

A CHINA ENVIRONMENTAL HEALTH PROJECT RESEARCH BRIEF

This research brief was produced as part of the China Environment Forum's partnership with Western Kentucky University on the USAID-supported China Environmental Health Project

Climate Change Impacts on China Environment: Biophysical Impacts

February 2009

By Elisa Chih-Yin Lai

All countries in the world face challenges in dealing with environmental problems stemming from climate change. China's challenges in adapting to climate change are particularly acute as it is a country struggling to prevent even more pollution and natural disasters that stem, in part, from 30 years of unchecked economic growth. According to scientific assessments by the Intergovernmental Panel on Climate Change (IPCC), global temperature increases may range from 1.4 degrees Celsius to 5.8 degrees Celsius by the end of the 21st century. In 2008, the China Meteorological Administration (CMA) stated that over the past century (1908-2007) the average temperature of the earth's surface in China has risen by 1.1 degrees Celsius. Between 1986 and 2007 China experienced 21 warm winters with 2007 being the warmest year since CMA began systematic meteorological measurements in 1951.¹ Furthermore, China is estimated to have annual average temperatures rise by 3.5 degrees Celsius by the end of the 21st century.² Like the United States, the impacts of global climate change in China are diverse, due to the country's vast size and its drastically different geographies—ranging from extensive mountains, grasslands and deserts to tropical forests and low-lying coastal areas. This research brief examines four major biophysical climate change impacts on China's environment: melting glaciers, rising sea levels, biodiversity loss, and increase in natural disasters.

MELTING GLACIERS

The pattern of annual mean surface air temperature in China parallels the global trend of rising average temperatures. While the global average surface temperature has increased by 0.3~ 0.6 degrees Celsius since the 19th century, the average increase in China within the same time period was 0.5~0.8 degrees Celsius.³ The phenomenon of rising surface temperatures in China is most significant in the Himalayan Mountain region. Xu Jianzhu, a researcher at the Center for Mountain Ecosystem Studies, concluded that the air temperature of the Tibetan Plateau is now increasing at the rate of 0.3 degrees Celsius every ten years, drastically faster than the global average.⁴

The rapid change in temperature has a direct and profound impact on glaciers. Projections show that a temperature rise of 4 degrees Celsius could trigger rapid melting of glaciers on a global scale.⁵ According to estimates at the Meteorological Administration in the Tibetan Autonomous Region, glaciers in Tibet have been melting at the rate of 131.4 km² per year for the past 30 years.⁶ The shrinking of these glaciers leads to: (1) flooding from glacial lakes into the upper reaches of the Yangtze River, and (2) lower volume of water in the Yangtze's downstream areas.

In an effort to prevent natural disasters and give early warning to residents who live in high-risk areas, the National Meteorological Administration, the Chinese Academy of Science, and the United Nations Environmental Programme (UNEP) have been observing and monitoring glacier activities in the Himalayan Mountains.⁷

Glacier Lakes Overflow

Glaciers melting in the Himalayas could lead to the overflow of 200 glacial lakes and produce large-scale flooding and mudslides in mountainous areas.⁸ Areas along the Sichuan-Tibet Highway (*Chuan*

Zhang Gong Lu), the upstream region of Yarkand River, the Eastern part of Pamirs Plateau, and the middle part of Mount Tian have all encountered increasingly frequent and devastating mud slides.⁹ In a particularly devastating example, on 10 June 2004, rapid landslides and massive flooding from the River Yi'ong Zangbo in the Tibetan Plateau destroyed major highways and bridges connecting neighboring regions. The massive flood destroyed approximately 10 bridges, 50 miles of highway and hundreds of homes in Tibet.¹⁰

