THE REGIONAL OUTSOURCING OF POLLUTION: INVESTIGATING URBAN AND RURAL DISCREPANCIES IN INDUSTRIALIZATION AND ENVIRONMENTAL DEGRADATION IN CHINA

A Thesis
Presented to
The Honors Tutorial College
Ohio University

In Partial Fulfillment
of the Requirements for Graduation
from the Honors Tutorial College
with the degree of
Bachelor of Arts in Sociology

by
Carly Taylor Mercer
June 2010
Table of Contents

Abstract ......................................................................................................................4

Introduction ...........................................................................................................5

Literature Review .................................................................................................7
  Globalization and Economic Development
  Regional Development
  Environmental Justice

Data and Methods ...............................................................................................21
  Methods
  Data
  Scales of Analysis

Findings ..................................................................................................................25

Discussion .............................................................................................................30
  Results
  Themes
  Sustainability
  Policy Implications
  Limitations of Study

Conclusion ............................................................................................................41

Appendix ...............................................................................................................47
  Table 1: Regional Groupings
  Figure 1: Map of Chinese Provinces
  Table 2: Pollution Indicators
  Table 3: Treatment Facilities
  Table 4: Population
  Table 5: Variable Definitions, Sources, and Descriptives
  Figure 2: Mortality Rates
  Figure 3: Gross Regional Product
  Figure 4: Ethnic Minority Population
Abstract

This study examines differences in indicators of industrialization and environmental degradation between urban and rural provinces in China. As China has developed, disparities have surfaced between these two regions, specifically in pollution levels, waste treatment capabilities, and characteristics such as gross regional product and ethnic minority population. To explore this inequality, this study comparatively analyzes variables from urban and rural provinces through the use of independent-samples t-tests. Unequal regional development and globalization have forged a “path of least resistance” for pollution, shifting environmentally harmful industry and waste sites to rural areas. This trans-regional outsourcing mirrors the larger trend of waste flows traveling from the global North to the global South and ultimately raises questions of sustainability and environmental justice.
Introduction

In January 2010, Zhejiang Puluodebang Pharmaceutical Co. Ltd was ordered to pay compensation to two counties in neighboring Anhui province after illegally dumping its chemical waste in roadside ditches. The pharmaceutical company dumped 395 tons of toxic waste in rural areas, which later spilled and contaminated soil and water sources, including 10 km of the Fuwo River, with chemicals known to cause damage to the central nervous system (New China News Agency 2010). Stories like these are becoming commonplace in modern-day China, where rampant economic growth as well as a brisk trade in transnational refuse has created a massive amount of waste that is rapidly spreading throughout the country.

Over the past few decades, China has experienced rapid economic growth and industrial development, and within a relatively short space of time has become increasingly integrated into the international community through trade and investment. In 1978, China initiated economic reforms that transformed it from a centrally planned regime to a market-oriented economic entity; from the time of these reforms to 2004, investment rose from zero to $60.6 billion, and China’s pro-trade stance has facilitated high external demand for its exports (Wu 2006: 3). This integration has been a key factor in China’s modernization and industrial growth, as well as its emergence as a world power: in 2002 the country became the primary site of foreign direct investment, displacing the United States (Grumbine 2007).

China is predicted to become the world’s largest economy between 2025 and 2035, and already leads the world in consumption of most of the important industrial
and agricultural commodities (grain, meat, coal, and steel) and is second only to the United States in its consumption of oil (Grumbine 2007). The factors surrounding this growth, such as urbanization and high levels of foreign direct investment indicate that this development will continue at a rapid rate. This has tremendous impacts on resources and interactions with other nations, raising challenges within China regarding the distribution and conservation of resources in the context of policy that ultimately favors economic interests over environmental protection.

This growth has been largely unregulated and is occurring on such a vast scale that it is having a disastrous effect on the environment. Prior to this period of rapid and unmitigated development, China’s fragile environment was already suffering under Maoist views of environmental problems as pertaining only to the rich, essentially declaring a war on nature to fuel China’s modernization (Chan 2004). Although this period of intentional environmental destruction is over, China’s economic advancement is still damaging the fragile ecosystem immeasurably. Deforestation, water scarcity and contamination, land degradation, and air pollution are all costs incurred by China’s pursuit of economic development.

China’s increasing importance in the international arena requires close analysis of the effects of industrialization and growth and prospects for sustainability in the future. The centrality of China to trade and production means that its environmental, economic, and social policies have international ramifications. The environmental impacts of China’s industrialization are widespread, but the distribution of these impacts throughout urban and rural areas may not necessarily be equitably shared.
This study examines the potential inequality that exists between these two regions; within this issue arise three central themes that bear further discussion: globalization, divergent regional development, and environmental justice. Each of these themes contains parallels between a broader, global context and the situation of urban and rural inequalities in China. Ultimately these themes reflect the importance of sustainable development not only in China and but for the entire planet, calling into question the pursuit of economic growth without consideration for the environmental consequences.
**Literature Review**

Globalization, regional development, and environmental justice are all integral aspects of the factors leading to urban and rural differences in industrialization and pollution. The intersections between these themes reveal the complex global and national trends that determine where environmental hazards end up.

**Globalization and Economic Development**

The world is becoming increasingly connected and interdependent due to globalization, and some countries are capitalizing on the advancement available through international trade and business relations. China in particular has benefited from opening up to foreign corporations and investment, and as a result has experienced high levels of development and economic growth (Wu 2006: 3; Co et al 2008; Lu and Wang 2002). Within a relatively short space of time, China has become increasingly integrated into the international community through trade and transnational investment participation, facilitating the growth of industry throughout the country; in 1990 exports of goods and services accounted for 19% of China’s GDP; by 2005 they accounted for 37% (United Nations Development Programme 2008).

Globalization is complex and can be approached in many different ways. For purposes of the present study I consider globalization to be a process of internationalization, or relations between countries based on interdependence and exchange (Scholte 2000, Hirst and Thompson 1996). After initiating economic reforms in 1978, China has used its interactions and exchanges with other countries to
form a base for its development. China’s prominence as a center for manufacturing has attracted corporations and investors from the world over, and its subsequent growth has drastically increased Chinese demand for electricity and industrial resources like aluminum, copper, nickel, and iron ore, as well as oil (Zweig and Jianhai 2005). While other nations consume countless Chinese goods and multinational corporations reap large profits by taking advantage of the low manufacturing costs of Chinese factories, these same factories contribute to the degradation of the Chinese environment (Fallows 2007).

