

Climate Change in China: Can China Be a Model of Sustainable Development?

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Abstract

China has developed dramatically in terms of Gross Domestic Product (GDP). Expressed in market exchange rates, its GDP overtook Japan's in 2010, making it the second largest economic power in the world. However, it recently also became the country with the largest amount of greenhouse gas emissions in the world. Its energy use (mostly consisting of carbon emitting coal and gas) has contributed to climate change, which has impacted not only the Chinese but also people all over the world. In recent years, China is changing its attitude about global warming, and is also trying to improve its energy system. This article reviews the empirical background of China's large greenhouse gas emission, the impact of climate change in China, and recent Chinese policies on global warming. It concludes that China needs strong institutions and the involvement of not only of the central government but also local government and citizens to effectively implement policy changes for sustainable development.

I. Introduction

Today, climate change is regarded as one of the most serious environmental problems. The problems caused by global warming, such as a rise in sea levels and droughts, have been reaching an unsustainable stage and will increase further over the next few decades. According to Intergovernmental Panel on Climatic Change (IPCC), by the year 2050, we have to reduce the amount of carbon dioxide emission by 50-85 percent compared to the emissions of year 2000 (Nettowaku, 2009). We need to change our energy system depending on fossil fuel to an energy system based on renewable energy.

According to the IPCC, global warming is caused by an increased concentration of greenhouse gases, mainly carbon dioxide, in the earth's atmosphere. Increased greenhouse gases change climate conditions, keep greater amounts of heat in the atmosphere, and raise the temperature near the surface of the earth to undesirable levels. Carbon dioxide is emitted mostly by human activities. To stabilize the concentration level as well as the earth's temperature in the long-run, we need to stabilize and then reduce our carbon dioxide emissions as soon as possible.

Although many countries, especially industrialized countries, now have adopted various mitigation policies, China is considered to have not yet adopted sufficient mitigation policies. Without the commitment of China (and the United States), it is difficult to stabilize greenhouse gas emissions even if other countries try to reduce them. Given that China has recognized that it will suffer immensely from climate change, could China be a model of sustainable development?

This article discusses the impact of climate change in China and the reaction of China to climate change. Following this introduction, a brief literature review and some empirical background (constituting the first three sections of this article), the fourth section will discuss the impact of climate change in China, focusing on agriculture, weather, society, health, and economics. The fifth section will then examine China's climate change policy, positive impacts of the policy, and challenges it is facing now, before the last section provides some conclusions.

II. Literature Review

There has been a lot of research on the impact of climate change in China and more recently also on Chinese policies toward climate change. The following are some interesting examples of this growing literature.

Lewis (2009) has examined the impacts of climate change facing China and states that there is a linkage between climate change and security.¹ According to him, water scarcity resulting from climate change can increase political instability in Tibet. Because the Tibetan plateau is the source of most Asian major rivers, Tibet has become a more crucial strategic territory and will have more conflicts over scarce water resources as its glaciers are melting and reduce river flow across East and South-East Asia. This article also mentions the impact of climate change on eastern coastal economic centers around the Yangtze, Pearl and Yellow River deltas, the pressure exercised by foreign countries to take greenhouse gas mitigation actions and China's reaction to the pressure. Lewis (2009) also helps us to understand the multi-dimensional impacts of climate change.

Xiong, Lin, Ju, and Xu (2007), who are mostly members of the Institute of Environment and Sustainable Development in Agriculture at the Chinese Academy of Agricultural Sciences, provide a quantitative analysis of critical thresholds in China's crop production by using the IPCC's medium-high and medium-low greenhouse gas projections.² This report concludes that the yield per hectare for the three main crops, rice, wheat, and maize, would drop significantly as temperature rises beyond 2.5 degrees Celsius, without the carbon dioxide fertilization effect.

As for Chinese policy toward climate change, Marks (2010), who is a Boren Fellow studying the climate change policy process, evaluates the Chinese policy and explains why the government has not been able to reach many of its targets, especially its goal of reducing energy intensity. The author argues that the fragmented nature of China's authoritarian system is one of the reasons why China has missed its targets. This essay suggests how the government can efficiently enact and implement climate change policies and how the international community can play a role to let the Chinese government have a greater compliance with climate change policies. For example, he states that China should strengthen the judiciary's capacity to oversee environmental law.