Decrease of Water Volume in Major Rivers

The region containing the sources of the two major rivers in China, the Yangtze River and the Yellow River, used to be covered by around 1,369.86 km² of glacier, whose abundant runoff provides water for both the Yangtze River and the Yellow River.¹¹ In recent years, the glacier coverage in the source regions has decreased by around 15km² from 1986 to 2000.¹² In 2007, Yang Yong, a geologist and environmental activist, traveled along the Yangtze River to trace it back to its source and observe changes to the environment along the way. Yang confirmed the shrinkage of the Jianggengdiru Glacier and Toutou River, the source of the Yangtze River.¹³ Chinese scientists predict that even if global warming stops, one-third of the glacial area in Tibet will disappear by 2050, and half will disappear by 2090.¹⁴ Glacial retreat may cause a transformation in the pattern of rivers that currently feed the Yangtze River. If these rivers fail to flow into the Yangtze River, the natural runoff volume of the Yangtze River is likely to decrease by 25 percent in the future.¹⁵ Furthermore, if the Yangtze River runoff decreases, the wetland ecosystem in Qinghai—a major migratory bird habitat located in northwestern China—will face possible desertification.¹⁶

RISING SEA LEVELS

Global warming has a direct impact on China's coastal areas as the rise in average global temperature accelerates the melting of ice caps and increasing sea levels rise. The "2007 Sea Level Monitoring Report," released by China's State Oceanic Administration, indicated that the average sea level along Chinese coastal areas has increased by 90 millimeters (mm) over the past 30 years.¹⁷ Sea level around Tianjin has risen by 196 mm, more than double the average increase in China.¹⁸

Rapid urbanization along China's coasts also exacerbates the threats from rising sea levels. Shanghai and Tianjin, for instance, show higher rates of sea level rise due to their high concentration of buildings and their over-extraction of groundwater, which decreases land load carrying capacity and accelerates land sinking.¹⁹ According to estimates by Chen Manchun, a research fellow with the Tianjin-based National Marine Data and Information Service, sea levels at the Yangtze River Delta will rise 20 to 60 cm, and levels at the Bohai Sea area will rise 30 to 60 cm.²⁰ With both global warming and urbanization contributing to rising levels, Shanghai and Tianjin are especially vulnerable to the impacts of climate change. Hong Kong, with its island geography, shares the same vulnerability to sea level rise as small island countries face.

Sinking Shanghai

Shanghai, located in a low-lying area near the mouth of the Yangtze River, has a relatively lower land level, making it inherently vulnerable to rising sea levels. As Shanghai has grown over the past three decades, it has pumped more and more groundwater.²¹ As a result, Shanghai sank 1.76 meters from 1921 to 1965.²² Although the Shanghai city government has stopped pumping groundwater, land reclamation represents another factor which could accelerate Shanghai's danger of sinking, making it even more vulnerable to sea level rises.

Shanghai's urban development is often seen as one of the world's largest land reclamation programs, with around 78,500 hectares of land created from the sea over the past 50 years and a projection to reclaim 40,000 hectares by 2010.²³ The city's most prosperous financial district, Pudong, is constructed on reclaimed land. Following the success of the financial district in Pudong, more land is being reclaimed around Chongming Island in Shanghai for the construction of an eco-city.²⁴

Reclaimed land has produced high economic profits in Shanghai, but such land is highly vulnerable to sea level rises. There is also the possibility of highly concentrated skyscrapers putting more weight on the land and causing Shanghai's marshy ground to sink.²⁵

The average altitude of reclaimed land in the Yangtze River Delta is only three to five meters above sea level. A 60 cm sea level rise will be a significant threat to Shanghai and its neighboring areas by exposing at least 18 million residents to the danger of flooding.²⁶ Zheng Guoguang, director of the China Meteorological Administration, warned that a sea level rise of 60 cm by 2050 could destroy Shanghai's economic growth, as well as structures constructed on reclaimed land.²⁷ Moreover, coastal erosion, salt water intrusion into the Yangtze River, and storm surges are likely to result from such a sea level rise.²⁸

Vulnerable Hong Kong

Hong Kong is especially vulnerable to sea level rise due to its geography, high concentration of skyscrapers, and massive amount of reclaimed land. The mean sea level of Victoria Harbor in Hong Kong has increased by 0.12 meters in the past 50 years.²⁹ The Hong Kong Observatory predicted that Hong Kong's mean sea level would increase by 48 cm if the global mean sea level increases .88 meters by 2100.³⁰

