

Environmental and Health Impacts of Air Pollution in China: The Perception of Undergraduate Students

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Abstract. The environmental and health impacts of China's air pollution are well researched and documented. Investigated to a lesser extent however, is the perception of Chinese citizens about how severe these very present consequences are. For that matter, it is equally little researched how foreigners perceive the same consequences as compared to Chinese citizens. This study was conducted to attain insight as to how Chinese students perceive the impacts of air pollution in China as compared to American students. Study groups of anonymous university students in China and American students of Hampden-Sydney College took surveys which were analyzed by U-tests to determine differences in opinion. It was found that both study groups agreed air pollution in China is a major problem and threat to the environment, but American students were significantly more in agreement with the statements. However, the groups clearly disagreed about government intervention with American students feeling that the government was not properly handling the issue or properly informing the public about its severity.

I. Introduction

Sources of Pollution

China began transforming its economy with the liberalizations of the 1970s with the change of power from Mao Zedong and Zhou Enlai to Hua Guofeng and Deng Xiaoping. When economist Deng Xiaoping came to power in 1978 there began a period of economic modernization that is associated with a rise of market capitalism in China accompanied by the most rapidly growing industrial sector in the world over the last 30 years. At the same time, China's population remained the largest in the world. With an immense population that by July 2009 is estimated to reach 1,338,612,968 (U.S. CIA 2009), China has had to take

considerable measures in order to slow down population growth. With such a massively overwhelming number of citizens and unimpeded economic growth, environmental degradation has become a major problem in China. Though blatantly real and present, many of the environmental issues have seen modest improvement over the past decade due to poor enforcement of existing government regulations—regulations that in many instances mirror those of the most progressive nations--and a lack of public awareness. In fact, China is the world's largest emitter of carbon dioxide and 66% of the population is exposed to this pollution everyday (Dong 2003). Due to poor regulation and farming techniques, 90%

of urban waters are polluted with waste water, and 70% of the rivers are polluted (Dong 2003). Respiratory diseases are among the leading the causes of death in China due to the air pollution. One of the main reasons why China has bad air pollution is because of their very heavy dependence on coal which puts about 20 million tons of sulfur dioxide in the air each year. Seventy-five percent of China's energy needs is reliant on coal, and with the economic growth has come a large increase in the demand for automobiles (Dong 2003).

An increase in international trade has also caused major environmental problems that were unanticipated. There are 253 international ports of entry in China through which 2538 metric tons of goods are shipped in and out of China. With this large amount of traffic, invasive species are easily able to enter the country. These species either come in on purpose as a means of treating other problems, or they find their own way into China.

Also accompanying the economic growth, are major construction projects such as the Three Gorges Dam and the largely successful 2008 Summer Olympics in Beijing. The TGD project makes up the three largest construction projects in the world and is taking a massive toll on the environment. The project has created a spread of invasive species over an area of 58,000 km² (New and Xie Zongqiang 2008). In a 2005 survey, it was discovered that there were currently fifty-five invasive species in the whole watershed (New and Xie 2008). The species were mainly composed of water plants such as water hyacinth. The water hyacinth and alligator weed, which is more damaging than hyacinth, are beginning to show future problems for the hydroelectric

plants. The problem with hyacinth is that it grows rapidly and causes congestion in waterways. Preventing the invasive species is something that is hard to do.

Another one of China's major projects is the South to North Water Diversion Project. The plan behind this project is to provide the Northern region of China with fresh water from the South. In order to accomplish this, China will use three routes running through the eastern, western and central regions of China. When the project is completed, it is estimated that thirty-eight to forty-eight billion cubic meters will be pumped into the Northern region of China. The eastern route will pump 18 billion cubic meters of water from the Yangtze River each year which will only account for 2-3% of the water ending up in the ocean (People's Daily 2001). This project will obviously take a large toll on the residents in these areas, along with the environment. According to Yuan Guolin, an expert of water conservancy and former deputy general manager of the China Yangtze Three Gorges Development Co, "Relevant departments of China will work out effective measures to control the project's possible damage to the ecological environment to the lowest level." (People's Daily 2001). The Chinese Government is also ensuring that all residents along the routes will be resettled at the expense of the government.

