mind.

The aim of this project is to establish connections between China's and Hong Kong's governmental policies, environmental regulatory policies, and the environmental degradation over the past few decades. To do this, we plan to identify unsustainable development policies

and practices within Hong Kong and mainland China that are causing or allowing environmental degradation, quantitatively assess levels of local environmental damage, and determine alternative policies that may make the region more sustainable. The first of these will be achieved through the use of interviews with scholars and representatives from conservation organizations in order to gain expert opinions on the matter. Additionally, we will conduct reviews of literature and environmental legislation in Hong Kong and mainland China. Quantitative analysis of resource exploitation and pollution will be done in order to identify major problems with China's environmental record. Following these, we will be able to demonstrate the relationships between China's resource exploitation, economic growth, and pollution, and use these to build an understanding of the reasons for the region's successes and failures in working towards sustainable development. We will then be able to reach our stated goal of recommending policies and measures that may be taken in both Hong Kong and China as a whole.

2. Background

This chapter will discuss the problems of resource exploitation and pollution in Hong Kong and Mainland China. Additionally, it will provide a historical context for the current environmental problems the region faces. Finally, previous successes and failures in environmental regulation will be discussed.

2.1. History

Prior to understanding China's and Hong Kong Special Autonomous Region's (HKSAR) current environmental states, their environmental condition from the recent past must be described. Changes in government policies and the economy in China over the past 30 years have caused environmental degradation (Gang, 2010, p. 3). The degradation has affected China's pollution levels, and these levels have been monitored over the last 30 years (p. 3). China's government introduced policies to regulate the pollution, and these policies are continually being modified. All of the aforementioned factors contribute to understanding China's current issues regarding environmental sustainability.

2.1.1. Pre-Handover China

Over the last several decades, China has undergone radical changes in both in its government policies and its economy. The 1980s began the shift from Mao's China, based on self-reliance, to a more globally open China under the direction of Deng Xiaoping. Though still a Communist country, China restructured itself under a newer set of ideals called the "'Four Modernizations'—in agriculture, industry, science and technology, and national defense" (Grasso, Corrin, & Kort, 2004, p. 241). Such deviations from the original Maoist ideology were at one time thought to be impossible. This shift in position became known as the "second revolution" (p. 241). This revolution relaxed both China's internal policies and its foreign

policies, allowing for interaction with the Western world; it created a flexible structure to grow into Deng's long awaited goal of a superior China.

Implementation of programs for the Four Modernizations created vast changes for China. To modernize, it had to be willing to interact with Western economies. As Zhao Ziyang, Deng's successor, said in Belgium in 1984, "China's door is open now, will be opened wider, and will never be closed again" (Grasso et al., 2004, p.248). This declaration demonstrated to the world that China was finally planning to cooperate with Western economies, and China welcomed the change with open arms. Western practices were anticipated with great enthusiasm by the Chinese, and they quickly became commonplace. "More than 50 million people are learning English, and many more are wearing Western clothes. Nearly 40,000 of the country's brightest college graduates have already gone abroad for further study, more than 15,000 of them to the United States" (Burns, 1985, para.2). Such desire for change only served to perpetuate China's shift from Maoism toward Deng's Four Modernizations.

2.1.2. China's Government

Despite China's desire to modernize, it did not aspire to Westernize entirely. This distinction was strong and caused much confusion because China wanted to learn Western practices, and it raised questions about whether or not it would adopt Western styles of government. Deng retracted the ban on intellectuals, causing the age-old criticisms of the Communist Regime to resurface. As Wei Jingsheng had proposed in 1979, "Deng's Four Modernizations…should include a fifth—democracy" (Grasso et al., 2004, pp. 250-251). These revolutionary thoughts caused unrest in China because the political leaders did not, and still do not, wish to rid China of Communism. Economic reforms were supported by Deng, but political change was not.

2.1.3. China's and Hong Kong's Governmental Progression

Simultaneously with China's yearning to modernize in the 1980s, China began making changes in its foreign policy. One of the most notable changes was China's interaction with Britain over the reclamation of Hong Kong. Starting in 1979, Sino-British negotiations began over the sovereignty transfer of Hong Kong back to China (Lam, 2007, p.2). From these negotiations a Joint Declaration was drafted and signed by both countries in 1984, which stated that "British administration of Hong Kong would end by 1997," (p.3). The Declaration gave hope to Hong Kong citizens by demonstrating China's desire to be flexible and open with the rest of the world. However, during the period between 1984 and 1997, turbulence within China diminished Hong Kong's faith in the Chinese government's commitment to abiding by the Joint Declaration. This loss of faith was caused by ambiguities in the Joint Declaration because it maintained that "China was a socialist system, while Hong Kong was a capitalist system," but it did not outline a political system for Hong Kong (Wong, 2004a, p. 2). After the 1989 Tiananmen Square Massacre, Hong Kong citizens took to the streets in protest of China's harsh, authoritarian regime. They did not want a government that would strip them of their liberties that the Declaration said would be protected (Mathews, Ma, & Lui, 2008, p. 46).

2.1.4. "One Country, Two Systems"

Two decades after the commencement of the Sino-British negotiations, Hong Kong was officially turned over to China in 1997 in what is known as "The Handover" (Wong, 2004b, p. 13). Due to unrest in China leading up to the handover and the uneasiness among the people of Hong Kong during its repossession, Deng Xiaoping's ideal of "one country, two systems" became crucial, though the British had no power to ensure such a standard would be enforced. In the 13 years since the handover, discrepant policies and political unfairness have become more

common. As Emily Leung said, “Beijing tried to assure Hong Kong people by pledging the mainland authorities would abide by local laws. Four years later, it is still an empty promise, and seriously undermines any claim that Hong Kong has the rule of law” (p. 13). Deng’s idea had been an almost perfect plan; the execution of it, however, has been less than ideal.

Since the handover, China has involved itself in Hong Kong as thoroughly as possible, much to the dismay of some Hong Kong citizens. To facilitate China’s integration, China established government offices within Hong Kong. Such offices include the Central People’s Government Liaison Office (CPGLO), Office of the Commissioner of the Ministry of Foreign Affairs (OCMFA), the People’s Liberation Army Garrison (PLA), and the HKSAR Chief Executive (Yep, 2007, pp. 250-251). These entities were designed by the Chinese Communist Party to keep watch over the Hong Kong and Macau regions. Even as recently as during the last five years hostility and resentment among citizens of Hong Kong toward China has existed. To alleviate the resentment caused by lack of governmental communication Hong Kong has created a presence in China’s government through three offices—Office of the Government of the HKSAR in Beijing, Hong Kong Economic and Trade Office in Guangdong, and the Trade Development Council with office locations throughout Mainland China. Hong Kong strives for a more democratic system where the aforementioned offices can be elected, but their requests are constantly denied (pp. 254-255).

Despite fundamental government differences between China and Hong Kong, China as a whole has grown to have a substantial international, economic presence. Shown in Figure 2-1 is a timeline from 1988 through 2008 showing changes in the percentage of both Gross Domestic Product (GDP) and average annual growth for China (HKSAR, 2009b, p. 43). During the

government's tumultuous 20 years that this chart is depicting, China saw a GDP growth of almost 1400%. China has had considerable economic growth internationally, and also internally.

KEY ECONOMIC RATIOS and LONG-TERM TRENDS

	1988	1998	2007	2008
GDP *(US$ billions)*	309.5	1,019.5	3,382.3	4,327.0
Gross capital formation/GDP	37.9	37.1	43.1	44.4
Exports of goods and services/GDP	14.8	20.3	39.7	36.6
Gross domestic savings/GDP	36.6	41.4	52.2	52.5
Gross national savings/GDP	36.7	40.2	54.1	53.6
Current account balance/GDP	-1.2	3.1	11.0	9.8
Interest payments/GDP	0.7	0.7	0.3	0.2
Total debt/GDP	13.7	14.1	11.1	8.7
Total debt service/exports	8.4	8.5	2.3	2.1
Present value of debt/GDP	..	..	10.8	8.2
Present value of debt/exports	..	..	25.5	21.3

	1988-98	1998-08	2007	2008	2008-12
(average annual growth)					
GDP	10.5	9.9	13.0	9.0	8.4
GDP per capita	9.2	9.2	12.4	8.4	7.7
Exports of goods and services	13.4	23.0	19.8	8.4	1.7

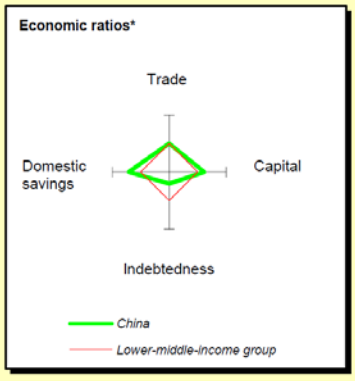

Figure 2-1: GDP Trends and Ratios in the Chinese Economy from 1988-2008 (The World Bank, 2009).