Hong Kong, located on the typhoon belt in the South Pacific Ocean, frequently suffers from flooding as a result of typhoons. With the global mean sea level rise of 30 cm by 2030, the effect of storm surge, which accompanies a typhoon, and may cause massive flooding in low-lying and coastal areas.³¹ In extreme cases, storm surge can be as much as 3 meters tall, with the average being between 0.5 and 1.0 meters.³² The increasing frequency of typhoons and storm surges, associated with sea level rise, not only pose a threat to the livelihood of residents living in low-lying coastal areas, but they also have the potential to damage above-ground railways and the subway system.³³

LOSS OF BIODIVERSITY

As one of the most biodiverse countries in the world, China is home to 17,300 species of plants and animals. This includes 667 vertebrates, unique genes, ancient flora and fauna as well as rare animal species.³⁴ For instance, species, such as giant pandas, golden monkeys and takins only exist in China's high mountain forests in the Southwest. Rapid industrialization, urbanization as well as logging, mining, and hunting, have led to degradation of the habitats of these species. The International Union for Conservation of Nature in its China Species Red list estimates that 34.74 percent of invertebrates, 35.92 percent of vertebrates, 69.91 percent of gymnosperm and 86.63 percent of angiosperm in China are endangered—the figures are far higher than the earlier, official government figures that ranged from 2 to 30 percent.³⁵

While urbanization and pollution are major drivers of biodiversity loss, climate change also contributes to biodiversity loss by altering the structure of ecosystems. The Intergovernmental Panel on Climate Change (IPCC) indicated that if the global average temperature rises by 1.5 - 2.5 degrees Celsius, around 20 to 30 percent of global species will face extinction.³⁶ According to IUCN's observation, 25 percent of mammals in the world are at risk of extinction and half of all the mammal species have dwindling populations, especially the Asian primates.³⁷

In the past 50 years, rainfall in the habitats of the giant panda, ranging from southwest China (Gansu, Shaanxi, and Sichuan Provinces) to east of the Tibetan plateau, has significantly decreased.³⁸ The decrease in rainfall threatens both the habitat and food source (bamboo) of the giant panda. Giant pandas, however, are not the only species that are endangered due to climate change. Qinling Mountain in Shaanxi Province is the natural habitat in Sichuan Province for the golden monkey, the takin, and the crested ibis.³⁹ The Qinling Mountain habit and the species inhabited within are decreasing as a result of the uneven distribution of rainfall and changing temperatures. Because of

the shrinking and the deteriorating of natural habitats, the number of Yunnan snub-nose monkey and the Tibet antelope are also decreasing.⁴⁰

Coral Reefs

China has abundant coral resources along its South China Sea, particularly around Hainan Island. Along China's coasts, the total area of atolls—also known as the platform reefs in the South China Sea—is approximately 30,000 km².⁴¹ The fringing reefs, spread along the coastal line, stretch from Dongshan Bay in Fujian Province to Luizhou Peninsula.⁴² Rapid urbanization, industrialization, and an increase in population along the coast have contributed to the degradation of many coral reefs. Over-fishing and coral mining are causing 80 percent of coral reef degradation around Hainan Island.⁴³

In addition to pollution, over-fishing, and coastal development, both the rise of ocean temperatures and the changing pH value in seawaters increase the vulnerability of coral reefs. Thus climate change is considered serious threat to coral reefs.