In order to get water to people in the North, southern residents will obviously have less water. In order to solve this problem, The Hanjiang Plain is a region of China that provides grain. This area is heavily reliant on the Hanjiang River which is a tributary of the Yangtze. Major water conservation efforts will have to be made in order to provide irrigation for the agriculture in

this region. Officials are even saying that water will have to be diverted from the Yangtze back into the Hanjiang. Qu Geping of the Environmental and Resources Protection Committee said that industrial pollution levels will be lowered by 10%, and will increase the sewage treatment to 45% rather than the current 15% (China Daily, March 2001). Also, all land that is reclaimed will be turned back into grassland and forest in order to solve the desertification process. It is important that China takes major steps in water conservation and treatment. This is a major undertaking considering the physics involved and the amount of resources that will be used. If China does not take serious control over pollution control, this could not only take water away from people who need it, but it could also have serious impacts on the land.

However, one of China's greatest accomplishments was that of the 2008 Summer Olympics held in Beijing. The problem with Beijing is that the air quality is extremely poor. There are always cases of travelers receiving respiratory problems due to the poor air. This was a serious threat for the athletes and fans that would be attending the games. In order to clean up their image, China actually limited their industrial production. Although the air quality was somewhat fair during the games, this was only because China closed many of their factories which put many of the citizens out of work. The nearby city of Tianjin lies seventy miles east of Beijing and closed forty of its factories for two months. The city of Tangshan ordered 267 businesses to close at a certain date in order to help with the cleanup effort. Although this improved the air quality, it was only temporary and placed many out of work (Yarley 2008).

Environmental Policy and Effects

With such an ever growing economy China's environment is suffering considerably. One major problem is the environmental pollution that erupts from coal combustion. China's pollution is damaging human health, air and water quality, agriculture and ultimately the economy (Energy Information Administration, 2006). Soon the environmental problems China is having will not only be their own problem but a problem for the planet.

Environmental law has been in place since the 1970s, and standards established for air, soil, and water along with industry regulations have been in place nearly as long, but the pollution continues (Beyer 2006). For example, Environmental Impact Assessments for new and existing expansion projects have been in existence for over thirty years, yet had been poorly organized and divided among different governmental organizations. Beginning in 2003, a national law was reorganized to create a unified version of the scattered EIA laws. "According to the law, all programs and plans on land use and development of natural resources are subject to environmental impact assessments" (Beyer 2006).

A provincial breakdown of the emissions reductions, from 2007 to 2008, shows that nearly every province or region achieved reductions in line with all other provinces. It is important to note that at the beginning of the 11th 5 Year Plans, local government officials were required to sign enforcement documents, which made the local government officials responsible for achieving emissions reductions. The

penalty for an official not achieving desired levels of emissions reductions is quite severe, from limiting an official's chances for promotion to losing his position.

For all the progress in pollution control, the report cites thirteen different sewage plants "were found incompliant either for lagged construction of the main body of project and supporting networks, or running at low capacity for a long time, abnormal operation without good reasons, substandard outflow or ineffective disposal of sludge" (MEP 2008). Further, the Ministry of Environmental Protection found eleven coal fired power plants had incompliant desulphurization facilities. Even more alarming is the fact that the true amount of COD pollution may be higher because monitoring only covers point source pollution, meaning non-point pollution such as animal wastes and fertilizers are unaccounted for. The monitoring of SO₂ pollution has been important as it is one of the main sources of air pollution, but monitoring of other air particulate should be considered. For example, China has one of the fastest growing car markets, and so there must be growing automobile emissions.

Water conservation and protection measures have experienced success under the 11th 5YP as there has been an increase in the number of sewage plants, and heavy industry now faces a resource fee for using water (World Bank 2008). However, agricultural irrigation water usage is not as closely monitored as heavy industry water usage. This is a major gap in monitoring as the burden placed on the water supply drawn from underground sources is not currently monitored, yet it is a major source of water for agricultural purposes. In protecting

water supply from sewage, China hopes to achieve an urban sewage treatment rate of 70% by 2010, a significant increase from the 52% treatment rate in 2005.

Yet there is another very important factor in China's declining environment that is often overlooked and definitely deserving of attention which are China's Forests. With such a large problem with carbon emissions the one thing that is certain today in reducing the pollution is the fact that forests act as very efficient carbon sinks (Kinver 2009). Therefore it is extremely important that China understands how important their forests are and how their growing economy and livelihood greatly depend on the forests, not to mention the earth as a whole depends greatly on them as well.

The changes in forest cover as well as the way people are using forests has now become recognized over the recent years as an important global environmental issue. Forests are also very connected to environmental issues like climate change, the carbon cycle, loss of biodiversity and sustainability of agriculture and forestry. They also protect watersheds needed for agricultural activity, provide timber needed for construction and industrial development, provide wood for cooking and heating, serve as sources of genetic material, and most importantly they regulate global biochemical cycles (Achad *et. al* 2006). Having forests as such an integral part of the environment has caused an increase in public and government policy which is aiding in the process to protect these critical terrestrial biomes that are important as carbon sinks in global climate dynamics.