Scholte’s (2000) definition of globalization as liberalization is another aspect of the situation of industrialization and pollution in China. Liberalization, in Scholte’s (2000) terms, refers to the removal of governmental restrictions in interactions between nations, meaning that transactions are less regulated and that economic incentives often outweigh the potential ramifications of violating governmental regulations that are in place. Pellow (2007) provides an example of how globalization and trade liberalization facilitate the transfer of electronic waste to low-tech “recycling centers” in China, which is an attractive site to dump waste because of the low labor costs and less strict environmental and labor regulations. Pellow (2007) cites extremely low e-waste worker wages ($1.50/day), the effectiveness of bribes in Chinese ports, and economic desperation of poor communities as a few of the main contributors to the continuation of e-waste dumping. Workers in poor rural villages depend on the income generated by the handling of electronics, the Chinese government pushes for economic development in the electronics sector, and U.S.
officials are unwilling to regulate the shipments of waste to these cheap processing centers, perpetuating this system of inequality (Pellow 2007).

World-systems studies offer insight into the position of China within the context of globalization. Wallerstein (1979) proposes a tri-modal world system that encompasses three types of “historical systems”: core, semi-periphery, and periphery. In this system the core nations are those in the developed, high-status sector, the semi-periphery are those in the middle that produce mid-wage products and whose market is generally controlled by the state, and the periphery consists of nations which are underdeveloped and in the low-status sector (So 1990:181). The core countries in this type of system are able to concentrate their capital by improving their technology, and therefore capture more of the share of production. They also accomplish concentration of capital through colonization (So 1990). World-systems theory brings to light issues that are often ignored in dependency theory’s bimodal conception of core and periphery (Wallerstein 1979). In the dependency approach, periphery nations are relegated to the realm of underdevelopment and exploitation and there is little explanation provided for nations like China, which clearly occupy a position above the periphery and below the core. Within this school of thought, the relationships between Western and Third World countries are described as exploitative and dependent both in economic and sociopolitical aspects (So 1990:262). Although the dependency concept may not accurately describe the whole situation in China, there are certainly features of exploitation and dependence that emerge both in China’s external relationship to core countries, and the internal relationships between its provinces.
While world-systems theory provides a comprehensive view of global interactions, the dependency school of thought encapsulates aspects of industrial development and pollution within China. Many of the aspects contained in the nation-level aspect of dependency theory can be extrapolated to a regional level; the major themes of exploitation and unequal development are visible in the case of China, with regard to urban and rural areas. Mascarenhas (2009: 137) refers to the theory of “internal colonialism” to describe this practice of exploitation between “core” and “periphery” regions within a society. It is important to understand China’s place in the world-system to track the sources of much of its polluting industry and imported waste, which are then “internally outsourced” to poorer regions within its own borders. A developing country that has progressed largely due to globalization and “export-oriented industrialization” (So and Chiu 1995), the issues posed by China’s close interactions with other nations also affect its citizens at the regional level in the distribution of both industrialization and environmental degradation. These interactions with other nations and the external processes of globalization have important internal effects on China’s environmental well-being and consequences in terms of the potential for regional development disparities and inequalities in exposure to environmental harms.

Regional Development

According to Lu and Wang (2002) China’s diverging trajectories of development in urban and rural regions evolved out of the reforms of the 1970’s. The
coastal areas had traditionally been more developed as a result of colonial influence before 1949, and in the post-reform era these inequalities became even more apparent as a result of the new focus on the “roles of market mechanisms in resource allocation and on decentralization and efficiency in decision-making” (Lu and Wang 2002:43). The coastal area’s established urban infrastructure and location attracted the majority of development initiatives, and the establishment of Special Economic Zones (SEZs) in the area facilitated an influx of foreign investment. As the coastal regions experienced a surge in development, subsidies for the central regions diminished and inequalities between the regions widened (Lu and Wang 2002).

Lu and Wang (2002) elaborate upon these claims, finding increasing interprovincial inequalities, within-regional inequalities, and urban-rural inequalities due to regionally-differentiated development since the reforms of the 1970s. DeGroot et al (2004) also find significant differences in their study of China’s regional development. Although they use four divisions (North, South, East, and West) as opposed to urban-rural divisions, their findings are generally consistent with the areas included in urban and rural regions. They find that the living conditions of residents of less developed regions suffer more in times of price fluctuations, and large gaps in income inequality are present. This disparity in development capacity and infrastructure between urban and rural areas is a key to understanding various dynamics in the country such as the varying impacts of pollution in urban and rural regions or the influence that globalization and foreign investment have had in China’s industrialization.
Wang et al (2009) illustrate the inequality in power that exists between the urban and rural areas in their analysis of the rise of “urban villages” on the periphery of urban-rural boundaries. These urban villages are unplanned developments that evolve as the siting of Special Economic Zones (SEZs) in rural areas attracts rural migrant workers. The government expropriates land gradually from farmers while keeping the village dwellings intact, thus leaving them with few options for work other than in the nearby industrial zone. Therefore, these areas urbanize quickly and informally with little infrastructure and have a high population of migrants from poor rural areas. The hukou system of registration and migration control classifies every citizen as a member of the agricultural (rural) population or the non-agricultural (urban) population; beginning in 1984, the adoption of a more open system of migration allowed rural-to-urban migration, but requires migrants to register for temporary residence and eligibility for urban benefits. Many do not register and are therefore ineligible for benefits (Hoy 2000). As urban villages developed officials took advantage of rural migrants’ hukou status to exclude them from urban services (Wang et al 2009). This distinction enabled further discrimination against rural residents in expanding urban areas.

Wang et al also note that the “early manufacturing, labor-intensive, and polluting industries” are often shifted to the outer, more rural areas of the SEZ as it expands, reinforcing the continual advancement of urban areas at the expense of the quality of life in poorer, rural areas (2009:965). While the authors conclude that these villages are integral in providing low-cost housing and jobs to the large number of
rural migrants who flood to the urban areas, they neglect to examine the impact of hastily developed urban areas on the environment and the underlying inequalities that cause the mass exodus of residents from rural areas. The influx of this “floating population” of temporary migrants has become what Smith (2000:91) terms a “new urban underclass” that is marginalized and ascribed an ethnic minority status by virtue of their rural origins. This group is disadvantaged in labor and housing opportunities, and their need for jobs provides another possible explanation for the prevalence and acceptance of polluting industry and waste processing centers in rural areas and on the outskirts of urban ones.

The majority of this rural industry developed with little planning or organization, thus contributing to pollution problems through lax supervision and shoddy maintenance. Wang et al (2007) characterize rural industry by its “small scale, outmoded technology, obsolete equipment, poor management, and heavy water consumption” (648). While Township and Village Enterprises (TVEs) are the lifeblood of rural economies, they are also the main source of much of the pollution in rural areas. As Chinese demand for products and resources has surged, rural enterprises have grown exponentially in number, creating an influx of new polluters. The spatial dispersion and small size of these enterprises (and therefore small fees to be extracted by environmental administrations), makes them very uneconomical and difficult for the understaffed environmental administrations to monitor (Wang et al 2007). Therefore, the combination of a marginalized and disadvantaged population, institutional inability to cope with the sheer volume and dispersion of industry, and
lagging technological development in rural areas creates a situation in which pollution flourishes.