China and Hong Kong have had considerable changes regarding their economic interchange. Figure 2-2 shows Hong Kong's GDP growth from 1989-2009 (HKSAR, 2009b, p.43). Internal contributions such as China's own GDP and external contributions like China's foreign relations are responsible for such growth. China has grown upwards within its own economy, and it has been branching out into foreign markets. Unlike in the 1980's when "manufacturing, construction and supply of electricity, gas, and water" were the major contributing factors, in the last two decades "Hong Kong's economy has become increasingly service oriented" (p. 43). Hong Kong has long been considered a freer market, and rather than it producing only tangible items, they are now giving more attention to services.

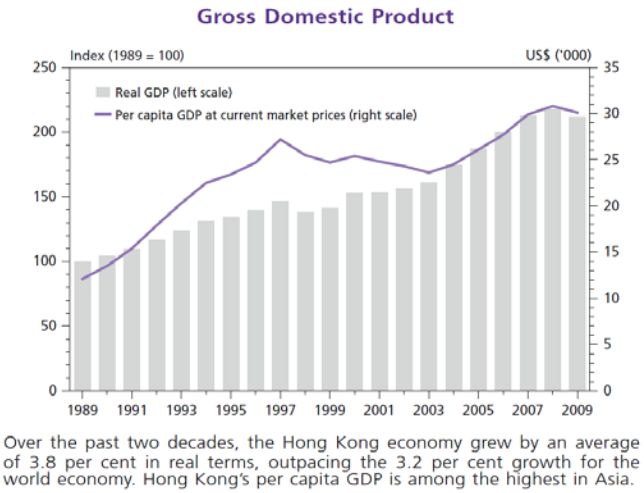

Figure 2-2: Gross Domestic Product of Hong Kong from 1989 to 2009 (HKSAR, 2009b, p 42).

Since the handover, "Hong Kong has continued to re-orient itself toward service activities, prompted by the changing regional and global economic environment and also by closer integration with the Mainland" (HKSAR, 2009b, p. 43). Figure 2-3 shows the changes in trade between Hong Kong and the Mainland over a four year time period; in 2008 there is a decline due to the global economic crisis that had been taking place, but it shows Hong Kong's economy was recovering by the end of 2009.

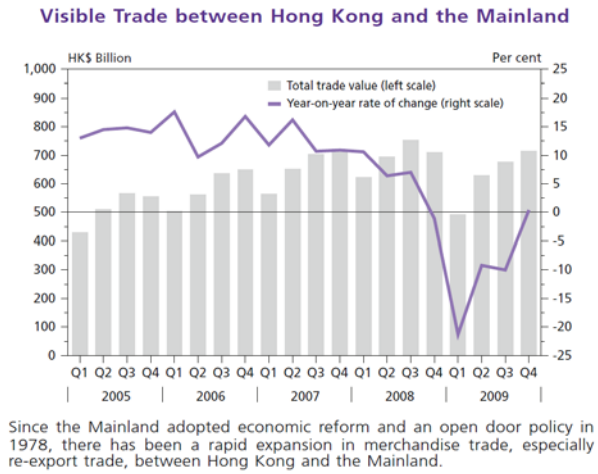

Figure 2-3: Trade between Hong Kong and Mainland China (HKSAR, 2009b, p 47).

The last three decades in Hong Kong and China have seen not only an economic surge but an industrial one as well. The handover expedited industrial growth. The Hong Kong Yearbook for 2009 has a small abstract stating, “Hong Kong has all the essentials that help business to flourish: low tax rates, first-class infrastructure, an effective legal system, free flow of capital and information. In addition, it has the most advantageous gateway to the mainland of China, one of the world’s fastest growing economies,” (HKSAR, 2009a, p. 94). These circumstances create an environment conducive to both Hong Kong and international businesses. Trade, services, and investment are three main sectors of business in Hong Kong, and they are ever changing.

Corporations flock to Hong Kong because of its economic policies. As of June 1, 2009, “Hong Kong was host to 6397 overseas, Mainland and Taiwan companies representing parent companies located outside Hong Kong,” (HKSAR, 2009a, p. 98). Foreign companies are boosting the Hong Kong economy by stimulating an inward direct investment of $6,325.8 billion (p. 97). Unlike some cities or areas of the world that have an industrial environment conducive to one specific type of enterprise, Hong Kong is rich in corporate diversity (see Figure 2.4). Hong Kong prides itself on its diverse corporate structure, and as a result, Invest Hong Kong was created in July 2000. This organization has branches around both Hong Kong and Beijing; its purpose is to help foreign companies establish themselves within Hong Kong (HKSAR, 2009a, p. 99). The magnitude of industrial investment has aided the industrial boom, but while it pitches the economy forward, other aspects of both China and Hong Kong have suffered, especially regarding the environment.

2.2. Resource Usage

As a result of its burgeoning economy, China has seen rapid and transformational industrial growth. To provide for these changes, the country has consumed increasing levels of resources of many types. In particular, energy, water, and land are the primary domains in which resource consumption has increased in recent years.

2.2.1. Energy

One of the most visible effects of China's industrial growth is its dramatic rise in energy production and consumption. According to data from the National Bureau of Statistics of the People's Republic of China (2009), net energy production in China increased by 248% between 1991 and 2008. This illustrates only part of the phenomenon; in addition to higher levels of energy production, energy consumption increased by 275% in the same time interval. For much of this period, China has consumed more energy than it has produced, as shown in Figure 2-4: Energy imports, exports in Mainland China (National Bureau of Statistics, 2009, sects. 6-1, 6-2).. Standing as a net energy consumer rather than a net energy producer is disadvantageous to China, particularly as its increase in energy usage does not appear to be waning (sects. 6-1, 6-2).

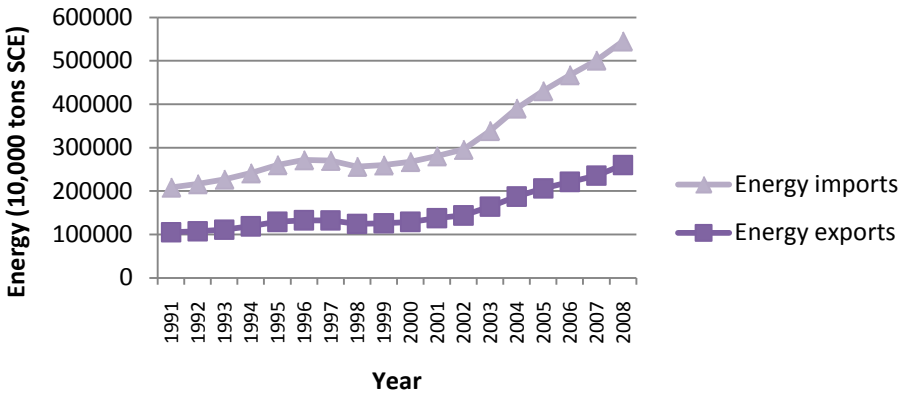

Figure 2-4: Energy imports, exports in Mainland China (National Bureau of Statistics, 2009, sects. 6-1, 6-2).

In recent history, coal has stood as the primary source of energy for Mainland China. Home to vast coal reserves, China uses these reserves to provide the large majority of its energy needs. Thus, an increase in energy usage coincides with an increase in coal mining and production—a trend which has held for the past two decades. While other sources of energy are used to provide energy for the Mainland, few rival the role coal plays in shaping China's energy profile, which is comprised of approximately 70% coal. An additional 18.7% of energy consumption comes from crude oil and 3.8% from natural gas. Hydropower, nuclear, and wind power have become more prevalent since 1991, increasing from 4.8% and 8.9% of total energy consumption between 1991 and 2008 (National Bureau of Statistics, 2009, sect. 6-2). However, this is still a very low proportion of total energy consumed compared to the use of hydrocarbon-based combustible energy sources. Figure 2-5 shows energy consumption by fuel type between 1991 and 2008.