¹ Lewis is an assistant professor of Science, Technology and International Affairs at Georgetown University and serves as an international advisor to the Energy Foundation China Sustainable Energy Program in Beijing.

² The medium-high (A2) and medium-low (B2) greenhouse gas emission pathways are climate change scenarios made using the Regional Climate Model PRECIS and socio-economic scenarios produced by the IPCC's Special Report on Emissions Scenarios (SRES).

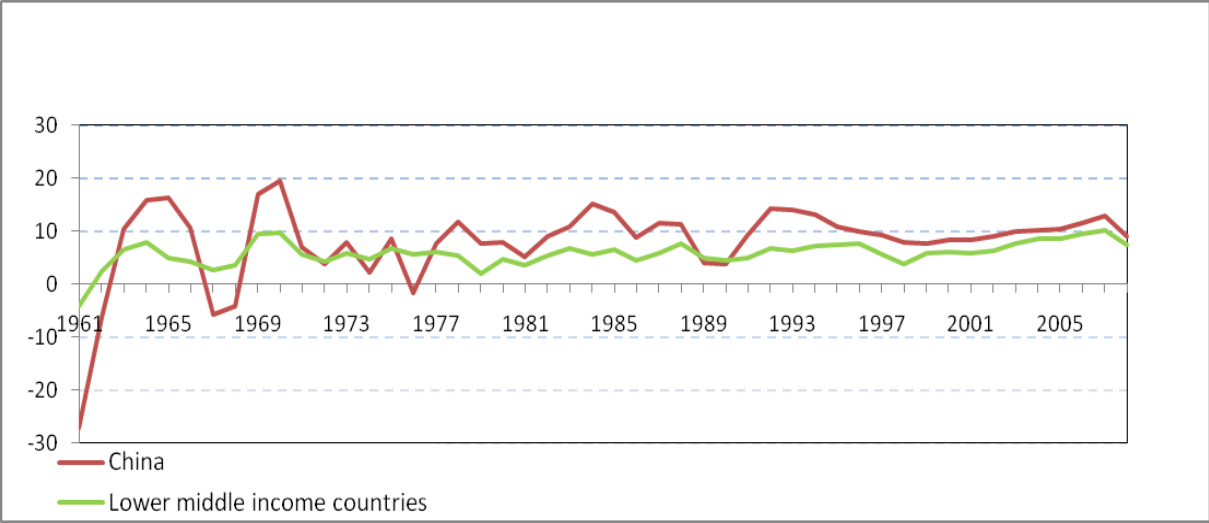
Lo (2010), who is a Ph.D. candidate of School of Politics and International Relations at the Australian National University, summarizes the recent overview of China’s national position on climate change, which includes the involvement in Copenhagen Summit, and the development of carbon markets in China. Lo argues that most Chinese climate change policies are controlled by the government, not by civil society, and he points out that most individual citizens do not consider climate change as a serious environmental problem.

Ying Ma (2010), who is a visiting fellow at the Hoover Institution at Stanford University, has written a feature on China’s views on climate change, stressing that China’s views on climate change are fundamentally tied to the country’s pressing need for continued economic development. The article also summarizes China’s climate change and points out that given the recognized impact climate change will have in China, the Chinese government has actually begun to aggressively tackle the climate change challenge at home.

III. Empirical Background

China, once had a centrally planned economic system, but has changed its economic system towards a more market-oriented system since 1978. The efficiency of these economic reforms contributed to a more than tenfold increase in GDP since 1978 (U.S. Central Intelligence Agency, 2011). Figure 1 shows China’s annual GDP growth is generally higher than other lower middle income countries since the economic reform in the late 1970s. Today, China is the second-largest economy in the world in terms of purchasing power parity and became the world’s largest exporter in 2010 (The Central Intelligence Agency, 2011).

Figure 1: Annual GDP Growth of China and Lower Middle Income Countries (percent)