The situation of regional development in China has left the rural provinces behind. Their resources are spread too thin to adequately deal with the pollution that is transferred from urban areas, and the desire of local governments for industrialization comparable to that of urban provinces means that environmental well-being is often sacrificed for economic growth.

Environmental Justice

This rapid and unmitigated growth in both urban and rural areas that prioritizes profits for capitalists and investors over environmental protection and the quality of life of its citizens is indicative of the “treadmill of production” concept described by Brulle and Pellow (2006). Business, government, and labor form an “economic growth coalition” that drives a continuous cycle that creates wealth as well as “negative byproducts” resulting from production, such as pollution and health impacts (Brulle and Pellow 2006: 108). This cycle disproportionately benefits businesses and individuals in the middle and upper classes—they enjoy the wealth generated through constant production, while the waste and environmental risks end up in poorer communities (Brulle and Pellow 2006). China’s push to develop at such a rapid pace reflects this concept, as forests, bodies of water, and agricultural land are destroyed to fuel economic growth regardless of harms. The most powerful business and government interests from within China itself as well as from other countries stand to
benefit the most while the rural poor bear a disproportionate share of the burden of environmental degradation.

Beck’s (1995) theory of risk society further brings to light some of the mechanisms behind the destruction of natural resources and distribution of the accompanying risks throughout society. Beck sees industrialization and modernization as having generated “uncontrollable” threats to the environment, the regulation of which is extremely difficult because the production of environmental risks is so widespread, generalized, and anonymous (Mythen 2004). This inability to identify a “culprit” in the regulation of environmental pollution is compounded by globalization and increasingly complex transnational business interactions. The often lengthy “commodity chains” that span the globe can diffuse responsibility among a large number of entities, making enforcement and punishment difficult. The idea that certain risks accompany progress and “acceptable levels” of these risks (pollution, in this case) exist “puts environmental despoliation up as an acceptable trade for profit maximization” (Mythen 2004). In China, the risks of pollution are accepted as a part of the process of industrialization, reflected in its willingness to accept outsourced industry from more developed countries. It is difficult to pinpoint any particular source of pollution or enforce environmental regulations because of dependence on industry and the numerous sources of pollution, none of which can be determined as the sole cause of an “injury” to a community.

The environmental injustices perpetrated at the global and national level in China are central to this discussion. Environmental injustice deals with the extent to
which “ethnic minorities, indigenous persons, people of color, and low-income communities confront a higher burden of environmental exposure from air, water, and soil pollution from industrialization, militarization, and consumer practices” (Mohai et al 2006: 404). This concept can also be referred to as environmental racism, and these practices can range from the siting of hazardous industries or dumps to the transnational transfer of hazardous wastes to countries that Mohai et al refer to as “on the geopolitical and economic periphery” (2006:419). As a result of being caught up in the global treadmill of production as a worldwide center of production, China suffers many of these environmental injustices, often explained away by officials using the rhetoric of risk society, in which environmental harms are simply a consequence of modernization and must be accepted as a part of a modern society providing jobs and economic growth.

Some theorists claim that these unequal distributions of environmental hazards are the result of the “path of least resistance” that makes poorer, minority areas less likely to protest the presence of these hazards (Schelly and Stretsky 2009). Proponents of this idea state that as people become more aware of the negative impacts of environmental degradation, they tend to object to the placement of hazards in their communities; therefore, polluting, dangerous industries end up in areas with “weak social, economic, and political capital,” and these areas are usually predominantly poor or minority areas (Schelly and Stretsky 2009).

Companies traditionally assumed that these poorer communities did not, or could not, object to pollution in their area because they were areas of little power
within the political system (Schelly and Stretsky 2009:371). Wealthier residents are more able to leave undesirable areas and as property values sink because of hazardous facilities, low housing prices attract disadvantaged low-income minorities, exacerbating the racial inequalities present in areas featuring locally unwanted land uses (LULUs) (Saha and Mohai 2005). These types of communities have less access to sources of power in society, land prices are usually low, and the potential influx of jobs and tax revenues to be gained may outweigh environmental concerns (Bohon and Humphrey 2000; Saha and Mohai 2005). This last claim, however, is not necessarily the case, as Tilt (2006) shows in his study of perceptions of risk from environmental hazards among Chinese residents in an ethnic community. Tilt found that regardless of socioeconomic status, as measured by occupation, concern about risks posed by environmental degradation from industrialization was prevalent. While the specific pollution concerns varied by occupational group, overall, recognition of harms resulting from environmental hazards was present in each. Residents recognized the fact that the environment could have a significant impact on their health and well-being. Such recognition of harms is further reinforced by a *New York Times* news article from May 2008 about Badui village in Gansu province, also known as the “village of dunces” due to the prevalence of mental retardation within the community believed to be caused by effluent from a fertilizer factory upriver. Village leader Li Yuntang, referring to the fish villagers raise just below the factory, stated "We eat the fish ourselves . . . We worry about the chemicals, but we have to eat" (Kristof 2008). The villagers understand that their health is jeopardized by pollution, but are resigned
to the negative effects that they may suffer because they have few other options and lack access to alternative sources of food and water. Figure 2 further illustrates the disproportionate health issues suffered in rural areas.

McCormick (2009:144) discusses the connections between environmental degradation and health problems, claiming that a shift to a “biomedical” view of health care has obscured the links between environmental exposures and illness. She states that the interests of corporations and complex political agendas often make it difficult to prove the source of environmental contamination, receive compensation for injuries, or force polluters to clean up. These impacts on health are compounded by the previously discussed tendency of corporations to site hazardous industries or dumps in poorer communities; the individuals in these areas can suffer negative health consequences from pollution and the costs of appropriate health care may be beyond what they afford.

Globalization has enabled China to become a globally-recognized economic power, and the boom in production has subsequently created a large amount of waste within the country. Seen through world-systems theory, China is a semi-peripheral nation whose relatively advanced level of development, low labor costs, and lax environmental regulation is exploited by “core” nations like the United States in the siting of polluting or hazardous industries (Pellow 2007). World-systems theory claims that semi-peripheral nations exhibit a distinct politicization of economic matters due to a desire to move towards a core state (So 1990). China’s desire for growth has politicized the economic arena and led to a strong push for development at
any cost, significantly weakening barriers to pollution. Thus, the most polluting industries of core nations like the United States have been “outsourced” to China with little backlash or efforts by Chinese officials to stop this practice. This process is supplemented by the transnational waste trade in which massive amounts of hazardous waste are transported from wealthier, western nations, and dumped in poor areas of China (Pellow 2007). This global trend of “outsourcing” of pollution to poorer areas through the “path of least resistance” discussed by Schelly and Stretsky (2009) is mirrored in activities within China as well. The waste received is sent to the poorer, less developed areas, and as Wang et al (2009) noted in their analysis of urban villages, the most polluting, heavy industry is moved from the developed areas to the edge of rural areas.