The value that humans place on forests in developing countries like

China is being lost due to startling rates of deforestation and degradation. A perfect example of this is happening in subtropical China, particularly in Guangdong Province, where large areas of forest lands have been subject to human impacts for many years, which includes clearing and fuel gathering. This is having such results as full hillsides becoming barren and then being subject to soil erosion; having little support for productivity. Now massive government efforts are underway as the native pine, *Pinus massonia*, are being used to reforest such barren land, because of they can tolerate nutrient poor soil and low moisture which are typical characteristics of these barren areas (JiangMing 1995). The PRC has recently planted approximately 2.5 million hectares (ha) in the Guangdong Province with the pine species. In an effort to protect the pine the government has forbid the cutting of trees in the region. With the rural population affected by this ban the government has allowed them to have regular and frequent harvesting of the understory and litter in the reforested areas; meaning raking litter from the ground, cutting understory plants to the roots, and raking and trimming the dead branches and twigs of trees. It may seem like it this is a nice compromise yet it represents a challenge because the understory and litter are two forest components that are usually thought to have no economic value, but in actuality are very important ecologically.

Research was done to study the effects the removal of nutrients and organic matter has on the forest as a whole. The goal was to see if the practice was in fact sustainable or not, and what alternative management options could be used if not. The results

found that not only was the structure and function of the pine forest below its regional potential, but when compared to other tropical pine plantations as well as native pine forests has the lowest biomass and rates of production even though it was the oldest of the forests that were reported. It was then proposed that an alternative practice would be to create a high priority for creating fuel wood forests, which the PRC is now implementing. Such an alternative will offset the carbon emissions as well as provide many advantages to the local people because the wood has higher energy content than that of litter and understory (Brown *et. al*). A similar study in the western region of Tianshan Mountains in 2001-2003 on how a logging ban policy, in accordance with the Natural Forest Conservation Program (NFCP), worked and if it was sustainable when done (Wang *et. al* 2006). With very similar results they found that a complete logging ban cannot replace sustainable forest management and that a more flexible policy should be adopted to resolve the technical, social and economic problems associated with the complete and suddenly implemented logging ban. The study concluded that public awareness and funding from China should be increased in order to strengthen the long term sustainability of the NFCP.

With many studies evaluating whether policies are sustainable under the PRC's belt leaves room for improvement in their policy making during their 11th five year program. They have moved policies to encourage sustainability while balancing land-use, economic growth, and demand for forest products. In the forestry sector, investments since 2000 have exceeded the total investments from 1949-1999.

In 1998 the Natural Forest Protection Program (NFPP) was introduced after a logging ban prompted by the most devastating floods in China's history. Along with the logging ban five additional programs were established to promote a more sustainable forest policy, otherwise known as the Six Key Forest Programs (SKFP) (Wang, Guangyu *et. al* 2007). China has invested \$22 billion in the last six years and plans to invest \$68 billion in the next four years. The SKFP's include more than 97% of China's counties and targets around 76 million ha of land for afforestation (Wang *et al* 2007). Afforestation is a type of reforestation that involves transplanting trees and replanting them in residential and commercial areas. The main goal of afforestation is to control desertification and curb sand storms from affecting major areas in China. A part of the five year plan now is a goal to control areas of dust sources surrounding Beijing and Tianjin and 75 counties to the north. Their five year plan states that "in arid and degraded areas where it would be more appropriate to plant a combination of trees, shrubs and grasses of indigenous or drought resistant species, local officials tend to plant fast growing species like poplar for the sake of easier and more tangible achievement within their term in office. This resulted in earlier plantations in the Three-North forest belt dominated by water consuming poplar, which has lowered the groundwater table and out-competed the native vegetation, weakening the resilience of an already fragile ecosystem" (World Bank 2008). An example of how this is happening can be seen through the timber investment group that formed in the PRC to conform to State laws that prohibit non-

PRC ownership of forest land named China Forestry Inc. Their main job is to supply landscape plants and trees to large scale urban development projects within China. With the recent economic slowdown the company sees opportunity to transplant in the Yunnan Province as an excellent way to add long-term value for their shareholders by creating another revenue source for the company. The CEO also said that they "will make closing the Yunnan Province forest a priority in order to begin pruning plants and trees for landscape transplanting as soon as the weather permits in May [2009]" (China Forestry Inc., 2009). China Forestry Inc. currently holds four user rights certificates representing 1,561 ha of state forest assets in China's Heilongjiang Province, which is where China's most valuable timber is found.