The rising sea surface temperatures and rising levels of carbon dioxide as a result of climate change are causing serious coral bleaching problems.⁴⁴ During the last decade, strong El Niño and La Niña weather pattern disruptions have become more frequent. In 1998, the effect of El Niño combined with the effects of global warming caused the highest recorded global mean for sea temperature; the abnormally warm temperature was destructive to coral reefs globally.⁴⁵ Coral bleaching was widespread, especially in the Western Pacific and Indian Oceans.⁴⁶ In Southeast and East Asia, 18 percent of coral reefs were destroyed in 1998.⁴⁷

The increase of carbon dioxide, a major contributing factor to climate change, is also causing ocean acidification. A quarter of carbon dioxide produced from fossil fuels interacts with water and causes carbonic acid.⁴⁸ Because coral is sensitive to pH changes, a moderate ocean acidification (a slight decrease in pH) can slow coral growth and cause coral calcification.⁴⁹

Coral reefs are home to numerous marine species. More than 4,000 fish species and a large variety of organisms—including sponges, starfish, and sea cucumbers—inhabit coral reefs.⁵⁰ The relationship between sea grass, fish and coral reefs is interdependent, with coral reefs providing sedimentation for sea grass to root in, sea grass supplying nutrients to feed coral reefs, and fish relying on both for protection.⁵¹ The destruction of coral reefs damages this interdependence within this fragile ocean ecosystem, triggering a major loss in marine biodiversity.

INCREASE IN NATURAL DISASTERS

In the IPCC's third assessment report, the IPCC concluded that extreme weather events, including heat waves, extratropical and tropical cyclones, droughts, intense rainfall, thunderstorms, snow avalanches and dust storms, are increasing in Asia, particularly in China.⁵² The *2004 Report of the State of the Environment in China* identified the increasing trend of abnormal natural disasters, including droughts, tropical cyclones, rain storms, dust storms, and thunderstorms.⁵³ The Chinese government's white paper titled *China's Policies and Actions for Addressing Climate Change* (issued 29 October 2008) stated that China has been experiencing an increased frequency and intensity in extreme climate phenomena, such as high temperatures, heavy rain and snow and severe droughts.⁵⁴

The China Meteorological Administration predicts that changing climate trends on land in China include: (1) increasingly frequent and severe dust storms in northern China, (2) less rainfall in eastern coastal areas, and (3) stronger snow storms in southern and central China.⁵⁵ The most notable climate trend in the coastal areas includes the increases in sea surface temperatures resulting in more powerful tropical cyclones.

In recent years, natural disasters have become more unpredictable and devastating in China. According to the China Meteorological Administration, there were more natural disasters than usual in 2006—such as flooding and mudslides caused by typhoons.⁵⁶ In 2007, Chinese officials and researchers ascribed the cause of killer typhoons and extreme weather to climate change.⁵⁷ In addition, there is an increasing trend in the strength, speed and destructiveness of typhoons, causing catastrophic damage to residents around coastal areas, especially those in the southeastern China.

The year 2004 proved to be an environmentally tumultuous one for China. That year, from September 2 to September 5, the Northeastern Sichuan region was hit by a tremendous rainstorm.⁵⁸ The rainstorm, accompanied by landslides, debris flow, and flooding, caused the death of 102 people and the collapse of 67,000 houses.⁵⁹ The extreme weather events, to some extent, verified the IPCC prediction that, sea level rise and altered frequencies and intensities of extreme weather would negatively impact natural and human systems.⁶⁰ Furthermore, in 2004, while China's coastal region was experiencing the problem of flooding brought on by killer typhoons and rain storms, the northern and western regions of China suffered from abnormally intense droughts.⁶¹

One striking example of increased impact of floods and droughts occurred between January and June in 2004, when the eastern region of Inner Mongolia and northeastern China had a severe lack of rainfall and snow, with less than 100 mm in total. Similarly, Jilin Province, located in northeastern China, observed that the total drought area was more than 196 *Qing* (1 *Qing* = 2.2710538 acres), the severe drought area was around 119 *Qing*, with 3 rivers (the Shuangyang, Xinkai, and Mushi) in Changchun City running dry.⁶²

The drought in the summer of 2004 not only hit Inner Mongolia and northeastern China, but by the fall the drought spread nationwide into the lower part of the Yangtze River and into southern China, including Guangxi, Guangdong, Fujian and Hainan provinces.⁶³ The Chinese Institute of Arid Meteorology in Lanzhou and the Chinese Academy of Science predicted that northern China will keep encountering severe drought over the next 10 to 15 years.⁶⁴ Global climate change potentially exacerbates the already severe lack of access to water and water shortage problems in northwestern China.