Ultimately, the issue at hand is one of inequality and responsibility: hazardous wastes and industries are being “outsourced” both around the globe and within the borders of nations to areas with little political or economic capital through a “path of least resistance.” World systems theory illustrates the connections between core, semi-periphery, and periphery nations that facilitate this transfer of pollution. The communities in semi-periphery and periphery areas are disproportionately affected by the negative impacts of environmental hazards exported from core nations, and are also less capable of mitigating the effects of pollution through treatment facilities or access to adequate healthcare. Wealthier nations or provinces are participating in the treadmill of production, racing towards economic development without consideration of the responsibilities owed to their citizens, citizens of other nations, or the
environment. These issues merit research in order to uncover the hidden sources of power and profit that influence the shifting of pollution around the globe despite regulations specifically created to stop these practices. In this study I seek to illuminate these global trends within a regionally differentiated setting: that of urban and rural provinces in China. The themes of globalization, regional development, and environmental justice are reflected in regional inequalities, demonstrating the issues discussed here on a smaller scale.
**Data and Methods**

In this study I perform a comparative analysis of variables across provinces in China to examine urban-rural discrepancies in the distribution of environmental hazards. In this section I discuss the data and methods used and their significance and implications, including any possible limitations.

**Methods**

For the purposes of this study, empirical analysis of secondary data provides the best illustration of provincial characteristics. Because the sample population of Chinese provinces is fairly small (N=30) and most of the variables concerning pollution, economic indicators, and population that I discuss below are scale measures, there were a limited number of statistical tests that I could perform. As a result of these factors, I chose to perform two-independent-samples $t$-tests on the data, combining the provinces into two regions (central and coastal) as the independent samples for comparison.

I used an observed significance level of 0.05 or less as the criterion to reject the hypothesis of no difference between the two regions in my analysis.\(^1\) Independent samples $t$-tests are appropriate to perform in that they identify the existence of a significant difference between two regions and reinforce the precise goal of this study:

\(^1\) The significance level indicates that the probability of these differences occurring is too great to be random.
to illustrate differences in pollution and industrialization between urban and rural areas in China.²

Data

I compile the majority of the data in this analysis from the 2008 *China Statistical Yearbook*. The *Statistical Yearbook* is published annually by the China Statistical Press and the 2008 edition contains the most recent data as of 2007. The *China Statistical Yearbook* is a reliable source that many studies have used and provides the best available data on China (e.g., Co et al 2008; Muldavin 1997). I supplement these data with the 2009 publication of *The State of China Atlas*. Specifically, I use variables concerning treatment facilities, urbanization, population, gross regional product, and industrial discharge and emissions to examine economic, environmental, and demographic factors in the coastal and central regions. The variables that I test illustrate pollution levels, treatment capacity, and regional population composition in the coastal and central areas. These variables indicate various structural inequalities that flow from income, ethnicity, and class distinctions. The types of variables are theoretically important in that they capture the dynamics of inequality from many different angles and show the impacts of underlying structural factors, from pollution treatment capabilities to the siting of polluting industries. Table 5 contains a more detailed description of these variables.

---

² I use the independent t-tests as a means of identifying the existence of difference to guide discussion; further testing will be necessary to confirm the importance of these regional discrepancies. For the purposes of this study, these tests will offer a preliminary examination and discussion of inequality in environmental degradation as experienced by the two regions.
Scales of Analysis

In exploring the regional impacts of industrialization and environmental degradation I divide China into two distinct spatial areas: coastal and central. In determining which provinces fall in each category, I rely on traditional divisions of the provinces into Eastern, Central, Western and Northeastern regions used in the *China Statistical Yearbook*. I then combine the Central and Western regions to form the group of central provinces, while the coastal and northeastern regions comprise the coastal area. The structure of China’s strong central government also reduces the possibility that differences between regions are the result of provincial environmental policies. Lu and Wang (2002) argue for the use of different spatial categorizations based on measures such as principal component analysis (PCA), which utilizes key variables to create similar groupings of provinces in development levels regardless of geographic location. However, for the purposes of this study, maintaining the geographically contiguous areas of coastal and inland areas best represent the characteristics of the urban-rural dichotomy I wish to explore. These divisions between coastal and inland areas are necessary to assess the impact of proximity to urban areas on pollution and industrialization.

Some researchers (e.g., Lu and Wang 2002) may claim that while these areas are contiguous, the provinces contained within these spatial categories may be disparate in levels of economic development. However, basic descriptive analysis of the provinces in central and coastal areas reveals that they have developed to comparable levels while sharing certain characteristics indicative of urban or rural
status such as gross regional product, population demographics, and urbanization, among others. It is important to note that the groupings created for this study generally fall in line with those created by PCA, reinforcing the appropriateness of the coastal-central division that I have established.³

This coastal-central division results in 13 provinces designated as coastal and 17 as central. From preliminary descriptive analysis there did not appear to be any outliers in the two regions that could significantly impact the sample means and subsequently skew the results of the t-tests used to determine if there was a statistically significant difference between the coastal and central regions.⁴ I summarize the provinces assigned to each region in Table 1.

⁴ I excluded the Tibet Autonomous Region from this study because of potential provincial discrepancies that may result from China’s historically contentious relationship with the Tibetan region. In preliminary descriptive statistics, Tibet’s provincial levels of development were drastically different from those of other provinces. In order to prevent any skewing of the data that might stem from Tibetans’ demands for genuine autonomy and their adverse relationship with the Chinese government, I removed Tibet from the dataset.
Findings

In this section I discuss the results of the independent samples t-tests and their implications. I discuss the tests resulting in significant differences and touch upon certain regional characteristics that may contribute to these variations.

Significant differences exist between urban and rural regions with regard to pollution, treatment facilities, and demographics, including minority population composition and gross regional product per capita. Tables 2, 3, and 4 reveal these results respectively. Findings in Table 2 show the variables for which pollution values for the rural provinces are worse, or higher, than those in urban provinces. While industrial dust emissions and ratio of treated wastewater meeting discharge standards are the only two measures in which the pollution levels are significantly higher in the rural regions, the fact that many of the other pollution variables were not significantly different indicates that comparable levels of pollution exist in both the urban and rural areas. The extent to which the coastal regions have developed compared to the rural regions would lead one to expect that the pollution levels in the urban areas would be different, if not much greater, than those in the rural areas. This lack of difference in some of the other pollution variables is further evidence of the exportation of polluting industries to underdeveloped rural areas without the capacity to handle the waste they produce. Although this similarity in pollution is important, the key findings are those that indicate higher levels in pollution measures in the central, rural provinces.