With forests covering over 163 million ha in China, the PRC has come very far in the past 3 decades concerning its views on forestry policy and conservation. Some may argue that China is destroying its forests at alarming rates and is doing nothing to stop. Yet China is a developing country and has been shown to make positive strides to keep their economy growing while protecting their forests and making sustainable policies. The literature varies in reference to how China is dealing with their forests and how they are affecting their environment as well as the global balance. Yet for the most part China's knowledge about the ecological systems and impacts of carbon emissions have on their future is growing quickly. In their five year plan they state that the main target for forestry is to increase forest coverage from 18 percent to 20 percent and reverse land degradation and desertification. The three types of measures that have been undertaken to

support the goals are: key national investment programs, policy reforms and societal participation.

Health Effects

Chinese citizens are subjected to a plethora of air pollution causing respiratory ailments which affect both rural and urban settings in a profound manner. A large number of the papers published on pollution and the correlated health effects in China have been conducted specifically in reference to the use of coal in households (Bonner *et al.*, 2009; Peabody *et al.*, 2005, Zhang, 2007). Studies such as that conducted by Peabody *et al.* have heavily supported the case that indoor air pollution, caused primarily by the use of coal in cooking, result in such lifetime diseases as chronic obstructive pulmonary disease and asthma. In addition to habitual exposure to the smoke of household utilized coal, outdoor air pollution is equally as threatening and is supported to be a major cause of morbidity from cardio-respiratory diseases (Goldberg *et al.* 2003, Kan *et al.* 2008). Another severe addition to the factors affecting air and lung pollution is cigarette smoking which is extremely prominent among the Chinese.

Indoor Air Pollution. Even in non-smoking households, the dangers of indoor air pollution from coal used in cooking presents a very serious threat to respiratory health. The correlation between coal smoke and lung cancer is heavily supported by numerous epidemiological studies (Zhang & Smith 1999) such as the investigations of Xuanwei (Chapman *et al.* 1989; Liu *et al.* 1991; Mumford *et al.* 1987) where the use of smoky coals in open fire pits has

led to high lung cancer rates in non-smoking women.

Chronic exposure to smoky coals can also cause decreased lung function (Shen *et al.* 1992; Jin *et al.* 1995) and immune system impairment by decreases in serum IgG content, peripheral T-lymphocyte activity, E-rosette formation rate, interleukin (IL)-2 induction activity (Wang *et al.* 1993) and natural killer cells (Mao *et al.* 1994). While these symptoms are reduced in households which use a chimney rather than an open fire pit, the prevalence of these health conditions is too significant to ignore. Carbon Monoxide (CO) poisoning (Zhang, X *et al.* 1996) and numerous other asthma like symptoms of respiratory illness (Pope and Xu 1993) are also found in people exposed to this pollution. CO poisoning is an often overlooked health condition, but is higher in coal smoke exposure than that in cigarette smoke (Zhang & Smith 1999). CO, which binds to hemoglobin in the place of oxygen causing oxygen deprivation, is a neurotoxin which can cause serious neurological problems especially in children of women exposed during late pregnancy (Zhang & Smith 1999).

Outdoor Air Pollution. The fact that outdoor air pollution is a burden on general and, in particular, cardiovascular health is not disputed. What is more recently investigated is what factors alter the effects of outdoor air pollution, such as socio-economic status or other demographics. In a study conducted by (Wong *et al.* 2008) in Hong Kong, significant associations were found between nitrogen dioxide, sulfur dioxide, particulate matter, and ozone with all non-accidental and cardiovascular mortality in middle or high areas on their social deprivation index (SDI).

However, SO₂ and NO₂ was more strongly associated with non-accidental, cardiovascular, and respiratory mortality in high SDI areas leading to the conclusion that neighborhood socioeconomic deprivation increases mortality risks associated with air pollution (Wong et al. 2008).

A separate study conducted by Kan *et al.* in 2008 in Shanghai revealed that outdoor air pollution was associated with all non-accidental mortality and cardiovascular disease. An increase of 10 µg/m³ in a 2-day average concentration of PM₁₀, SO₂, NO₂, and O₃ corresponds to increases in all non-accidental mortality of 0.25%, 0.95%, 0.97% and 0.31% respectively. These results were shown to be more evident in the cool season, females, elderly and areas of low educational attainment.