According to World Bank estimates, 480 million Chinese, almost 40 percent of the population, are currently living in regions facing water scarcity.⁶⁵ The occurrence of droughts in China, as the United Nations and the World Bank predict, will continue to increase in severity in the next 50 years. Extreme weather events, including typhoons, floods, and droughts have caused great economic loss and adverse human health impacts.

CONCLUSION

The ancient Chinese proverb “Man Must Conquer Nature” (*Rending Shengtian*) is relevant not just for China, but captures the unsustainable natural resource consumption and damage that accelerated with the Industrial Revolution in the 18th Century. Over the past three decades there has been a greater recognition globally that environmental resources are finite, fragile, and exhaustible. While there is still political debate over whether current global warming is naturally occurring or due to industrialization, climate change is indeed occurring and it poses severe threats to every country. An examination of China's melting of glaciers, rising sea levels, loss of biodiversity, and increasing natural disasters underscores how potentially devastating each one of these climate change phenomena can be for the Chinese people, and all of humankind.

Elisa Chih-Yin Lai has been a CEF research intern since September 2008. She will complete her Master's in International Affairs at American University in Washington, DC in May 2009. She can be reached at elisacylai@gmail.com.

The author would like to thank Elizabeth L Malone at the Joint Global Change Research Institute for her comments on the near final draft. All opinions and errors that exist in the paper are those of the author.

¹ Information Office of the State Council of the People's Republic of China. (2008). "China's policies and actions for addressing climate change." (October). [Online]. Available: http://www.gov.cn/english/2008-10/29/content_1134544.htm.

² Tracy, A., Trumbull, K., & Loh, C. (2006). *The Impacts of Climate Change in Hong Kong and the Pearl River Delta* (Rep.). Civic Exchange. Hong Kong: Civic Exchange.

³ IPCC. (n.d.). "IPCC Special Report on Emissions Scenarios." In *Intergovernmental Panel on Climate Change*. [Online]. Available: <http://www.ipcc.ch/ipccreports/sres/emission/082.htm>.

Yuhui, D., Gouyu, R., Guangyu, S., Peng, G., Xunhua, Z., Panmao, Z., De'er, Z., Zongci, Z., Shaowu, W., Huijun, W., Yong, L., Deliang, C., Xuejie, G., & Xiaosu, D. (2007). "China's National Assessment Report on Climate Change (I): Climate change in China and the future trend." *Advances in Climate Change Research*, 3, 1-5.

⁴ AFP. (2008, August 22). "Global warming: water resources in Himalaya are threatened". In *Yahoo HongKong News*. [Online]. Available: <http://hk.news.yahoo.com/article/080822/8/7u3q.html>.

⁵ "The Global Glacier Decline." *Glaciers at risk*. [Online]. Available: http://www.panda.org/about_wwf/what_we_do/climate_change/problems/impacts/glaciers/index.cfm.

⁶ China Meteorological Administration website. [Online]. Available: <http://www.cma.gov.cn/>.

⁷ Ministry of Water Resources website. [Online]. Available: <http://www.mwr.gov.cn/zxbd/sbkkzt/20060719/75999.asp>

⁸ Zhaxi. (2007, December 6). "200 glacier lakes at Himalayas may overflow due to global warming." *People Net*. [Online]. Available: <http://env.people.com.cn/big5/6621863.html>.

⁹ Zuopin, J., & Ailin, Z. (2005, May 8). "Prediction: Glaciers on Tibetan Plateau are recessing at a higher rate." *Tibetan News Net*. [Online]. Available: http://www.chinatibetnews.com/huanbao/2005-11/08/content_44969.htm.

¹⁰ Ibid.