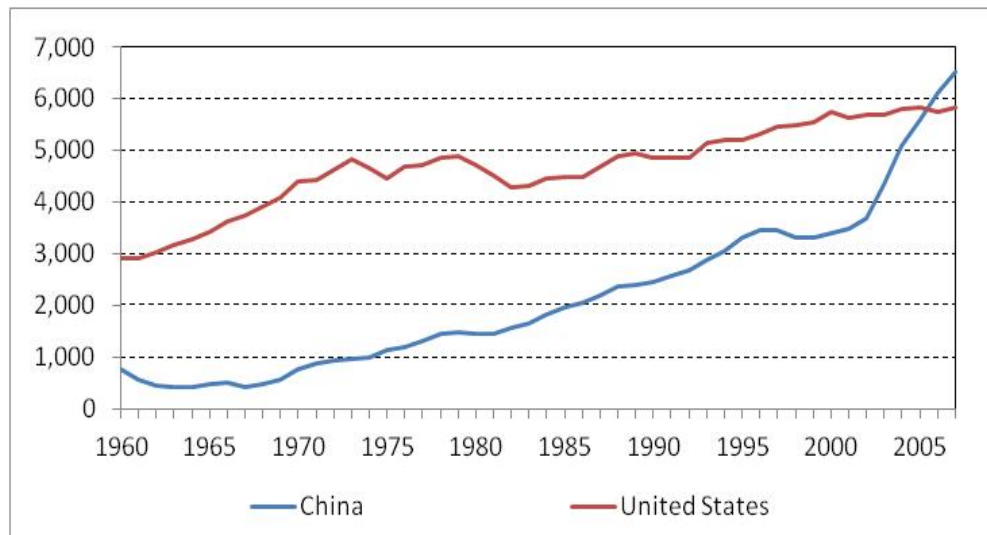
Source: Created by author based on World Bank (2010) *World Development Indicators* (as posted on the World Bank website; downloaded on May 5, 2010)

In China, industry and construction account for about 48.6 percent of its GDP (U.S. Department of State, 2010). Especially, mining and ore processing, which includes iron, steel, aluminum, coal, and so on, are the main industries. Especially, use of coal has contributed to large amount of carbon

dioxide emission. Consumer products (including electronics) are also important industries in China (U.S. Department of State, 2010).

However, the rapid economic growth came with significant environmental damages. As Figure 2 shows, China's carbon dioxide emission has been increasing, especially since the economic reform of the late 1970s. Figure 2 also shows China's considerable increase of carbon dioxide emissions compared with the United States. As can be seen in Figure 2, China became the world's largest emitter of carbon dioxide in 2006. A World Health Organization (WHO) report on air quality in 272 cities worldwide says that seven of the world's 10 most polluted cities were in China.³ Lack of water is also a problem, especially in Northern China.

Figure 2: Carbon Dioxide (CO₂) Emissions in China and the United States (megatons)

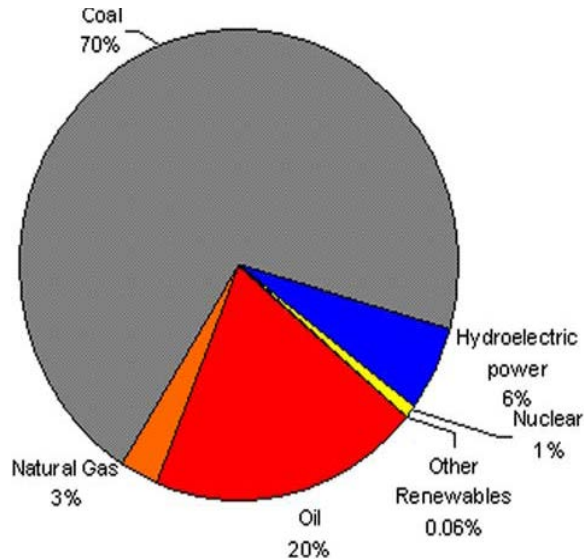


Source: Created by author based on World Bank (2010) *World Development Indicators* (as posted on the World Bank website; downloaded on May 5, 2010)

With rapid economic growth, China's demand for energy increased dramatically because of the massive investment in infrastructure and heavy industry (Morton, 2008). They now produce and use more raw materials than any other country, and Chinese people, whose living standard has been raised significantly, use more energy in their daily life than any other country. China is now the largest energy consumer and the second largest energy producer in the world. China is also the third largest net importer of crude oil (U.S. Department of State, 2010). China's electricity consumption is expected to increase by more than four percent a year through 2030 (U.S. Department of State, 2010). As shown in Figure 3, coal accounted for 70 percent of China's energy consumption in 2008. It is largely China's dependence on coal, which makes China the world's largest emitter of greenhouse gases.

³ As stated in the report of the U.S. Department of State (2010).