The fact that numerous pollution indicators were worse in rural areas, accompanied by disparate levels of development, confirms the rise of pollution and
environmental degradation in previously underdeveloped areas with less population density. On average, the ratio of wastewater discharged that meets standards is about 93% in urban areas and 84% in rural areas. This is a serious problem in the rural provinces specifically because they do not have the ability to discharge wastewater directly into the sea, as the coastal provinces do; therefore, they discharge directly into the rivers that cross much of the inland area, contributing to pollution of water for consumption and irrigation for agriculture. The subsequent degradation of the water supply resulting from industry directly affects the health of rural residents and their quality of life, and when major contamination of water sources occur, rural residents may have no alternative access to clean water. An example of this situation occurred in Anhui province in 2000, when six residents of Fuyang died from exposure to contaminated water, despite the city’s designation as a “Clean Industrial City,” because local officials would clear the river systems with clean water during inspections. Local officials ignored the complaints of residents because heeding them would require a massively expensive overhaul of the industrial system and would shut down much of the city’s industrial “base” (Economy 2004:7). Economic interests are clearly being favored over health and environmental protection, and the regulatory practices in place are easy to circumvent, with officials giving the appearance of environmental consciousness when in reality the practices of local industry are extremely hazardous to the water system.

The results concerning treatment facilities confirm the existence of differing levels of environmental degradation in urban and rural areas. Water is one of China’s
scarcest and most polluted resources, and the State Environmental Protection Administration has developed a classification system for the different levels of water pollution consisting of six grades. Grades I, II, and III are acceptable for drinking, swimming, household use, and supporting aquatic life; Grades IV and V are not suitable for use as drinking water, but Grade IV can be used for industrial purposes and Grade V can be used for agricultural purposes. Grade VI water is essentially useless (Gustavsson-Tingvall et al. 2008).

Water quality throughout most of China is poor: in 2008 the Ministry of Environmental Protection’s annual State of the Environment Report stated that 78.4% of the water in China’s major lakes and reservoirs was Grade IV or worse (not suitable for human contact). Of the seven large river systems in China (the Yangtze, Yellow, Pearl, Songhua, Huaihe, Haihe, and Liaohe Rivers), 45% of the water was Grade IV and higher, with 20.8% failing to meet Grade V standards (MEP 2008). In rural regions, most inhabitants get their water supply from these heavily polluted surface water sources: 40% of the rural population does not have access to piped drinking water and 32% of households in the lowest income quartile rely primarily on surface water, as opposed to 11% in the highest income quartile (World Bank 2007).

The fact that poorer rural areas have significantly fewer water treatment facilities than the urban areas illustrates that there is, generally, a lower quality of water available to rural residents. This study found that the rural provinces have an average of .46 wastewater treatment facilities per 10,000 persons, while urban provinces have .79 wastewater treatment facilities per 10,000 persons. This unequal
distribution of water treatment facilities exacerbates the impact of the already worse water pollution in the rural areas, where residents do not have access to alternate sources or treated water. This distribution likely contributes to the higher levels of wastewater not meeting discharge standards in rural areas discussed above. The more wealthy coastal areas can afford more treatment facilities in order to mitigate the effects of water pollution.

In addition to wastewater treatment facilities, urban areas had more waste gas treatment facilities overall and more waste treatment factories per 10,000 persons than rural areas. Waste gas treatment facilities number 7,019 total in urban provinces as compared to 4,180 in rural provinces, and waste treatment factories per 10,000 persons number .005 and .003, respectively. It is clear that these disparities in treatment capacity impact the rural provinces’ ability to cope with pollution issues in an effective way; in fact, the treatment capacity of waste factories in urban areas is more than double that of the rural areas, at 13,541 tons per day, as compared to 5,609 tons per day. Because of these discrepancies in treatment facilities, the rural areas are significantly less equipped to deal with their increasing pollution levels and in general, they have few alternatives to lessen the impact of this pollution on their health and well-being.

Finally, measures of regional demographics also indicate that significant differences exist between rural and urban provinces. Gross regional product in urban and rural areas is, as expected, also statistically significant. Figures 3 and 4 reveal some of these results. These values indicate inequalities that stem from the rural
provinces’ dependence upon heavy industry and agriculture, while the urban provinces benefit from foreign direct investment (FDI), the placement of special economic zones (SEZs), and exports as part of their shift towards a more modernized economy (Co et al. 2008, Lu and Wang 2002). The gap in gross regional product between rural and urban areas illustrates a lack of resources that can be allocated to deal with pollution problems and the need for the income that industry and development brings. In addition, there is a distinct difference in ethnic minority populations in urban and rural areas—only seven of the urban provinces even have a substantial enough ethnic population to be included in the t-test, as compared to twelve of the rural provinces. The ethnic minority population as a percentage of total population in urban areas is about 36%, versus 54% in rural areas; this difference in population composition illustrates a possible reason why this inequality exists between urban (coastal) and rural (central) areas. Minority populations tend to have less power within the structure of political opportunity, and disproportionately bear the brunt of environmental problems within their communities as a result of their inability to challenge the siting of heavy industry and environmental hazards (Brulle and Pellow 2006).

These findings point to key trends in environmental degradation and industrialization, environmental justice, and regional variation in China on a number of fronts. First, pollution levels are similar between urban and rural areas, if not higher in rural areas, as a result of increasing development in coastal areas and the subsequent shift of heavy industry to rural areas. Second, the rural areas are less equipped to deal with their increasing pollution problems, as rapid new industrialization has left these
provinces without the infrastructure or institutions to monitor pollution; the drive to develop economically means that solving environmental issues is not a priority. Third, these rural provinces are developing without a concomitant significant increase in gross regional product and are primarily areas where ethnic minority populations live, indicating the existence of a “path of least resistance” leading to the outsourcing of pollution to poorer areas where jobs are deemed more important than health impacts and pollution. I elaborate on these themes in my conclusions.
Discussion

Results

In this analysis I find significant differences between urban and rural areas in China with regard to pollution, the prevalence of waste gas and wastewater treatment facilities, treatment capacity, ethnic minority population composition, and gross regional product, as well as other variables seen in Tables 2, 3, and 4. In measures for all of these factors, conditions in rural areas were significantly worse than those in urban areas. Rural provinces had higher ratios of substandard discharged wastewater and higher industrial dust emissions, fewer treatment facilities and lower treatment capacity (as measured in tons per day), and lower gross regional product. Rural regions also had higher concentrations of disadvantaged ethnic minority populations, a possible indicator of how pollution ends up in these regions and why the treatment structure in place to deal with pollution in these poorer regions is woefully inadequate. These variables all contribute to inequalities between rural and urban areas, and a number of important themes emerge in this research. These themes include globalization, unequal regional development, and environmental justice.