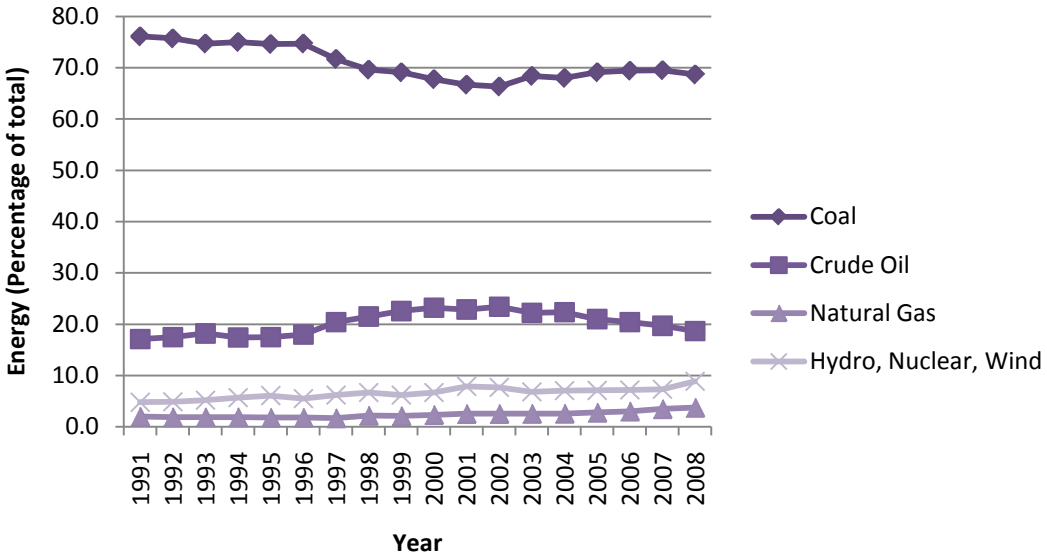

Figure 2-5: Energy consumption by fuel in Mainland China (National Bureau of Statistics, 2009, sect. 6-2).

Given Hong Kong SAR's different development history relative to the Mainland, as well as its status as a primarily urban region, it is unsurprising that its energy usage profile is dissimilar to that of Mainland China. Data from the Hong Kong Census and Statistics Department (2009) indicate that, relative to the Mainland, increases in total energy usage have been much lower per year between 1991 and 2007. This is due partly to its high population density and public transit networks, which allow for more efficient energy usage. Additionally, according to the United Nations (2010), approximately 28% of energy used comes in the form of imports from beyond Hong Kong, particularly Mainland China.

Hong Kong also relies on oil and natural gas, rather than coal, to meet most of its energy needs. This is an important distinction when seeking to understand how governmental energy policies may apply to Mainland China and Hong Kong (Adamo, Foley, Graef, & Stone, 2002, p. 62). A combination of high levels of energy imports and differing sources of energy make Hong Kong's energy consumption and production profile rather different from that of the Mainland. As a result, energy policies effective in reducing energy consumption or promoting cleaner energy in the Mainland may not work in Hong Kong, and vice versa.

2.2.2. Water

Due to its location and size, Mainland China is host to a variety of different climates and terrains, each with differing levels and distributions of available water. The growing population and shifts in the economy have necessitated both greater levels of water usage and differing profiles in usage in recent years. The Organization for Economic Co-operation and Development, or OECD (2006), indicates that, in general, approximately 80% of available water resources in the Mainland lie in Southern China. Southern China stands as a producer of many

agricultural goods for the nation, such as rice (p. 76). However, most of China's agricultural centers are located in the North, significantly impacting the availability of water in the region.

Despite the relatively high levels of precipitation and water resources in the South, Mainland China suffers from among the lowest per-capita levels of water availability in the world. Drought and water overuse are frequent, particularly in the Northern agricultural regions. This coincides with annual declines in water usage in agricultural sectors, as well as usage increases in both urban and industrial sectors. As a result, China has seen a net decrease in water consumption across the nation (OECD, 2006, pp. 77-78). This decrease in consumption does not, however, sufficiently offset the growth in population; per-capita water availability has been declining annually as well.

In China, most available water is consumed for agricultural purposes, though over time agricultural water usage has been declining. According to the National Bureau of Statistics of the PRC (2009), as of 2008 approximately 62% of water went to agriculture and 24% to industry. This stands in contrast to usage in 2000, when 69% of water was used for agriculture and 21% was used for industry. This relative decline in agricultural water usage shows little signs of slowing. Residential water consumption has been occupying a growing, though still relatively minor share of total water consumption—from 10% in 2000 to 12% in 2008 (sect. 11-18). Figure 2-6 illustrates the changing ways water has been used in Mainland China since 2000.

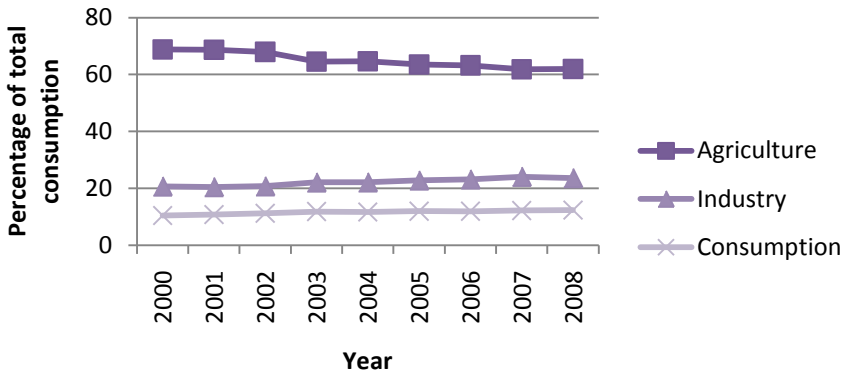

Figure 2-6: Water consumption in Mainland China by sector (National Bureau of Statistics, 2009, sect. 11-18).

According to Adamo et al. (2002), Hong Kong uses comparatively less water per capita than the Mainland. This is in large part due to the fact that Hong Kong is a densely-populated urban area with a relatively restricted set of water needs. For example, it has little agricultural land relative to other parts of the Mainland. A granite bedrock base prevents Hong Kong from being able to draw its own water. Thus, despite lower demand for water, approximately 76% of it is imported from outside sources (pp. 47, 53).

2.2.3. Land

Given China's status as one of the largest countries in the world, its use of available land impacts both domestic and international communities. Food production, for example, has historically proven to be a problem for the Mainland. As of 2007, arable land made up only 15% of China's total land area. Currently, land in China falls into the following categories: 59.9% agricultural (includes arable land, permanent crops such as trees, and pastures) and 22% forest, with the remainder being used for other purposes (World Bank, 2010).

China's previous exploitation of its forests, at rates far exceeding their ability to replenish themselves, has had a variety of negative effects on the nation's ecosystems. The State Forestry Administration of the People's Republic of China (2010) has undertaken reforestation programs

to combat these effects, such as desertification and soil erosion in the North. These attempts have been met with success in recent years, according to the World Bank (2010); forest coverage grew from 16.8% to 22.0% between 1990 and 2007. Figure 2-7 shows the growth in forest area since 1990.

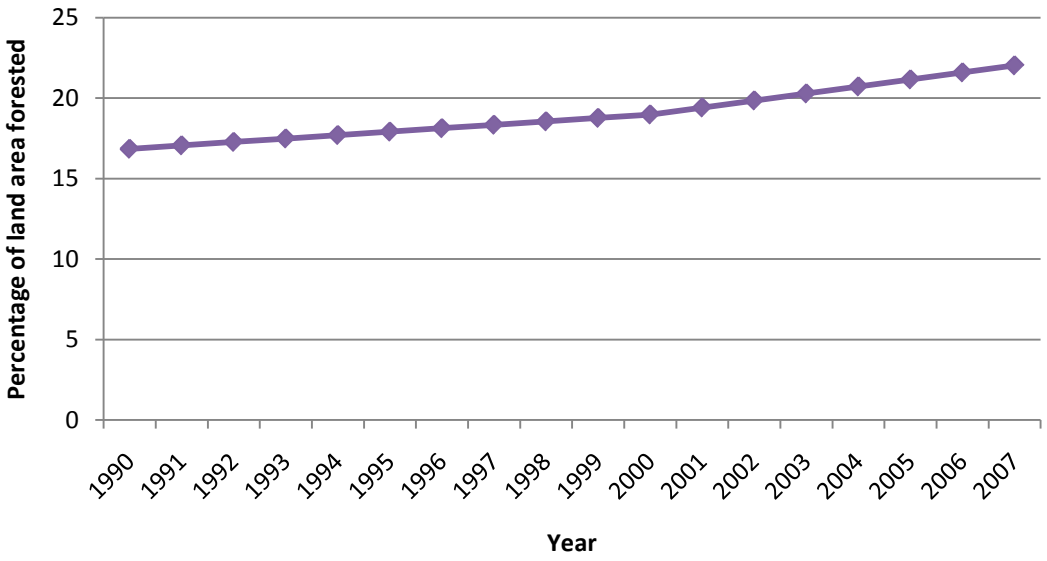

Figure 2-7: Percentage of land covered by forest in Mainland China (World Bank, 2010).