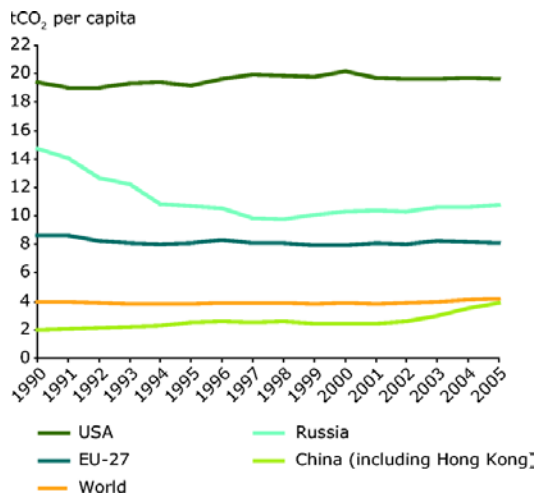
Figure 3: Total Energy Consumption in China, 2008



Source: Danny (2010), Figure 1, p. 974.

Although China was already one of the largest emitter of greenhouse gases when it ratified the Kyoto Protocol, it had not committed itself to national or joint reduction targets because China was still regard as a developing country in terms of GDP per capita. China often states continued economic development is more important than environmental protection because approximately 150 million Chinese people still live below the poverty line and China's GDP per capita only recently exceeded 3,000 dollars (Ma, 2010). Also, because of its huge population, emission of carbon dioxide per capita in China is still much smaller than other industrial countries (see Figure 4).

Figure 4: Energy-related CO₂ emissions per capita in the European Union (EU-27), the United States (USA), Russia, China and the World



Source: European Environment Agency (2009), Figure 7.3.

However, under the pressure from other countries, the Chinese government is trying to change its energy production focusing on coal and oil to alternative energy production focusing on nuclear and renewable energy. In 2009, China invested 34.6 billion dollars in clean energy, and it has installed renewable energy capacity of 52.5 gigawatts, which is second in the world behind the United States (U.S. Department of State, 2010).

IV. Impact of Climate Change in China

Without questioning the multi-dimensional impacts of climate change, this section tries to focus on the impact of climate change on China's weather, agriculture, economy, health, and social stability.

IV.1. Impact on Weather

Sea level rise stems from climate change can increase the number of more serious natural disasters. Since the 1950s, the sea level along China's coastline has been raised at a rate of 1.4-3.2 millimeters per year (Lewis, 2009). It is estimated that the sea level along China's coastline will rise between 0.01 and 0.16 meters by 2030, and between 0.4 and 1 meters by 2050 (Lewis, 2009). Higher sea levels tend to bring floods more easily and intensify storm surges. Higher sea levels also can be a cause of aggravated coastal erosion and salt-water intrusion (Lewis, 2009). According to Lewis (2009, p. 11), "a 1-meter rise in sea-level would submerge an area the size of Portugal along China's eastern seaboard; the majority of Shanghai- China's largest city- is less than 2 meters above sea level." Also, twelve coastal provinces in China account for 42 percent of its population and 73 percent of its GDP (Lewis, 2009).

IV.2. Impact on Agriculture

Droughts and water shortage stem from climate change make a negative impact on agriculture in China. As Xiong, Lin, Ju, and Xu (2007) state, without the carbon dioxide fertilization effect, there is a possibility of decrease in the yield per hectare for the three main crops, rice, wheat, and maize, would drop significantly as temperature rises beyond 2.5 degrees Celsius.

Water shortage is a big problem in China even now. The World Bank projected that China's water demand would increase from 50 billion cubic meters to 80 billion, a growth of 60 percent, when its population was projected to grow by 126 million between 2001 and 2010 (Brown, 2001). Meanwhile, industrial water demand would increase from 127 billion to 206 billion cubic meters, an expansion of 62 percent (Brown, 2001). As Tibetan glacier save melting and river flow is reduced, further water shortage will happen. It is estimated that the total area of China's western glaciers will decrease by 27.2 percent by 2050 (Lewis, 2009). If water tables fall, pumping costs will be raised and it will make underground water too costly for farmers for irrigation. According to the Geological Environment Monitoring Institute, the average level of the deep aquifer in the Hebei Province (in the heart of the North China Plain which produces more than half of China's wheat and a third of its corn), decreased 2.9 meters in 2000 (Brown, 2001). Also, all of following factors, weak prices, decreasing water tables and droughts, contributed to reduce the grain harvest in 2001 to 335 million tons although it was 392 million tons in 1998 (Brown, 2001). Furthermore, China earned 417 million dollars and 420 million dollars, respectively from exports of rice and maize in 2006. Poor crop stems from climate change might reduce revenue from exports of agricultural goods.