Themes

Environmental degradation and industrialization in China has both local and global implications. Through the processes revealed by world systems theory, globalization has opened China up to foreign investment and development as a semi-peripheral nation. The core nations of the world have taken advantage of China’s push
towards industrialization, outsourcing heavy industry and waste there, which are then internally “outsourced” from urban areas to rural ones within the country. This process is a result of the environmentally unjust “path of least resistance” leading to these poorer, less politically-empowered communities. Globalization has caused an influx of enterprise and growth without concomitant expansion of infrastructure or regulations for dealing with pollution and protection of the environment and Chinese citizens in rural areas. The consequences of this unregulated growth and the associated environmental impacts are far-reaching; they include the deterioration of the health of rural residents, the destruction of precious resources such as water and farmland, desertification, and the creation of an ethnic underclass in developed rural and urban areas.

The marginalization of China’s rural, ethnic minority population through the *hukou* system and the unplanned expansion and development of rural areas into “urban villages” deprives them of the ability to voice concerns about environmental harms, take advantage of public services, and generally relegates them to a sector of society that is “invisible.” Rural residents’ needs for jobs and income also mitigates some of the concern about environmental degradation— they are aware of the potential consequences to their health and well-being but have few alternatives in terms of sources of clean water or areas with less air pollution. It is through a process of what world systems and environmental justice theorists refer to as “internal colonialism,” that these harms end up in rural areas. In addition, the proliferation of environmental hazards is deemed acceptable through the espousal of risk society rhetoric— in which
pollution is a reasonable trade-off in pursuit of growth. The pace of China’s development is relentless, with rural populations bearing the majority of the negative consequences without sufficient treatment capabilities or appropriately stringent regulations.

_Sustainability_

It is China’s continued development that will bring to the forefront questions of sustainability and the compatibility of its industrialization and economic development goals with an agenda of environmental protection. Unequal regional development, globalization, and environmental justice are all important to the discussion of sustainability in China and each plays a large role in determining its viability. As a developing country that has progressed so quickly, China is being forced to deal with economic growth and environmental pressures concomitantly. This places strain on the country and it must sacrifice economic resources to address a problem that most developed countries were able to deal with once they had reached a stable level of development and industrialization.

Because China’s pollution affects the global environment it is an issue that requires not only China’s attention, but also the attention of countries that have invested in the manufacturing industry there and whose products are created in factories causing the pollution. It is this “interdependence” aspect of globalization that raises the question of different nations’ responsibilities towards one another; the pollution produced by factories and the economic growth enabled by trade with other
countries are inextricably tangled up in international affairs. Connections are also forged globally through commodity chains that involve transnational labor, marketing, and production processes (Marshall 1998). Other countries depend on China’s production capabilities and cheap labor to keep the global commodity chain running smoothly, but if this process proves ultimately to be unsustainable, both China and nations involved in the global economic system will suffer. China’s people also cannot continue to bear the brunt of the global production of pollution and environmental hazards through the unjust distribution of harms in the global economic system. Risk society’s acceptance of environmental degradation as a counterpart of modern society is not a sustainable concept, especially in light of the accompanying negative health issues and destruction of natural resources. Therefore it is in the interests of all to maintain sustainable modes of development and production.

Without significant change in China’s development, the carrying capacity of the Earth will be exceeded as the nation approaches levels of development similar to those of the United States (Cann 2005). It is not plausible to prevent other countries from developing the same amenities that developed nations currently enjoy, therefore the difficulty lies in reconciling demand for economic growth with environmental and social concerns. Defined as “development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs,” (Cann 2005:3) sustainable development has been put forward as a way to attain both. Essentially, sustainable development entails environmentally responsible use of resources and technology to further development, but in a way that does not
negatively impact the environment. Sustainability is a complex term, ideally focusing on synergistic interrelations between the economy, society, and the environment to maintain growth as well as resources. It therefore has many different meanings for manufacturers, corporations, governments, and environmental organizations, and also requires a large amount of communication, cooperation, and enforcement among these varied groups.

Sustainable development means moving in a very different direction from the traditional model of development, requiring many tradeoffs to ensure effective long-term protection of the environment and economic development. As findings here reveal, China is facing a potential environmental crisis as well as increasing exposure to pollution among its rural population. Issues with pollution measures and treatment capacity indicate systemic failures in regulation and a need to make environmental protection and development compatible. A development paradigm based on sustainability would reduce the negative impacts of industrialization suffered by rural populations while maintaining a reasonable rate of economic advancement and lessening the wastefulness and inefficiency of rural factories.

In addition to the issue of China’s large population and scarcity of resources, the rapid rate of its industrialization raises barriers to sustainable development initiatives. The enthusiasm of the government for this growth and support of economic advancement over environmental protection makes it difficult for sustainable development to be a top priority in policymaking. The idea of “pollute first, clean up later,” as many of the already developed nations around the world were able to do, is
the dilemma China now encounters, as it is no longer a viable option. There is a clash between local and central authorities on environmental interests; while the central government has nominally recognized the need to monitor and control air quality and pollution, and has enacted environmental and industrial regulations, local Environmental Protection Boards (EPBs) lack the funds and/or the impetus to enforce these regulations. Often however, it is more in the interests of local governments to favor economics over the environment in order to maintain growth and provide jobs, or they simply lack the monetary resources to implement environmental protection initiatives, and EPBs answer mainly to the demands of local governments (National Academy of Engineering and National Research Council 2008). Also, as previously discussed, the rural population generally lacks the economic or political capital to demand change from their local governments, or the desire to drive away job-generating industry.

The results here further reinforce evidence of these priorities- treatment facilities in rural areas are few, are certainly not sufficient to meet the needs of the population, and the amount of dust emissions and wastewater released into the environment indicate a bias in favor of industry, not sustainability and protection of the environment. However, to continue with any kind of development, sustainability must become a part of the process. If it does not, pollution in rural areas will worsen, negative health impacts will increase, and in addition to a growing bifurcation between rural and urban populations, development may suffer in both regions as the resources necessary to sustain growth are exhausted or destroyed.
China faces many challenges in its efforts to curb environmental degradation and embark on a more sustainable type of development, and tradeoffs will have to be made to diminish short-term profits in exchange for longer-term survival and maintenance of the environment. While these obstacles are significant, the benefits that both China and the world stand to gain from sustainable development far outweigh the possible challenges: an agenda focusing on sustainable development is not only an environmentally sound choice that may lessen injustices and inequalities between rural and urban areas, but may also be necessary for China’s continued growth and success. A development plan that reflects treadmill of production and risk society theories, which assume unlimited production and resource possibilities and accept environmental hazards as a consequence of economic growth, may prove to be the country’s downfall. China’s resources are scarce and rapidly dwindling while its population is suffering from the consequences of rampant environmental degradation. The risks posed by development are so ubiquitous and generally untraceable to a single source that the population views them as acceptable.

While the data in this study reveal significant inequalities in pollution and treatment facilities, instances of concerted protest against environmental degradation are few in China because these levels of risk are considered acceptable in return for economic development. These polluting industries have been outsourced to rural areas via the “path of least resistance.” The relatively high proportion of ethnic minorities in rural areas, the need for jobs, and the local governments’ push for industry over environmental protection create a situation in which the treadmill of production is
prioritized, and the machinery of growth is very difficult to slow down once set in motion.