As the economy of China has changed, so have its methods of land distribution and usage of available land. According to Ng and Tang (1999), land distribution and usage was for many years determined by the national government of Mainland China. Due to perceived weaknesses in this scheme in the face of a growing and globalizing economy, the national government has, since the 1980s, given local governments increasing levels of control over their own land allocation. This has given local governments opportunities to distribute land in ways that benefit their districts economically. Rather than buy and take ownership of the land, entities wishing to purchase land do so on a lease agreement with the state (pp. 7-10).

This localized control over land allocation has enabled the Mainland government to use a mixture of planned and market-based economics to its maximal benefit (Ng & Tang, 1999, p. 10). In Southern China, particularly Guangdong Province, this permits companies from Hong Kong to establish new manufacturing centers in Mainland China. As of 2009, 93% of Hong Kong manufacturers had manufacturing facilities in Guangdong Province (Cheung, Wilford, & Hills, 2009, p. 252). While conducive to economic growth in Guangdong, this heavy influx of Hong Kong businesses puts the environmental health of the region at risk.

Unlike the Mainland, Hong Kong uses free, open markets for land distribution (Ng & Tang, 1999, p. 9). While this strategy does not have a significant impact on the growth-centric motivations for land purchase and development, it provides individual citizens with a greater role in determining the outcome of prospective land transactions. As of 2001, Hong Kong has designated about 40% of its land to remain undeveloped for a variety of purposes (Adamo et al., 2002). However, land that has not been designated as undeveloped is often densely developed. Thus, while its land markets are freer, land available for development in Hong Kong is costly and difficult to find.

2.2.4. Effects of Resource Usage

China and Hong Kong's growing economies have coincided with intense and rapid growth in resource consumption in recent decades. The impacts of such rampant consumption are readily apparent: overuse of water supplies, heavy energy usage in the form of fossil fuels (both produced and imported), and intensive land development have all contributed to a dire environmental situation in both Hong Kong and Mainland China. While there has been recovery in some sectors, such as forest coverage, on many fronts the impacts of such resource exploitation either have become or soon will become apparent.

For the people of China, rapid economic development has typically continued with or without their approval, and until recently, attempts to speak out against such development have been met with repression. According to Mertha (2008) in *China's Water Warriors: Citizen Action and Policy Change*, this has changed; excessive use of water resources has led to actual and effective community action in recent years, increasing the role of citizens in development processes (p. 3). The people of Guangzhou, capital of Guangdong province, have become more willing to voice their opinions as well, indicating that the vast majority of residents of the city are opposed to the influx of Hong Kong businesses on the grounds that they have contributed to environmental degradation in the region (Cheung, Wilford, & Hills, 2009, p. 252).

2.3. Pollution

As a result of lax environmental regulation enforcement and rapid economic and industrial growth, pollution has become a severe problem for the Hong Kong and mainland China. This section discusses pollution across three main areas—air in urban centers, water, and waste—and the effects of heavy pollution on the region.

2.3.1. Urban Air Pollution

As of 1999, sixteen out of twenty of the world's most polluted cities are located in China; its air pollution is considered to be among the worst in the world (He, Huo, & Zhang, 2002, p. 400). Urban air pollution in China is a byproduct of energy consumption, particularly coal consumption, as well as rapid increases in the number of vehicles used in cities. Air pollutant emission has become a severe problem for China, damaging the economy and contributing to severe health problems among its population (He, Huo, & Zhang, 2002, p. 398). There are several air pollutants which significantly affect the urban air quality of China: total suspended particulate matter (TSP), sulfur dioxide, nitrogen oxides, and acid rain.

According to the China National Ambient Air Quality Standards (CNAAQS), the most significant air pollutant in Chinese cities is Total Suspended Particulate matter (TSP) (He, Huo, & Zhang, 2002, p. 404). Figure 2-8 indicates that the average annual concentration limit for TSP in China is 0.30 mg m^{-3}. Unfortunately, on average, the annual concentration of TSP in 93 Chinese cities over the past 27 years has been 0.40 mg m^{-3}. The highest annual concentration of 0.63 mg m^{-3} was recorded in Lanzhou, in Northwestern China, while the lowest annual concentration of 0.08 mg m^{-3} was found in the city of Haikou in Southern China.

TABLE 1 Concentration limits for some pollutants in the CNAAQS (mg/m^3)

Pollutants	Averaging time	Class I	Class II	Class III
TSP	Daily	0.12	0.3	0.5
	Annual	0.08	0.2	0.3
PM_{10}	Daily	0.05	0.15	0.25
	Annual	0.04	0.1	0.15
SO_2	Daily	0.05	0.15	0.25
	Annual	0.02	0.06	0.1
NO_2	Daily	0.08	0.08	0.12
	Annual	0.04	0.04	0.08
NO_x	Daily	0.1	0.1	0.15
	Annual	0.05	0.05	0.1
CO	Daily	4	4	6
O_3	Hourly	0.12	0.16	0.2

Figure 2-8: Concentration limits for some pollutants in the CNAAQS (mg/m^3) (He, K., Huo, H., & Zhang, Q., 2002, p. 401).

As can be seen in Figure 2-9, TSP concentrations increase from South to North and East to West. For example, the following TSP concentrations were measured by region: 0.46 mg m^{-3} among eleven Northern coastal cities, 0.49 mg m^{-3} among thirty-eight Northern inland cities, 0.24 mg m^{-3} among fifteen Southern coastal cities, and 0.31 mg m^{-3} for twenty-nine Southern inland cities (Zhang, et al., 2010, p. 1642). Due to recent changes in Chinese energy infrastructure, coal combustion cleaning technology, afforestation and municipal sanitary engineering, TSP concentration has declined in urban areas of China over the past three decades.

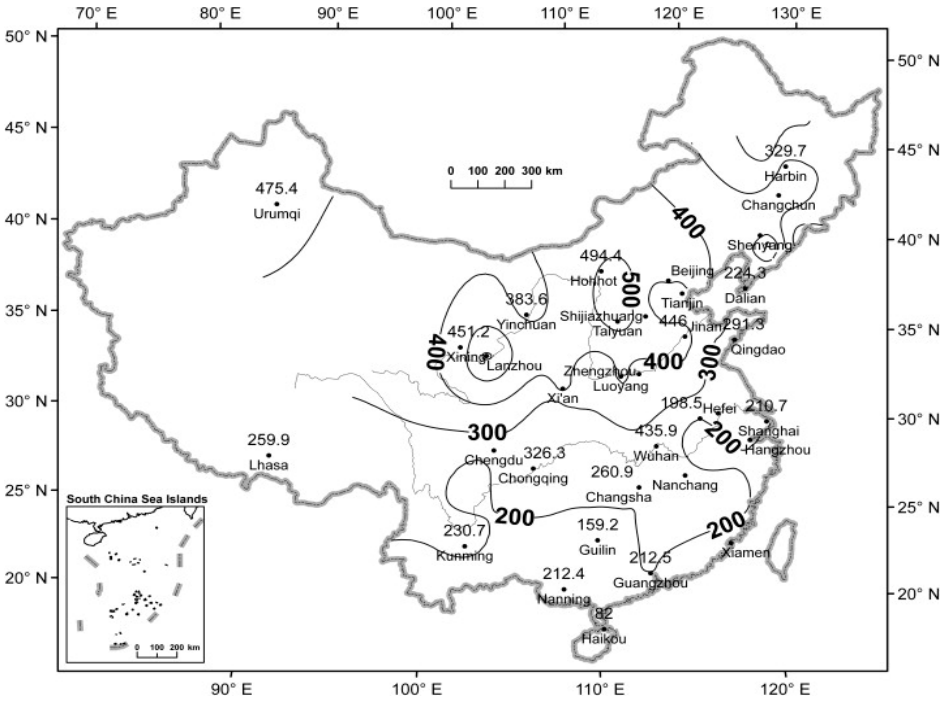

Figure 2.9

Figure 2-9: Distribution of annual avg. TSP concentration (C_{tsp}) in China, 1981-2007(μg m^{-3}) (Zhang et al., 2010, p. 1643).