Environmental Tobacco Smoke. Besides the obvious effects of smoking on adults, environmental tobacco smoke (ETS) has often detrimental effects on children and non-smokers. In a study conducted by Chan-Yeung and Dimich-Ward, the prevalence of ETS exposure was analyzed by the presence of the tobacco associated bio-marker cotinine and surveys. The effects on a grown woman in a household with a smoking spouse was represented by the increase of 0.31 ng/mL of cotinine in those with non-smoking partners to 1.99 ng/mL in those whose partners smoked 30 or more cigarettes per day (Chan-Yeung and Dimich-Ward 2003). It was found that 53.6% of non-smoking adults and children were exposed to ETS. Of those people, children are most at risk as their greatest exposure is from family members in the home and their lungs are not fully developed. Childhood ETS exposure inevitably leads to reduced lung function, increased risk of lower

respiratory tract illnesses, acute exacerbation of asthma resulting in hospitalization, increased prevalence of non-allergic bronchial hyper-responsiveness, increased risk for sudden infant death syndrome (SIDS) and possibly increased risk for asthma (Chan-Yeung and Dimich-Ward 2003).

In a separate study conducted by Dong et al. in 2007, the effects of ETS on respiratory symptoms were investigated in 6053 kindergarteners in 15 districts of northern China. Surveys filled out by parents of these children revealed that ETS during pregnancy results in an increased prevalence of asthma [odds ratio (OR), 3.38; 95% confidence interval (CI)] and asthma symptoms [OR, 3.00; 95% CI: 1.28-7.03] including persistent cough, phlegm and wheezing. In terms of how prevalent the exposure was, 14% had been exposed to ETS during pregnancy, 46.4% had current exposure, 0.5% of mothers were current smokers, 31.8% of fathers were current smokers (Dong et al. 2007). Further, the relative severity of those exposed for households with 1-10 cigarettes smoked per day was 36.2% and 10.2% for households with greater than 10 cigarettes per day

II. Methods

Study design and procedure

This was a simple cross-sectional study that used a demographic and agreement based survey designed to sample undergraduate students in Chinese Universities and American undergraduates at Hampden-Sydney College in Hampden-Sydney, VA. Due to the nature of the survey questions, the identities and respective universities of Chinese students who took the survey

were agreed to remain anonymous. The survey was distributed electronically through an online survey service. Over a three month period, forty U.S. and twenty Chinese students were sampled. In the demographic survey, participants were polled to assess their age, siblings, respiratory health and smoking habits. This was taken into account when interpreting the agreement based survey conducted to assess the general opinions of American and Chinese students on the severity of and governmental influence in China's air pollution. The results of the American students' perception were compared to that of the Chinese students.

Statistics

Given the size and nature of the data collected from the sample groups, all data was tested for differences by the Mann-Whitney U-Test. The exact probability was adjusted for ties by two tailed probability, if testing for any difference, or a one tailed probability if either group was expected to answer a certain way. The results of the U-Tests are displayed in table 3.

III. Results

Due to the fact that some of the questions involved questions about government, many Chinese students refused to take parts of the survey. However, adequate samples were taken to ascertain the general opposition between the Chinese and American perception of air pollution in China among undergraduate students.

Demographics

All American participants were males between the ages of eighteen and twenty two. All but three participants had up to four siblings with 14 having one and 14 having two siblings. There was one outlier with more than 6 siblings. Of the participants, 8 were involved in an environmentally related club. Only one participant had been diagnosed with asthma and had a parent or sibling with asthma. Eight were current smokers and 4 were previous smokers.

Among the Chinese participants were 28 males and 12 females all between the ages of 17 and 22. Participants were from a variety of provinces including Shanxi, Shang Hai and Shan Dong. Twenty seven of the participants had no siblings, 8 had one sibling and 5 had two siblings. None of the participants were in an environmentally related club. Two of the participants had respiratory ailments and one had parents or siblings with respiratory ailments. None of the participants were smokers.

Agreement Portion

Given the scale of the data, grand assumptions cannot be made. However, there are several notable differences in the perception of how severe pollution is in China and their confidence in governmental influence toward the issue within the sample groups. This data (*see tables 1 & 2*) was interpreted in light of the fact that all questions refer to air pollution specifically in China, both groups are at the same academic level and neither group was aware of the other group's responses. When generally compared, the responses 'Strongly Agree' and 'Agree' were consolidated to 'in agreement' while the responses

'Strongly Disagree' and 'Disagree' were consolidated to 'in disagreement'. The U test however was still conducted on a 5 scale basis.