IV.3. Impact on Economics

Reduced crops, natural disasters, social unrest, and diseases that stem from climate change all have negative impacts on economics. As mentioned before, China might lose its revenues from exports of agricultural goods which accounts for about 15 percent of its GDP (Lewis, 2009). Desertification cause already now annual direct economic losses of approximately 6.5 billion dollars (Lewis, 2009). Therefore, rising sea levels and intensified natural disaster can cause a serious economic damage in China. Large cities converge in the coastal areas, which concentrate much of China's economic activity, and would suffer severely if they have floods. According to Dollar (2007), the incorporated health and non-health cost of outdoor air and water pollution accounted for approximately 5.8 percent of China's GDP in 2003 (or about 100 billion dollar a year). Thus, although China has concerned negative impact of its economy when it implements climate change policy, inaction can bring more economic loss in the future.

IV.4. Impact on Health

Climate change and abnormal weather that stems from it affects human health and can spread diseases. Heat waves increases cardiovascular mortality and respiratory diseases, and malnutrition is prevalent due to the lack of crop (see Li et al. 2010). According to World Health Organization, 2.4 percent of world wide diarrhea and 6 percent of malaria are due to climate change (Tarantola, 2009). Because vector diseases such as malaria and dengue fever and flood-borne infections such as salmonella tend to be prevalent in warmer months, global warming have a possibility to increase these infectious diseases. Even in Europe, extreme weather can be a catastrophe. In summer of 2003, 27,000 people died because of abnormally high temperatures in Europe (Tarantola, 2009). Also, after a flood, disease, such as cholera, dysentery, typhoid, and paratyphoid, tend to spread easily.

IV.5. Impact on Social Stability

Climate change also can cause conflicts. According to Lewis (2009), climate change was one of the most important factors that changed the dynastic cycle in ancient China through the period of the late Tang to Qing dynasty. 70-80 percent of peak war activity and most dynastic transition in China occurred during 'cold phases' (Lewis, 2009). Dropped thermal energy input decreased the productivity of land, and this had a negative impact on people's daily life and resulted in conflict. As mentioned in the literature review, Lewis (2009) states that water scarcity that stems from climate change can cause a political instability in Tibet, which is the source of most Asian major rivers including the Yellow River, the Mekong, and the Indus. Tibet will be a more strategic territory, and China might have tension with neighboring countries, for example, Vietnam, Pakistan, Nepal and India over water scarcity. Lewis (2009) predicts ethnic conflicts in the region because he assumes that many climate refugees from neighboring Asian countries, who are affected by drought, migrate to China. We do not know whether ethnic conflicts will happen or not, but they seem to have at least social unrest because of the water battle and massive inflows of refugees from different ethnic groups.

V. China's Policy toward Climate Change

Although China had not committed any reduction targets, criticism from other countries changed the Chinese leaders' attitudes toward climate change. Now, they increasingly recognize its serious environmental problems. In 1998, China upgraded the previously-weak State Environmental

Protection Administration from an agency to a ministry-level agency, and renamed it as Ministry of Environmental Protection (MEP) (U.S. Department of State, 2010). This change reflects that the Chinese Government realized its important role on environmental protection.

Also, in the same year, the National Development and Reform Commission (NDRC) came to have leadership responsibility for climate change instead of the socialist-led China Meteorological Administration (Marks, 2010). NDRC creates national development strategy, including the country's five-year plans. Although NDRC's highest priority is economic growth, not environmental protection (Marks, 2010), they are now increasingly paying attention to climate change as well. For example, China's 11th Five-Year Plan (2006-2011) calls for "greater energy conservation measures, including development of renewable energy and increased attention to environmental protection" (U.S. Department of State, 2010). The 12th Five-Year Plan will call for "continued energy efficiency gains, greater use of non-fossil fuels, and increased attention to environmental production" (U.S. Department of State, 2010).

China is trying to shift their energy source from coal to cleaner energy such as oil, natural gas, renewable energy, and nuclear energy. It is estimated that nuclear energy will grow from 1 percent in 2000 to 5 percent in 2020 in the share of electricity (U.S. Department of State, 2010). Also, China's renewable energy law calls that energy from non-fossil fuel sources should account for 15 percent (U.S. Department of State, 2010).