Sulfur dioxide, or SO_2, is an air pollutant produced from industrial production, energy transformation, and residential cooking. However, sulfur dioxide is mainly formed from the combustion of sulfur compounds, such as those contained in coal and petroleum—the main energy sources of China. In 2005, 25.49 million metric tons of sulfur dioxide were released into the atmosphere in China—the highest recorded level of sulfur dioxide emission in the world at the time.

According to China's Statistical Yearbook, average sulfur dioxide emissions throughout the whole country were 14.02 metric tons per 1,000 people from 1991 to 2006. In 2006, however, sulfur dioxide emission reached 19.37 metric tons per 1,000 people. (Song &Woo, 2008, p. 231). Overall, sulfur dioxide emission levels are higher in coastal municipalities and provinces such as Beijing, Shanghai, and Tianjin than in Central and Western areas of China. Average sulfur dioxide emission levels are the same in Central and Western areas of China,

reaching 21.6 metric tons per 1,000 people. China's Eastern provinces like Zhejiang, Anhui and Fujian emit the lowest levels of SO_2 compounds at 15.2 metric tons per 1,000 people. Sulfur dioxide is one of precursors of acid rain, a significant public health hazard resulting from pollution.

Acid rain has been one of the most important environmental issues facing China since the late 1970s. In the beginning of the 1980s, two cities in Southwestern China, Chongqing and Guiyang, and Nanchang in Southeastern China, began to experience acid rain (He, Huo,& Zhang, 2002, p. 410). Since the 1990s, acid rain has occurred in the Southeast and North coastal areas, as well as the Northern areas of China. Currently, acid rain areas are mostly found in Southern regions of China, such as areas south of the Yangtze River and in Guangdong, Hunan, Fujian and other provinces. Approximately 40 percent of China is being exposed to acid rain. As of 2005, 696 cities of China have had acid rain events (Song & Woo, 2008, p. 231).

Soil composition and meteorological conditions may be factors that cause acid rain to occur in particular regions. For example, even though Northern China has a higher rate of acid rain's precursor emissions, SO_2 and NO_x, Southern China has experienced more acid rain. Soil in the North of China has more alkali in its composition, and alkali is known to neutralize the acidic ions in the rain. Pollutants get mixed and transferred over large areas due to scattering of atmospheric gases.

During the past decade, the average concentration of nitrogen oxides (NO_x) has not changed dramatically in China (He, Huo, & Zhang, 2002, p. 410). In general, Northern Chinese areas have higher average concentration of nitrogen oxides than Southern areas, and urban areas face much higher concentrations than rural areas. NO_x concentrations in Guangzhou, Beijing, Shanghai and Wuhan have steadily increased over the past decade. This is primarily due to the

rapid growth of the vehicle population, as vehicles are major contributors to urban NO_x pollution. The total number of vehicles in China was approximately 40 million by end of 1998; that year, vehicles in Beijing had released 0.12 million tons of nitrogen oxide, mostly in parts of the city with high traffic densities. Poor traffic management, poor maintenance, and slow infrastructure development have been major contributing factors in the vehicle emissions problem in China.

2.3.2. Water Supply and Water Pollution

Since water is essential to life, water quality has always been a very important issue in China. According to The State Environmental Protection Administration's (SEPA) 2002 annual report, the water quality of most river systems in China at the time was so poor that the water was not suitable for human use (Economy, 2004, p.69). For example, water quality reports for Lake Tai, one of the largest fresh water bodies of China, indicate that nearly 60 percent of its water is only suitable for irrigation.

The rise of township and village enterprises (TVEs) has caused major local water pollution as well (Economy, 2004, p.70). Various water pollutants from these enterprises get dumped into surrounding water bodies, contaminating water used for drinking, irrigation, and other human uses. The following two sections provide specific examples of water bodies and their environmental states.

The Pearl River

The Pearl River (see Figure 2-10) flows through the Pearl River Delta Region (PRDR) Economic Zone in Southern China's Guangdong Province. The PRDR Zone, Hong Kong, Macau and the Daya Bay areas are supplied by water from the Pearl River Delta. Sustainable

development of these areas directly relies on rational use, utilization, and management of the Pearl River water resources.

Figure 2-10: Pearl River Delta Region (Net Resources International, 2010).

The Pearl River is the main water source for Guangzhou, the capital of Guangdong province. Since the 1990s, Guangzhou has seen a major rise in its total population, partially caused by the migration of people from surrounding rural areas. By 2005, the number of people in Guangzhou had reached 9.7 million (Dong & Mei, 2010, pp. 78-84). Population growth in the city directly affects the environmental management of the city, including its use of water. The Pearl River is used in Guangzhou for drinking, navigation, industrial, and agricultural uses.

Through the study on the influence of urbanization on the surface water quality in Guangzhou between 1986 and 2000 numerous data were collected on eight main pollutants in the Pearl River from nine important locations of Guangzhou (p. 78). These pollutants included permanganate value (COD_{Mn}), phosphorus, nonionic ammonia, nitrate nitrogen, and petroleum. The study determined that industrial discharge and living sewage are the main pollutants of the

water sources in Guangzhou (p. 82). Also the results of this study verified the direct negative effect of the high intensive urbanization and industrialization on the surface water quality of the Pearl River in Guangzhou province.

Yangtze River

Water quality in the China's largest river, the Yangtze, has declined significantly since the beginning of the 21st century. The percentage of water not suitable for human contact has almost doubled to 48.5% since 2000 (Economy, 2004 p. 69). Water pollution has a negative effect on the fishing industry of China, which has been the case with the Yangtze River. The main pollutants that have unfavorable effects on the fish population in the river, even in low concentrations, are endocrine disrupting chemicals (EDCs) (Song et al., 2010, p.1). Endocrine disrupting chemicals are natural or synthetic compounds that change an organism's hormonal and homeostatic systems responsible for homeostasis, reproduction, and development (Diamanti-Kandarakis, et al., 2009, p. 5). Effluent from wastewater treatment plants, untreated sewage and upstream wastewater are additional sources of severe water pollution in the Yangtze River. There have been numerous organic contaminants detected in the river that are very dangerous for the aquatic life of Yangtze due to their high toxicity.

2.3.3. Waste Pollution

Waste disposal is one of the most pressing environmental problems facing China today. Urban areas of China generated 190 million tons of municipal solid waste in 2004 (World Bank Report, 2005, p. 3). These enormous amounts of waste disposal have had significant consequences for China's ecological situation, such as the proliferation of land areas known as "brownfields". According to the World Bank, brownfields are "lands contaminated from inadequate disposal practices or chemical spills" (p. 41). There are at least 5,000 brownfield sites

in 660 Chinese cities, which require major funds from the Mainland government for remediation. In addition, there are unregulated dumping areas in most cities of China; without reliable data it is unclear what the impact of the dumped waste is on the surrounding ecosystems. Due to the density of population and shortage of clean water, contamination of groundwater is a very significant problem in China. As most landfill sites do not meet environmental standards or are simply filling up, China must find alternative methods of waste management for both municipal solid waste (MSW) and what is known as "special waste".

Municipal Solid Waste

Waste generated from households is known as a municipal solid waste (MSW). Since 1995, the volume of MSW produced in China has increased by 45% between 1995 and 2004 due to immense population growth and urbanization (Hong, Li, & Zhaojie, 2010, p. 2362). High amounts of MSW require development of waste treatment systems for the safe disposal of municipal solid waste; as a result, by the end of 2004 there were 559 MSW disposal systems in 661 cities in China. As shown in Figure 2-11, the amount of generated MSW has been growing by approximately 80,000,000 tons per year.

There are three ways of municipal solid waste treatment: landfill, composting, and incineration. The majority of MSW (86.5%) is disposed of in landfills. However, only 35% of China's landfill sites were considered to be safe in 2005 (Hong, Li, & Zhaojie, 2010, p.2362). With numerous known cases of landfills contaminating groundwater and surface water, China has been trying to dispose of their waste with alternative technologies, such as composting and incineration. During the process of composting, remnant organic materials get decomposed and can be reused as soil conditioners in agriculture. Incineration, on the other hand, is the combustion of organic materials contained in the waste. Incineration has both positive and

negative effects on the environment. Even though it provides energy recovery and waste volume reduction, flue gas released during the incineration has significant amounts of carcinogens, such as dioxin, furan, and fly ash. Fabric filters, activated carbon powder injection system, and scrubbers are implemented in the incineration process to remove dioxins and heavy metals contained in the fly ash. However, complete removal of these materials is almost impossible.