When asked if air pollution is a major problem (*u-test two tailed, $p < .05$*), presents a threat to the natural environment (*u-test two tailed, $p < .05$*) or is a threat to human beings (*u-test two tailed, $p > .05$*), a majority of both groups agreed that it was in all cases. However, in each case, there were more Chinese students who were either neutral or disagreed than did Americans. For questions one and two, the statistics support the case that American students were more in agreement than Chinese students.

The majority was not in agreement on any of the other questions. When asked if air pollution is comparatively worse in China than in other nations, a majority (55.0%) of Chinese students was neutral with 35.0% in disagreement. A majority of American students (82.5%) was in agreement that it is comparatively worse with 5.0% in disagreement. Therefore, American students were more in agreement (*u-test one tailed, $p < .05$*).

When asked if air pollution was a health threat, a majority (45.0%) of Chinese students was in disagreement with 35.0% in agreement. A majority of American students (37.5%) was in agreement with a close 35.0% remaining neutral. Though a majority of American students were in agreement, a surprisingly high number were also neutral. Also, while a majority of Chinese students were in disagreement, there is too much neutral overlap to confirm a dominant opinion from either sample group (*u-test two tailed, $p > .05$*).

When asked if the severity of air pollution will decrease in the next 20 years, a majority (60%) of Chinese students was in agreement. American students were not as confident in this statement as a majority (47.5%) was in disagreement with only 22.5% in agreement. There was therefore a significant difference between the American and Chinese students' responses (*u-test two tailed, $p < .05$*).

The following questions concerned government intervention, so two tailed tests were run under the assumption that Chinese participants were answering objectively. When asked if adequate action is being taken to solve the air pollution issue a majority of Chinese students (40.0%) was in agreement while a majority of American students (60.0%) was in disagreement (*u-test two tailed, $p < .05$*). When asked if the government is properly handling the air pollution issue a majority of Chinese students (55.0%) was in agreement while a majority of American students (50.0%) was in disagreement (*u-test two tailed, $p < .05$*). When asked if the government is informing the public about air pollution a majority of Chinese students (45.0%) was in agreement while a majority of American students (60.0%) was in disagreement (*u-test two tailed, $p < .05$*).

The final question was whether Chinese students are more informed about air pollution than foreigners. It was expected that Americans students would be comparatively more in disagreement due to their expectation that the government was not informing the public, so a one-tailed test was used. Chinese students were mostly neutral (45.0%) with a majority of American students (52.5%) in disagreement that they were (*u-test one tailed, $p < .05$*).

IV. Conclusions.

China is a large and rapidly growing economy and population. Its environmental issues is generally those that are associated with an industrial nation with a large population—in this case, the largest population on earth—that happens to have a great determination to develop higher levels of per-capita income for its populace, even at the expense of other pressing health and environmental concerns. China has as do many other developed and developing nations, sophisticated laws on the books for the protection of the environment and for the maintenance of public health. Student perceptions show that Chinese students perceive their environment to be better, and likely to become better still, than US students perceive the environment to be. Perhaps the desire to develop high incomes in China, begun with the reforms of Deng Xiaoping, continue to dominate views and perceptions over and against the realities and responsibilities of being the world's principal emitter of greenhouse gasses.

Table 1. Perception of Chinese undergraduates on air pollution in China displayed as a percent and actual number in parenthesis. The top responses are bolded to represent the majority between those in agreement, neutral or in disagreement.

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Air pollution is a major problem in China.	25.0% (5)	40% (8)	20.0% (4)	5.0% (1)	10.0% (2)
Air pollution presents a threat to the natural environment.	30.0% (6)	55.0% (11)	10.0% (2)	0.0% (0)	5.0% (1)
Air pollution presents a threat to human beings.	60.0% (12)	35.0% (7)	5.0% (1)	0.0% (0)	0.0% (0)
Air pollution is comparatively worse than in other nations.	5.0% (1)	5.0% (1)	55.0% (11)	25.0% (5)	10.0% (2)
Air pollution is a health threat.	15.0% (3)	20.0% (4)	20.0% (4)	40.0% (8)	5.0% (1)
The severity of air pollution will decrease in the next 20 years.	10% (2)	50% (10)	20.0% (4)	20.0% (4)	0.0% (0)
Adequate action is being taken to solve the air pollution issue.	15.0% (3)	25.0% (5)	30.0% (6)	30.0% (6)	0.0% (0)
The government is properly handling the air pollution issue.	5.0% (1)	50.0% (10)	20.0% (4)	20.0% (4)	5.0% (1)
The	0.0%	45.0%	30.0%	25.0%	0.0%

government is informing the public about air pollution. (0) % (9) % (6) % (5) (0)

Chinese are more informed about air pollution than foreigners. 5.0% (1) 20.0% (4) **45.0%** (9) 20.0% (4) 10.0% (2)

Table 2. Perception of Hampden-Sydney undergraduates on air pollution displayed as a percent and actual number in parenthesis. The top responses are highlighted to present the majority between those in agreement, neutral or in disagreement.