Policy Implications

China’s current mode of development and its resulting environmental damage is actually costing China immeasurable amounts of money. China’s economy has had an average annual growth rate of about 9% over the past decade; however, environmental problems have reduced this growth by at least two percentage points, if not up to 12 percentage points (Chan 2004). This loss of productivity is the result of many factors, including health problems of workers caused by the poor air quality for example. The World Bank estimates about $20 billion per year is lost by workers’ health issues, in addition to another $38 billion a year due to failed crops and lost industrial output among other factors (Chan 2004). It is clear that China must implement significant policy change in order to lessen the costs of pollution and maintain growth.

One of China’s clear issues lies in the enforcement of environmental protection through its institutional and regulatory frameworks. A lack of communication between local and central authorities, as well as a lack of transparency inhibits the ability of agencies to enforce mandates and regulations. The central authority, SEPA, should be given more power to enforce and enact change in tandem with local EPBs to ensure that local vested interests in economic development do not outweigh the central government’s concern with environmental pressures.
NGOs should be given more freedom to obtain information; they are important actors in efforts to expose environmental violations, and also as a type of third party monitoring organization. As Gerald Chan (2004) notes, NGOs have been instrumental in raising public awareness of environmental issues, as well as introducing the people to environmental law, with which they can seek damages from the government from problems relating to pollution or environmental degradation.

In the future it will also be increasingly important for other nations to contribute to China’s efforts in sustainable development; if nations such as the United States remain interdependent with China in matters of business and manufacturing, then they are also responsible for the monitoring the extent to which their factories affect the environment in China. A type of third party monitoring group may be implemented to ensure international corporations’ compliance with environmental accords or sustainability requirements in China.

*Limitations of Study*

The findings in this study clearly support the fact that pollution is distributed unequally between urban and rural provinces in terms of treatment capacity, wastewater and waste gas emissions, and is exacerbated by the inability of poor, ethnic populations to exercise power within the political opportunity structure. While this study seeks to provide a comprehensive assessment of environmental degradation and inequality in China, there are some aspects of this situation that, while important, were not available to be tested in this project. Structural and bureaucratic conditions in
China are notoriously difficult to penetrate and resistant to change, and the convoluted chain of authority descending from national governing organizations to local ones have been cited as a main barrier to the implementation of environmental regulations and the cleanup of rural industries, perpetuating rural-urban inequality (Wang et al 2007, Economy 2004). While this trend is not examined here, it may be a contributing factor in the lax supervision and monitoring of rural factories and TVEs, leading to increased pollution in rural areas. It also impedes the success of the environmental movement and environmental NGOs in China. These themes are important directions for future research in assessments of the situation of environmental degradation in China.
Conclusion

The findings presented in this study illustrate the convergence of three main themes that contribute to inequality between urban and rural regions in China in terms of environmental degradation and economic development: globalization, unequal regional development, and environmental justice. These themes each bring to light the question of the sustainability of China’s current mode of development and the potentially irreversible costs to the population and the environment.

The importance of this study lies in the exposure of physical factors that exacerbate the unequal distribution of harms between rural and urban regions in China. The lack of treatment facilities and lowered treatment capability, indicators of higher pollution and contamination in wastewater and air quality, and lower gross regional product in rural areas create a situation that places citizens’ health at risk. This cycle of “outsourcing” despite recognition of environmental degradation is perpetuated by the comparatively dire economic situation of rural communities- they need the jobs provided by industrialization, regardless of the extent to which these industries are wasteful or polluting.

These findings illustrate a system in which factories and waste are exported to poorer rural areas that need the work provided by industry, and who have few viable options. These areas become increasingly polluted but lack the infrastructure and treatment facilities to mitigate the environmental costs of economic growth, leading to destruction of natural resources and health problems caused by contaminated water sources and extremely low air quality. Ultimately, this system is both unsustainable in
its inability to conserve resources for the future, and unjust in the unequal distribution of environmental hazards between urban and rural provinces. It is important to recognize the global implications of these findings, their applicability to similar situations within the United States itself, and the need for more stringent regulation of environmental hazards in disadvantaged communities. The results of this study are essentially a call for greater fairness and equity in pursuit of development, a call for the protection of those who are suffering the environmental consequences of a global risk society. Both China and the rest of the world must recognize that our current system is unsustainable, unjust, and values economic advancement over the lives of human beings.
Bibliography


Appendix

Table 1: Regional Groupings

<table>
<thead>
<tr>
<th>Coastal</th>
<th>Central</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing</td>
<td>Shanxi</td>
</tr>
<tr>
<td>Tianjin</td>
<td>Inner Mongolia</td>
</tr>
<tr>
<td>Hebei</td>
<td>Anhui</td>
</tr>
<tr>
<td>Liaoning</td>
<td>Jiangxi</td>
</tr>
<tr>
<td>Jilin</td>
<td>Henan</td>
</tr>
<tr>
<td>Heilongjiang</td>
<td>Hubei</td>
</tr>
<tr>
<td>Shanghai</td>
<td>Hunan</td>
</tr>
<tr>
<td>Jiangsu</td>
<td>Guangxi</td>
</tr>
<tr>
<td>Zhejiang</td>
<td>Chongqing</td>
</tr>
<tr>
<td>Fujian</td>
<td>Sichuan</td>
</tr>
<tr>
<td>Shandong</td>
<td>Guizhou</td>
</tr>
<tr>
<td>Guangdong</td>
<td>Yunnan</td>
</tr>
<tr>
<td>Hainan</td>
<td>Shaanxi</td>
</tr>
</tbody>
</table>

Figure 1  
Map of Chinese Provinces
Table 2: Pollution Indicators

<table>
<thead>
<tr>
<th>Variable</th>
<th>F-value (sig.)</th>
<th>t-value (sig.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio of Industrial Waste Water Meeting Discharge Standards</td>
<td>9.543 (.005)</td>
<td>2.614* (.016)</td>
</tr>
<tr>
<td>Industrial Dust Emissions (ton/person)</td>
<td>1.805 (.190)</td>
<td>-3.010** (.005)</td>
</tr>
</tbody>
</table>

*** significant at .001 level  
** significant at .01 level  
* significant at .05 level

Table 3: Treatment Facilities

<table>
<thead>
<tr>
<th>Variable</th>
<th>F-value (sig.)</th>
<th>t-value (sig.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Gas Treatment Facilities per 10,000 persons</td>
<td>1.112 (.301)</td>
<td>2.180* (.038)</td>
</tr>
<tr>
<td>Waste Water Treatment Facilities per 10,000 persons</td>
<td>23.567 (.000)</td>
<td>2.415* (.030)</td>
</tr>
<tr>
<td>Waste Treatment Factories per 10,000 persons</td>
<td>1.243 (.274)</td>
<td>2.088* (.046)</td>
</tr>
<tr>
<td>Number of Facilities for Treatment of Waste Gas (set)</td>
<td>22.346 (.000)</td>
<td>2.346* (.048)</td>
</tr>
<tr>
<td>Treatment Capacity (ton/day)</td>
<td>14.795 (.001)</td>
<td>3.041** (.008)</td>
</tr>
</tbody>
</table>