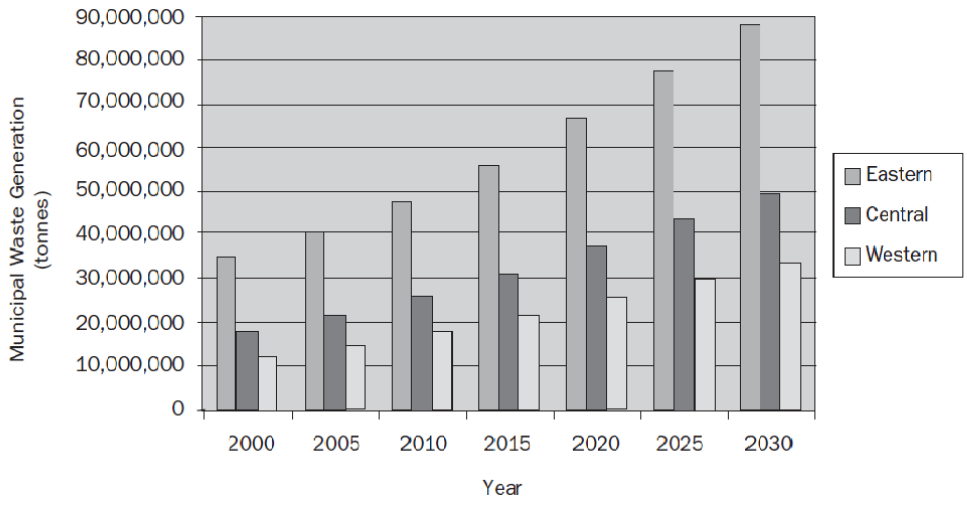

Figure 2-11: Projected Municipal Waste Generation in Urban Areas of China by Region (World Bank, 2005, p. 7).

Special wastes

"Special wastes" are wastes that necessitate special treatment programs before being disposed (World Bank, 2005, p.41). Hazardous waste, demolition waste, medical waste and disproportionately problematic wastes fall under the category of special waste. Specific local and national planning programs are required for the management of this particular kind of waste. While segregation and containerization facilities are necessary for medical waste management, hazardous waste management requires identification and proper manifest of its waste before an actual disposal. Annual production of special waste in China has been increasing significantly

since the beginning of the 1990s. For example, the amount of demolition waste has increased from 7.7 million tons to 13.5 million tons between 1991 and 1999 in Hong Kong (Beardsley, Freyberger, Kim, 2002).

2.4. Prevention and Remediation Techniques

Due to the extreme nature of the pollution and waste situation in China and Hong Kong, we will now examine certain strides that have been and are being taken to prevent and remediate these problems. Over the past thirty years, China has utilized both legislative and technological measures to manage these environmental issues.

2.4.1. Legislation in China

China's first legislative step towards environmental protection came in September 1979 (ERM, 2009, p. 1). The People's Republic of China passed a trial Environmental Protection Law, which defined the initial goals and tasks of environmental regulation. This law established a legal foundation for environmental protection. It began the process of putting specific regulations on the exploitation and use of natural resources, as well as the prevention and remediation of industrial pollution. The law also instituted a "polluter pays" principle, whereby industries are held accountable by the government, and it emphasizes the fact that environmental protection is an obligation of all citizens (Zhang, Wen, & Peng, 2008, p. 133).

Typically, public pollution accidents occur because the enterprise or project where pollution was generated failed to assess the environmental impact comprehensively and take corresponding strategies and actions to prevent negative impacts. According to the Environmental Resource Management (ERM), there are four policies set in place from the Environmental Protection Law that play a significant role in environmental protection in China (2009, pp. 2-3). The first policy calls for the formation of environmental protection institutions

and the definition of their functions. The second policy defines environmental liability and sets up a "Pollution Charging System". Through this system, the government of China is able to tax industries based on the amount of pollution and waste produced beyond designated limits. The third puts forward the approval of environmental impact assessment practices where government officials are allowed to inspect and assess specific pollution and waste discharge practices within an industry. Additionally, this policy requires industrial development projects to obtain an environmental impact assessment report before the actual implementation of a project. The last policy details the "System on Three Simultaneity", where pollution control facilities must be able to handle all polluting output from industries that are the source of pollutants that the facilities handle. If they cannot do so, measures must be taken to increase the pollution control capacity for the industries' pollutants (Zhang et al., 2008, p. 133). Many of these policies solved initial pollution problems. However, over the next ten years China's government was not able to hold many industries accountable for the excessive amounts of waste and pollution they produced. Because of this lack of authority, larger industries decided to pay the monetary tax charge imposed by the government rather than implementing new technology and infrastructure for pollution or waste remediation (Jahiel, 1998, pp. 766-767).

This trend continued until the late 1980s when Premier Li Peng issued statements questioning the Chinese government's financial commitment to environmental protection through their newly implemented economic development policy (Jahiel, 1997, pp. 91-92). Under Peng the Chinese government enacted a new revision of the Environmental Protection Law that further increased taxes on industries' excess pollutants and waste. By 1987, China adopted two new laws: the Water Pollution Prevention and Control law and the Air Pollution Prevention and Control law, (Zhang et al., 2008, p. 131). Under the Water Pollution Prevention and Control law,

the People's Republic of China sought to prevent and remediate the pollution of groundwater and fresh water bodies such as rivers, lakes, canals and reservoirs. The Air Pollution Prevention and Control law is much more technical. This law requires enterprises to use energy efficient, low polluting, clean technologies, and asks the economic management authorities such as the State Development and Planning Commission, to produce lists of equipment that are not to be used. The law also requires the sorting and washing of high-ash coal, which would further increase the demand and use of cleaner coal (Sinton, 2000, p. 2).

Major change regarding environmental policy came in the 1990s. In general, China's policies shifted their focus from "end control of pollutants" to the "source control of pollutants". Instead of trying to control waste discharge by industries, the government sought to pinpoint problems within an industry's production process (Zhang et al., 2008, pp. 135-136). Through this new methodology, waste and pollutant discharge from industries could be measured and tracked more efficiently. In 1995, China, due to severe waste problems, promulgated the Solid Waste Prevention and Control law (Shouren, 1999, pp. 2-3). Industries that produced hazardous waste were forced to barrel their pollutants and dispose of them at specific dump zones or landfills. Before this law, industries often dumped their hazardous waste wherever it was convenient or into the ocean.

Following major environmental policy changes in the late 1990s, the Standing Committee of the China National People's Congress also amended many other laws to include environmental protection and resource conservation. According to the ERM (2009), one significant change was the amended Criminal Law, into which a new clause on 'Crime relating to Endangering the Environment and Resource Protection' was added to define the penalty for

actions that cause environmental pollution and resource damage and enhance the legal power of the environmental legislation (p. 1).

Additionally, China instituted a National Ninth Five-Year Plan from 1996 to 2005. Through this plan China implemented the Total Emission Control Policy, Pollution Fee Policy, and the energy policy of ‘‘substituting coal with gas and electricity’’ (Zhao, 2008, p. 1). These policies were deployed to encourage enterprises to comply with emission standards, to develop environmental infrastructure, and to improve the deteriorating environmental status. During this period China also implemented its ‘‘Trans-Century Green Project Plan’’. This plan focused on key regions including three rivers (Huai River, Hai River, and Liao River), three lakes (Taihu, Chaohu, and Dianchi), Beijing, Bohai Sea, the Three Gorges Reservoir and the upper reaches of the Yangtze River. In these regions funds were raised to ensure environmental degradation was strongly being prevented and/or limited (Zhang et al., 2008, pp. 136-137).

As a result of China’s environmental strategy and National Ninth Five-Year Plan, significant investment in pollution prevention can be seen from 1991 to 2006 (see Figure 2-12).

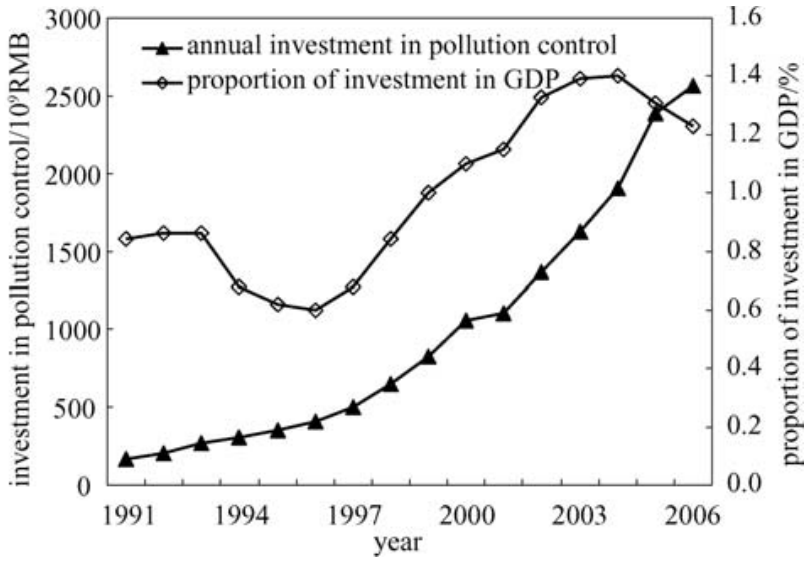

Figure 2-12: Change in Investment to Environmental Pollution Treatment in China (Zhang et al., 2009).