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Air pollution is a major problem in China.	72.5% (29)	25% (10)	2.5% (1)	0.00% (0)	0.00% (0)
Air pollution presents a threat to the natural environment.	52.5% (21)	45.0% (18)	2.5% (1)	0.00% (0)	0.00% (0)
Air pollution presents a threat to human beings.	45.0% (18)	50% (20)	5.0% (2)	0.00% (0)	0.00% (0)
Air pollution is comparatively worse than in other nations.	47.5% (19)	35.0% (14)	12.5% (5)	5.0% (2)	0.00% (0)
Air pollution is a health threat.	5.0% (2)	32.5% (13)	35.0% (14)	17.5% (7)	10.0% (4)
The severity of air pollution will decrease in the next 20 years.	7.5% (3)	15.0% (6)	30.0% (12)	42.5% (17)	5.0% (2)

Adequate action is being taken to solve the air pollution issue.	0.00 % (0)	10.0 % (4)	30.0 % (12)	42.5 % (17)	17.5 % (7)
The government is properly handling the air pollution issue.	0.00 % (0)	7.5% (3)	42.5 % (17)	27.5 % (11)	22.5 % (9)
The government is informing the public about air pollution.	5.0% (2)	5.0% (2)	30.0 % (12)	45.0 % (18)	15.0 % (6)
Chinese are more informed about air pollution than foreigners.	0.00 % (0)	12.5 % (5)	35.0 % (14)	27.5 % (11)	25.0 % (10)

Table 3. U-test results showing the one and two tailed p values.

	U	U'	one-tailed p	two-tailed p
Q1	177.5	622.5	0.0001	0.0001
Q2	288.0	512.0	0.027	0.0541
Q3	457.0	343.0	0.1854	0.3708
Q4	99.0	701.0	0.0001	0.0001
Q5	377.0	423.0	0.3558	0.7116
Q6	559.0	241.0	0.0044	0.0089
Q7	583.0	217.0	0.0012	0.0024
Q8	601.5	198.5	0.0004	0.0008
Q9	588.0	212.0	0.0007	0.0015
Q10			0.0313	0.0626

IV. Discussion

Regarding the governmental issues, the differences are obvious. While the reasons for these differences may or may not be so obvious, it can be said that Chinese students strongly support their government while American students are skeptical of its competence toward this issue. It may be the case that Chinese participants answered biased for fear of consequences resulting from comments on the government. However, the fact that some students refused to take the survey leads to the conclusion that those who did may have been answering without bias.

The Ministry of the Environment for the People's Republic of China considers the environmental situation grave. Beijing and its neighboring north-east Chinese provinces have the world's currently worst levels of nitrogen dioxide according to the European Space Agency (Lancelet 2005). While there is much speculation as to whether reported pollution emissions are being presented objectively and the extent to which present regulations are actually being enforced, what is clear is the

government's power to enact environmental legislation. China's Five Year Plans are an indication of the government's targets for national economic development and, "key indicators of the directions and changes in development philosophy" (Fan 2006).

China's 11th Five Year Plan, 2006-2011, consists of 15 sections with 48 total chapters (Fan 2006). Both the 9th 5YP and 10th 5YP failed to meet the environmental goals established, as overall pollution emissions rose. However, this plan is different from previous 5YPs because of its two striking principles for development which include "a 'concept of scientific development' (*kexue fazhan guan*) and constructing a 'harmonious socialist society'—that became the foundation of the Plan" (Editorial Group 2006). So while plans like the doubling of GDP from the year 2000 by 2010 remain, Premier Wen Jiabao stated in October 2005 that, "building a harmonious socialist society entails giving priority to employment, social security, poverty reduction, education, health care, environmental protection, and safety" (Fan 2006).

Regarding the environment, nearly all of the Plan's environmental targets are 'restricted', meaning they mean to accomplish them by local and central government intervention rather than 'expected' market forces. Concerned largely with conservation of resources and reduction of pollution, the Plan is aiming for such changes as a decrease in energy consumption per unit of GDP by 20 percent, 30 percent less water consumption per unit of industrial value added, decreased emissions of major pollutants by 10 percent, and increased forest cover from 18.2 to 20.0 percent.