Now, China is trying to strength ties with other countries and organizations for sustainable development. In 2009, China and the United States decided to establish the U.S.-China Clean Energy Research Center which will focus on "building energy efficiency, clean coal including carbon capture and storage, and clean vehicles" (U.S. Department of State, 2010). In addition, they inaugurated the U.S. China energy Cooperation Program, which is a "public-private partnership focused on joint collaborative projects on renewable energy, smart grid, clean transportation, green building, clean coal, combined heat and power, and energy efficiency" (U.S. Department of State, 2010).

At the 2009 United Nations Climate Change Conference in Copenhagen, China promised to reduce its carbon intensity, or the carbon dioxide output per unit of GDP, by 40 percent to 45 percent from 2005 through 2020 (Ma, 2010).

V.1. Results

As mentioned, in 2009, China invested 34.6 billion dollars in clean energy, which is almost twice as much as 18.6 billion the United States invested (Ma, 2010). As a result, it has installed renewable energy capacity of 52.5 gigawatts, which is second in the world (U.S. Department of State, 2010). Also, between 2003 and 2008, China planted 20 million hectares of trees, and it now has the world largest man-made forests with 45 million hectares (Ma, 2010). Forests have an important role to absorb carbon dioxide. According to NDRC, from 1980 to 2005, man-made forests absorbed 3.06 billion tons of carbon dioxide (Ma, 2010). Also, China's climate change white paper says, to shift its energy source from coal, China asked more than 2,000 heavily polluting papermaking plants, chemical plants, and printing and dyeing factories, and 11,200 small coal mines to close in 2007 (Ma, 2010).

V.2. Challenges

Although China shifted its attitude toward climate change and it now strengthened its environmental legislation, it is still far behind from achieving targets. For example, although the 11th Five-Year Plan (2006-2010) calls for 20 percent reduction in energy per unit of GDP and an increase in forested land to 20 percent, China reduced its energy intensity by only 1.2 percent, much lower than its target of 4 percent in 2006 (Marks, 2010).

Lack of a strong institute to oversee the implementation of climate change policy is another problem. The MEP, China's primary state-level environmental regulator, has not worked effectively to check the implementation of policies. For example, the amount of money for environmental protection accounted for only 1.3 percent of GDP in the 10th Five-Year Plan (Marks, 2010). In addition, although the U.S. Environmental Protection Agency has 17,000 employees, the MEP has less than 1,000 (Marks, 2010).

Moreover, there is a problem how to involve local government in national new course. Some local government officials have already complained that central government's new policy focusing on energy and environment interferes. Under the China's 11th Five-Year Plan, job performance, including success in reducing energy intensity, heavily influence on local official's job performance evaluation although its highest priority remained economic growth (Ma, 2010).

Also, Chinese citizens tend not to be involved in the process of the policymaking. There are few Chinese non-governmental organizations (NGO) at present who can oppose national or local government's limited commitments (Lo, 2010). Also, individual citizens tend not to be considered climate change as the most serious environmental problem. For example, According to the survey of 3000 Chinese residents conducted by the Horizon Research Consultancy Group in 2009, climate change was ranked fourth among ten environmental problems and only 6 percent of the respondents attribute climate responsibility to the citizens (Lo, 2010).

VI. Conclusion

China has made some progress toward climate change policy. Although economic development still has priority over climate change, China now not only creates institutions which address climate change but also introduces many policies with numerical targets. However, these policies are often controlled by central government, and many targets are not achieved. China have not had strong climate change institute which can oversee policies, and many citizens do not recognize how climate change heavily impact on their daily life. To address these challenges, China should undertake three actions.

First, China should strengthen its institute to oversee the implementation of climate change policies. The government should legislate for stricter environmental law that vest institutions more authority. Also, it should give climate change institutions more resources so that they can expand their size and work effectively. Second, China should give incentives to local government officials and they should work together. Finally, China should invest more on environmental education to inform citizens the importance to address climate change. Although the effects of climate change are multi-dimensional and the Chinese people will be affected negatively by many factors, many people have not yet fully realized the severity of the problems they will face. Therefore, the government should promote environmental education for citizens to raise awareness of climate change. These educated people can then pressure local or central government to work more effectively. Strong institutions which can implement policies effectively and involve not only

central government but also local government and citizens are the key for sustainable development in China.

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