There is a steady increase in annual investment in pollution control from 1991 to 2000; however there is a substantial increase in annual investment in pollution control from 2001 to 2006. During 1996-2005, the total investment in pollution control reached 1.16% of China's total GDP. In 2006, total investment in pollution control reached 1.23%, a historical record for China (Zhang et al., 2008, p. 136).

2.4.2. Legislation in Hong Kong

Beginning in 1981, Hong Kong formed the Environmental Protection Department (EPD) to begin tackling pollution issues that plagued the region. The EPD, at the time, functioned mainly as an executive department enforcing environmental laws and implementing environmental policy (Environmental Protection Department [EPD], 2005a).

The first laws enacted by the EPD were the Water and Air Pollution Control Ordinances. Under these laws, the EPD could designate specific areas of high pollution as a water or air control zone (EPD, 2005b). Within these targeted zones, the EPD provided statutory powers over the control of effluents to both the air and water. Under these statutory powers, the EPD was able to minimize overall pollution within the specific control zones.

In the late 1980s, the Environmental Protection Department internally restructured itself as it established branches for each area of environmental pollution. Under these new branches the EPD began laying out plans for future environmental protection (EPD, 2005b). In 1989, the EPD published “A Time to Act”, a comprehensive ten year plan for fighting environmental pollution. Through this plan, the EPD sought to set forth waste management programs along with territory-wide schemes for sewage collection and disposal. The plan also called for a

greater environmental awareness and education amongst communities in Hong Kong. This was motivated by a need to make communities aware of their responsibilities in creating and maintaining a healthy and pleasant environment (EPD, 1989, p. 46).

At the turn of the decade, the EPD enacted multiple regulations to address continual pollution issues within Hong Kong. Beginning in 1992, the EPD added to the Air Pollution Control Ordinance so that vehicle design standards complied with emission regulations for all new vehicles (EPD, 2005b). A year later, the EPD also commissioned three new landfills strategically located in the West New Territories. These landfills were located in remote locations where environmental impact and any effluents from it would be minimal (EPD, 2004, pp. 4-10).

Continuing into 1994, the EPD launched its first territory-wide waste reduction campaign called the "Use Less Plastic Bags Campaign". Under this year long program, 35 million fewer plastic bags were used during the year (EPD, 2005b). The EPD also initiated Hong Kong's first Air Pollution Index (API). Communities in Hong Kong are able to see the current status of air pollution through the API, further increasing public awareness on dangerous levels of air pollution (EPD, 2005b). As the EPD continued with its plan in 1997, it enacted a new law regarding environmental planning and assessment. Under the Environmental Impact Assessment Ordinance, the EPD set out a structure for controlling environmental impacts of major development projects. Numerous developing industries are required to get environmental permits for their construction and operation due to this ordinance (EPD, 2005b).

Although the EPD has put forth a strong effort to combat these pollution problems, Hong Kong's environment quality since the Handover in 1997 has not improved, and has even grown

worse in many areas. That is not to say there have been no improvements, but Hong Kong residents still suffer from dangerously high levels of air pollution, poor water quality, and rapidly diminishing landfill space (Loh, 2007, p. 1).

2.5. Summary

The legislative policies and records that have resulted from studies of China's environmental pollution have stemmed from China's industrial rise and economic reforms. The last three decades of China's history have had the greatest environmental impact, and have prompted research into environmental sustainability. Analyses of environmental sustainability could not have been conducted if prior research into China's history and government had not been carried out. The development of the analyses has aided in the development of additional legislation at both the national and individual state levels. Unfortunately, the policies that have been implemented to date have not effectively addressed the issues of pollution and resource exploitation. As a result, environmental damage has grown and corporations, the government, and individuals have had to increase their involvement.

3. Methodology

The goal of this project is to connect environmental policies and regulatory legislation from the governments of Hong Kong and mainland China to the environmental reality of the region, and from this recommend measures which may be taken to help ensure more sustainable development. Over the course of this project, we seek to identify unsustainable development and practices resulting from policies and actions taken within Hong Kong and Mainland China that are causing environmental degradation. The following methodology for reaching our goal is presented in three main sections detailing current environmental regulations, resource exploitation, and environmental damage.

3.1. Investigation of Current Legislative Policies

We will conduct an investigation into both China's and Hong Kong's environmental laws, policies, and regulatory measures that address environmental and pollution issues. This research will determine other areas of research, and that research will be described in the subsections that follow. An understanding of the government's investment regarding pollution control will give us information from which to base our interviews and inspections. This research is ongoing. The majority of the legislative research will be conducted prior to departing for Hong Kong, and once in Hong Kong we plan to utilize the HKIEd library and other archival resources for further research as needed.

3.1.1. Interviews with Scholars

To adequately address the significance of the environmental situation in China and Hong Kong, we plan to conduct interviews with scholars in Hong Kong whose expertise lies within the fields of China/East Asia, environmental science, and environmentally sustainable development. Scholars will have a deep understanding of the intricacies of China and Hong Kong's successes

and failures regarding the achievement of environmental sustainability and will be able to direct us toward further research materials. Interviews with scholars will focus on the current environmental issues facing China and Hong Kong, their long-term effects, and possible solutions or other strategies to prevent or help resolve the issues in question. We will aim to interview scholars from a variety of fields to gain a well-rounded perspective on the environmental issues currently facing the region.

Potential candidates we have found are three associate professors at the HKIEd: Dr. Wendy Chen, Dr. Irene Cheng, and Dr. Eric Tsang. Dr. Chen is listed as an associate professor who teaches environmental studies and has done research about urban environment. Dr. Irene Cheng teaches environmental studies and environmental education. Lastly, Dr. Eric Tsang teaches environmental studies and environmental education, and he conducts research on environmental science and conducts monitoring studies. For all three, their teaching areas and research areas directly correspond with the scope of our project, and we plan to schedule a time to meet with them within the first week of our stay in Hong Kong. We also plan to contact other experts in environmental studies from other universities, such as Hong Kong University, Hong Kong University of Science and Technology (HKUST), and Hong Kong Polytechnic University.

3.1.2. Interviews with Non-governmental Organizations

In addition to interviewing scholars, we plan to contact non-governmental organizations (NGOs) with special interests in environmental protection and pollution reduction. These organizations will be able to inform us on environmental issues that prompted their organization's formation and research. Their information will lead us to other sources of information and material to use for our comparison. Some organizations which we will consider

for interviews are the World Wide Fund for Nature, Civic Exchange, Friends of the Earth Hong Kong, and Greenpeace; more will be added as needed.

3.2. Assessment of Environmental Damage

To gain a proper understanding of natural resource concerns, we plan to investigate major natural resource areas with respect to resource overuse and degradation. This analysis will be conducted using reviews of literature regarding natural resource usage and degradation. By doing this, we will gain an understanding of the effects of Hong Kong's and China's development on the quality and quantity of available natural resources.

3.2.1. Quantitative Data Analysis

To help understand how the environment of the region has changed in recent years, we will gather and analyze quantitative data regarding pollution and resource usage. In doing so, we will have a firm quantitative measure by which we can judge the effectiveness of environmental legislation in Hong Kong and China. These data will be further analyzed as explained in Section 3.3.

3.2.2. Literature Review

We plan to use a literature review to inspect the impact of pollution in the years following Hong Kong's handover to China. We will be looking for data showing the effects of pollution in the region over the past few decades. This information will be used to develop a quantitative, comparative analysis between pollution and legislation. This will be discussed further in the subsequent section.

3.3. Comparative Pollution Analysis

A combination of qualitative and quantitative approaches must be used to properly assess the scope and severity of environmental damage in Hong Kong and China. To this end, we will perform comparative analyses of pollution and regulatory measures. We hope to create tools with which one may compare environmental damage and regulation, such as graphs combining a timeline of legislation and the levels of individual types of pollution. For example, one graph might measure the legislation timeline on the x-axis with air pollution levels on the y-axis. This will allow us to tie together and understand the relationships between environmental degradation and legislative efforts in the region.