The American students are less in agreement with the Chinese students about the possibility of less severe pollution in China twenty years from now. This possibly presents the case that there is more confidence among Chinese students than American students in the ability of the country to recover from such a heavy period of industrialization and implement environmentally conscious standards to cut down on pollution.

China's goals are ambitious and similar to the environmental goals of other developed nations, yet China continues to be one of the world's worst polluters. From an optimistic perspective, the new plan and government leaders have adopted a point of view that may curb China's dilemma. As several interviews and The Lancet's World Report support, "the prime minister Wen Jiabao and president Hu Jintao have stressed the need for "balanced development" that takes more account of the environmental costs of economic growth", additionally they, "are increasingly willing to consult international NGOs and to tolerate the growing number of small domestic groups of green activists" (Lancet, 2005).

Additionally, a Report on the Major Pollutant Discharges of All Provinces, Autonomous Regions and Municipalities for the First Half of 2008, published by the Ministry of Environmental Protection, indicates that China for the first time in several decades has reduced pollution emissions. The report goes on to cite reductions of Chemical Oxygen Demand (COD) emissions 2.48% from 2007 to 2008, and SO₂ reductions down an even greater 3.96% over the same period (MEP 2008). The reductions can be attributed to the strengthened and improved administrative and policy measures that

focus on the environment, such as holding provincial governments accountable for attaining pollution reduction goals and increasing fees associated with pollution discharge. One of the main reasons for the decrease in SO₂ emissions is the phasing out of smaller 8.63 GW coal-fired power plants in favor of 40.6 GW coal-fired desulphurization plants (MEP 2008).

Americans were comparatively more in disagreement with the statement that Chinese citizens were generally more informed about air pollution than foreigners. It is interesting to note that while Chinese students, being mostly neutral, were unable to come to a consensus on their knowledge about the issue, American students were willing to say that Chinese citizens were not more informed. This indicates two things. First, while there was significant agreement with the statement that the government is adequately informing the public about air pollution, Chinese students feel that Chinese citizens are largely as informed as foreigners; not more or less, since the survey group was mostly neutral with that statement. Two, that American students, who were strongly in disagreement with the government's adequate supply of information and this statement have little confidence in either the average Chinese citizen's access to or initiative to gain information on air pollution.

According to the China Chemical Reporter (2009), "Research and investigation shows that most enterprises are not aware of the serious influence of nitrogen oxides emission except the electric power generating enterprises, and the environmental protection departments do not give enough emphasis to supervising the emission of nitrogen oxides". With a deficit of such knowledge in such a necessary and seemingly obvious place, one must

wonder to what extent an average citizen is aware of the same dangers that nitrogen oxide emitting enterprises are not.

With China recently surpassing America as the world's heaviest air polluter, disagreeing with the statement that 'pollution in China is comparatively worse than in other nations' supports the case that Chinese students are unaware of just how much environmental destruction is being incurred. Also, neither group was in a clear state of agreement with the statement that air pollution is a health threat, it may be inferred that neither group is fully aware of the serious respiratory consequences of exposure to air pollution. However, as Chinese students are witness to the presence of such health disparities in the given environment to a greater degree, their disagreement with the question is significant.

China's unprecedented economic growth over the past twenty years has not only placed a major burden on the environment, but created great economic disparity between the thirty one mainland provinces (Heilig 2006). The central and western provinces have, in general, Gross Domestic Products and Purchasing Power Parities much less than the developed coastal and eastern provinces. Regions such as Guangdong and Jiangsu have year 2003 GDPs that rank between Indonesia and Australia's GDPs, while the provinces of Qinghai

and Ningxia rank between Honduras and Estonia (Heilig 2006). Greater disparity can be seen, in terms of Per capita GDP in 2003, between areas such as Shanghai, which ranks along Sweden and Singapore, while the province of Guizhou ranks between Sudan and Cambodia (Heilig 2006). China as a country falls between Lebanon and Venezuela, when compared on a national scale within the same parameters (Heilig 2006).

China is now at a point as a country with one of the largest GDPs in the world that it has the ability to better address and handle the tough environmental challenges it is facing today. It must embrace the significant role its environment plays within its borders and in the global community. The government has the power and financial capability to make significant strides in environmental protection and restoration. China must recognize that it stands to lose much of the economic success, gained over the past decades, if it does not ensure progress is being made. A concerted effort by the Chinese government and its people can achieve great goals, much greater than most nations could imagine. One only needs to study the rise of China's modern economy to realize the People's Republic of China has the power and ability to achieve environmental sustainability.

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