*** significant at .001 level  
** significant at .01 level  
* significant at .05 level
Table 4: Population

<table>
<thead>
<tr>
<th>Variable</th>
<th>F-value (sig.)</th>
<th>t-value (sig.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Population (10,000 persons)</td>
<td>1.202 (.282)</td>
<td>0.296 (.796)</td>
</tr>
<tr>
<td>Urban Population Proportion</td>
<td>8.663 (.006)</td>
<td>4.585*** (.000)</td>
</tr>
<tr>
<td>Rural Population Proportion</td>
<td>8.663 (.006)</td>
<td>-4.585*** (.000)</td>
</tr>
<tr>
<td>Ethnic Minority Population</td>
<td>13.141 (.002)</td>
<td>-3.402** (.006)</td>
</tr>
<tr>
<td>Ethnic Minority Population as Percentage of Total</td>
<td>0.873 (.363)</td>
<td>-2.362* (.030)</td>
</tr>
<tr>
<td>2007 Gross Regional Product (100 million yuan)</td>
<td>11.168 (.002)</td>
<td>2.837* (.013)</td>
</tr>
<tr>
<td>2007 GRP Per 10,000 Persons (100 million yuan)</td>
<td>14.999 (.001)</td>
<td>4.159*** (.001)</td>
</tr>
<tr>
<td>Percent of Urbanization</td>
<td>8.106 (.008)</td>
<td>2.961* (.011)</td>
</tr>
</tbody>
</table>

*** significant at .001 level  
** significant at .01 level  
* significant at .05 level
<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Definition</th>
<th>Source</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Gas Treatment Facilities per 10,000 persons</td>
<td>Number of waste gas treatment facilities serving the population in a region</td>
<td>China Statistical Yearbook 2008</td>
<td>1.353</td>
<td>0.603</td>
</tr>
<tr>
<td>Waste Water Treatment Facilities per 10,000 persons</td>
<td>Number of waste water treatment facilities serving the population in a region</td>
<td>China Statistical Yearbook 2008</td>
<td>0.6009</td>
<td>0.3691</td>
</tr>
<tr>
<td>Waste Treatment Factories per 10,000 persons</td>
<td>Includes waste treatment in landfills, burning, and piling</td>
<td>China Statistical Yearbook 2008</td>
<td>0.0041</td>
<td>0.0021</td>
</tr>
<tr>
<td>Number of Facilities for Treatment of Waste Gas (set)</td>
<td>Refers to total number of waste gas treatment facilities in a region</td>
<td>China Statistical Yearbook 2008</td>
<td>5410</td>
<td>3531.443</td>
</tr>
<tr>
<td>Treatment Capacity (ton/day)</td>
<td>Treatment capacity of waste factories, including landfills, burning, and piling</td>
<td>China Statistical Yearbook 2008</td>
<td>9046.367</td>
<td>7488.823</td>
</tr>
<tr>
<td>Total Population (10,000 persons)</td>
<td>Refers to the total number of people alive at a certain point of time within a given area as of the 31st of December, not including residents in Taiwan Hong Kong SAR, Macao SAR and Chinese nationals residing abroad</td>
<td>China Statistical Yearbook 2008</td>
<td>8444.00</td>
<td>23100.968</td>
</tr>
<tr>
<td>Urban Population Proportion</td>
<td>Refers to all people residing in cities and towns as proportion of total population</td>
<td>China Statistical Yearbook 2008</td>
<td>47.982</td>
<td>14.674</td>
</tr>
<tr>
<td>Variable Name</td>
<td>Definition</td>
<td>Source</td>
<td>Mean</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>---------------------------------------------</td>
<td>--------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Rural Population Proportion</td>
<td>Refers to population other than urban as proportion of total population</td>
<td>China Statistical Yearbook 2008</td>
<td>52.018</td>
<td>14.674</td>
</tr>
<tr>
<td>Ethnic Minority Population</td>
<td>Total number of people designated as one of China’s 65 ethnic minority groups residing in a region</td>
<td>China Statistical Yearbook 2008</td>
<td>433.615</td>
<td>533.293</td>
</tr>
<tr>
<td>Ethnic Minority Population as Percentage of Total</td>
<td>Ethnic minority population as percentage of total regional population</td>
<td>China Statistical Yearbook 2008</td>
<td>47.245</td>
<td>17.704</td>
</tr>
<tr>
<td>2007 Gross Regional Product (100 million yuan)</td>
<td>Refers to the final products at market prices produced by all resident units in a region during a certain period of time</td>
<td>China Statistical Yearbook 2008</td>
<td>9176.081</td>
<td>7563.921</td>
</tr>
<tr>
<td>2007 GRP Per 10,000 Persons (100 million yuan)</td>
<td>Gross regional product per 10,000 persons</td>
<td>China Statistical Yearbook 2008</td>
<td>22302.23</td>
<td>14103.787</td>
</tr>
<tr>
<td>Percent of Urbanization</td>
<td>Percent of urbanized area in each region</td>
<td>The State of China Atlas 2009</td>
<td>46.28</td>
<td>16.408</td>
</tr>
<tr>
<td>Ratio of Industrial Waste Water Meeting Discharge Standards</td>
<td>Refers to percentage of industrial waste water that reaches national/local discharge standards regarding pollutants with or without treatment (industrial waste water discharge is the volume of waste water discharged by industrial enterprises through all their outlets)</td>
<td>China Statistical Yearbook 2008</td>
<td>0.8806</td>
<td>0.1143</td>
</tr>
</tbody>
</table>
Table 5 continued

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Definition</th>
<th>Source</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Dust Emissions (ton/person)</td>
<td>Refers to volume of dust emitted by production process of enterprises and suspended in the air for a given period of time, including dust from iron and steel works, coke-screening systems, coke plants, lime kilns, and cement production in building material enterprises, but excluding soot and dust emitted from power plants</td>
<td><em>China Statistical Yearbook 2008</em></td>
<td>0.0058</td>
<td>0.00394</td>
</tr>
</tbody>
</table>

Figure 2

**Mortality Rates for Diseases Associated With Water Pollution (per 100,000) in China in 2003 and World Averages in 2000**

Figure 3

Gross Regional Product by Region

<table>
<thead>
<tr>
<th>Region</th>
<th>Gross Regional Product (100 million yuan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal Region</td>
<td>13516.89</td>
</tr>
<tr>
<td>Central Region</td>
<td>5856.54</td>
</tr>
</tbody>
</table>

Figure 4

Ethnic Minority Population

- Urban: 6.15%
- Rural: 93.85%

Region:
- Urban
- Rural