3.4. Summary

We anticipate conducting a literature review of local legislation and scholarly literature, as well as conducting interviews with scholars, which will allow us to identify issues regarding pollution, resource consumption, and forms of resource exploitation. In doing so, we will be able to understand the methods the governments of Hong Kong and China have been employing to address environmental issues in the region. We plan to inspect the extent of pollution to generate a quantitative analysis of environmental damage despite governmental policies and regulations in Hong Kong and China. From our gathered data, we anticipate being able to make recommendations regarding measures that may be taken to alleviate local environmental issues, and to create a foundation for further study on sustainable development.

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Appendix A: Hong Kong Institute of Education

The Hong Kong Institute of Education (HKIEd) is a publicly-funded institution whose mission is to support educators in their pursuit of both ground-breaking instructional methods and their own lifelong learning (The Hong Kong Institute of Education [HKIEd], 2010). There is a hierarchical structure of organization with President Anthony Cheung as the top-most authority. The secondary level of authority is held by the Vice President of Research and Development, the Vice President of Academics, and the Vice President of Administration. Below this secondary level of administration are Associate Vice Presidents who, in some cases, are in charge of other offices, and the remainder of the offices, departments, and centers fall under the jurisdiction of one of the secondary authorities. Figure A-1 gives a visual representation of the organizational structure. HKIEd is also affiliated with other universities in Hong Kong such as Hong Kong University of Science and Technology, Lingnan University, and the Chinese University of Hong Kong.

Officially founded on 25 April 1994, after 141 years of operating primarily as a university for educators, HKIEd became a more research-based institution and is continuing to expand its offerings, (HKIEd, 2010). Despite such growth, the institution does not list its budget for public view. HKIEd is a moderately sized school with the total number of students being 7,153, a total staff of 1,043, and 403 of those 1,043 being faculty. Professor Paul Harris, the individual in charge of sponsoring the HKIEd project for WPI, is a faculty member of the Arts and Sciences and sits as Chair Professor of both the Department of Social Sciences and the Department of Science and Environmental Studies.

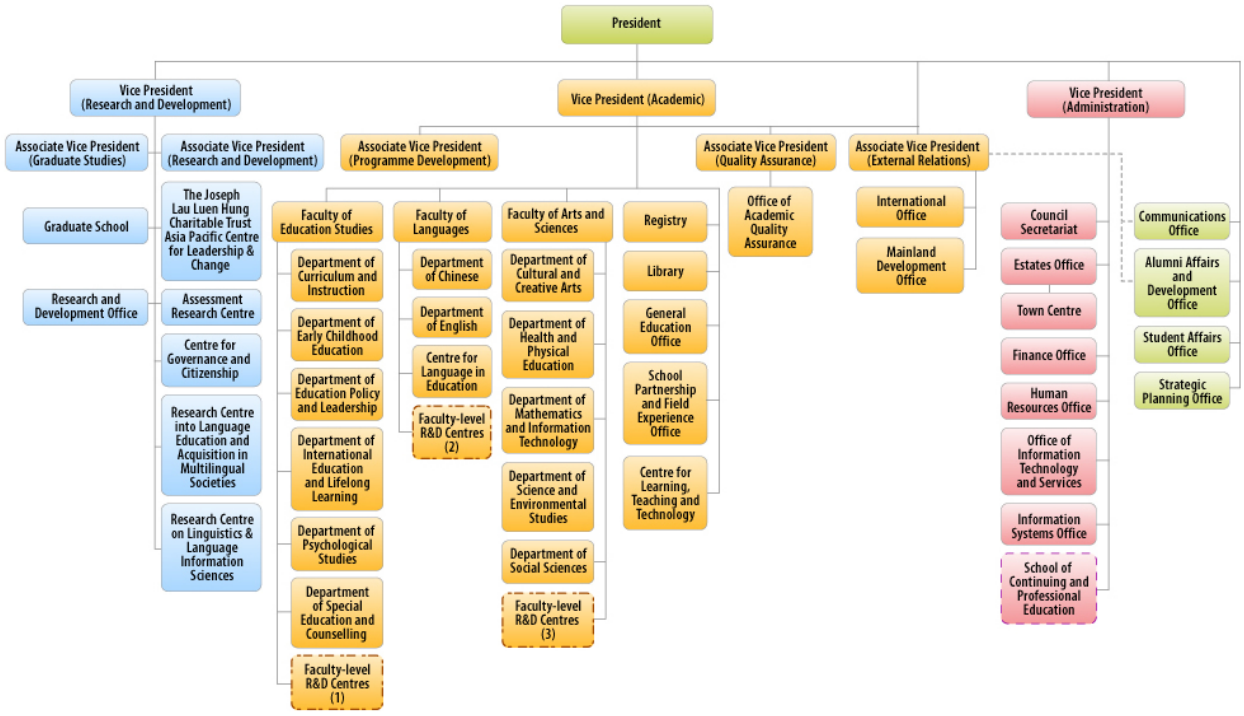

Figure A-1: Organizational Structure of the HKIEd (HKIEd, 2010, Organizational Structure).

The institute is hoping to become a leading university in the Asia Pacific region (HKIEd, 2010). To accomplish its goal, the staff and faculty have been networking with other universities in Hong Kong, with Mainland China, and internationally. They hope to use their contacts to gain greater influence to further enhance their research. HKIEd also plans to have their current and future research "contribute to the advancement of knowledge, scholarship and innovation, with sustainable impact on social progress and human betterment," (HKIEd, 2010, About HKIEd).

As far as addressing the problem of sustainable practices in Hong Kong, HKIEd does not list specific organizations with which it works. There are, however, several organizations in Hong Kong working on this problem including, but not limited to: Sow Asia (2010), Business Environmental Council (2010), and Sustainable Development: The Government of Hong Kong Special Administrative Region (2010).

Appendix B: Interactive Qualifying Project

The Interactive Qualifying Project (IQP) is a unique project requirement for students attending Worcester Polytechnic Institute (WPI). When a student begins work on their IQP, they are expected to examine a problem or societal issue pertaining to science and technology. While working on an IQP, students are assigned a sponsor and usually work in teams of two to four students. In some cases, a student will do his or her IQP alone, which is also acceptable. IQPs, characteristically, are not linked to a student's field of study. Student teams are composed of students from all disciplines at WPI.

Students, however, usually do not pick their IQP subject matter. Ideas for IQPs are generated by external sponsors or faculty on campus. Sponsors will often choose a problem area for students to research thoroughly. Student teams with off-campus sponsors, the term before leaving to start their projects, take project-specific courses and do necessary research to submit a project proposal. Once off campus, student teams then work exclusively on their project using the proposal they have designed. Student teams sponsored on campus or not going abroad do not have to take any specific courses before starting their IQP; instead, they work on their project for a single term or spread over multiple terms.

In the case of our project, we were given a topic addressing the issues of pollution and environmental policy within China and Hong Kong, and how lax regulations over the years have permitted excessive pollution and unsustainable consumption. Taking a more in-depth look at this, we have decided the aim of our IQP is to identify legislative and business practices significantly impacting Hong Kong and Mainland China's environment and resources. To do this, we plan to identify unsustainable development policies and practices within Hong Kong and Mainland China that are causing environmental degradation, quantitatively assess levels of

environmental damage in Hong Kong and Mainland China, and determine alternative policies which may make for a more sustainable region.

As stated by the Interdisciplinary and Global Studies Division (2010), “the objective of this interdisciplinary requirement is to enable WPI graduates to understand, as citizens and as professionals, how their careers will affect the larger society of which they are a part.” We anticipate our project will fulfill this objective and provide us with the skill set needed to further study sustainability in China or other parts of the world. We will develop a greater understanding of the process required to make large-scale environmental changes, and how they will impact the future of not just China, but other developing nations.

Appendix C: Interview Protocol for Scholars

1. What prompted you to enter the environmental studies field?
2. What is the main goal of your research?
3. What environmental issue(s) prompted your research?
4. Are there any pieces of legislature that address the issue you are researching?
5. What steps do you think Hong Kong and/or China could take to address the problem?
6. What areas of Hong Kong do you think have suffered the most environmental damage?

Appendix D: Interview Protocol for Non-Governmental Organizations

1. What prompted the development of your organization in this region?
2. What does your organization hope to achieve?
3. What are the current environmental issue(s) your organization is addressing?
4. Are there any pieces of legislation that address the issue you are researching?
5. How do you think the local governments have performed in addressing the environmental issues which your organization considers important?
6. What steps do you think local governments could take to address the problem?
7. What areas of the region's environment have undergone the greatest changes within your organization's area of focus?