¹¹ Chamling Rai, S. (2005, March). *An Overview of Glaciers, Glacier Retreat, and Subsequent Impacts In Nepal, India and China* (Rep.) (J. Thomas K, Comp.). World Wildlife Fund. WWF Nepal Program. [Online]. Available: <http://assets.panda.org/downloads/himalayaglaciersonreport2005.pdf>.

¹² Ibid.

¹³ Ahaoxie (Ed.). (2006, September 16). "Glacier shrinkage shortens 1/4 of the Yangtze River?" In *EEDU*. [Online]. Available: <http://www.eedu.org.cn/news/resource/water/200609/10072.html>.

¹⁴ AFP. (2007, November 21). "Climate change is threatening Tibet." *Yahoo Taiwan*. [Online]. Available: <http://tw.news.yahoo.com/article/url/d/a/071121/19/omfa.html>.

¹⁵ Ahaoxie (Ed.). (2006, September 16). "Glacier shrinkage shortens 1/4 of the Yangtze River?" In *EEDU*. [Online]. Available: <http://www.eedu.org.cn/news/resource/water/200609/10072.html>.

¹⁶ Chamling Rai, S. (2005, March). *An Overview of Glaciers, Glacier Retreat, and Subsequent Impacts In Nepal, India and China* (Rep.) (J. Thomas K, Comp.). World Wildlife Fund. WWF Nepal Program. [Online]. Available: <http://assets.panda.org/downloads/himalayaglaciersonreport2005.pdf>

¹⁷ State Oceanic Administration, People's Republic of China. (2008, January 22). *2007 Sea-level Monitoring Report* (Rep.). [Online]. Available: <http://www.soa.gov.cn/hyjww/ml/pm/news/webinfo/2008/01/1200912279916958.htm>.

¹⁸ Ibid.

¹⁹ Ibid.

²⁰ Chen, W. (2007, April 4). "Heed global warning on sinking Shanghai." *China Climate Change Info-Net*. [Online]. Available: <http://www.ccchina.gov.cn/en/newsinfo.asp?newsid=7459/>.

²¹ Shen, R. (2008, October 5). "Shanghai highrises could worsen threat of rising seas." *Reuters*. [Online]. Available: <http://www.reuters.com/article/globalenvironment08/idustre49502k20081006>.

²² Ibid.

²³ Bezlova, A. (2007, September). "Shanghai Prepares for Climate Change." In *Country Water Action: People's Republic of China*. [Online]. Available: <http://www.adb.org/water/actions/prc/shanghai-climate-change.asp#a2>.

"Bank Supports Shanghai's Beach Reclaiming Project." (2001, September 17). *People's Daily*. [Online]. Available: http://english.people.com.cn/english/200109/17/eng20010917_80424.html.

Bezlova, A. (2007, June 7). "CHINA: Shanghai Under Siege." *Asia Water Wire*. [Online]. Available: <http://www.asiawaterwire.net/node/539>.

²⁴ Bezlova, A. (2007, September). "Shanghai Prepares for Climate Change." In *Country Water Action: People's Republic of China*. [Online]. Available: <http://www.adb.org/water/actions/prc/shanghai-climate-change.asp#a2>.

²⁵ Shen, R. (2008, October 5). "Shanghai high-rises could worsen threat of rising seas." *Reuters*. [Online]. Available: <http://www.reuters.com/article/globalenvironment08/idustre49502k20081006>.

²⁶ Bezlova, A. (2007, June 7). "CHINA: Shanghai Under Siege." *Asia Water Wire*. [Online]. Available: <http://www.asiawaterwire.net/node/539>.

²⁷ Bezlova, A. (2007, September). "Shanghai Prepares for Climate Change. In *Country Water Action: People's Republic of China*." [Online]. Available: <http://www.adb.org/water/actions/prc/shanghai-climate-change.asp#a2>.

²⁸ Ibid.

²⁹ Yashi, Z. (2004, June 14). "Sea level at Victoria Harbour will rise 0.12 meter in 50 years." *China Net*. [Online]. Available: <http://www.sars.gov.cn/chinese/chinesecommunity/586712.htm>.

³⁰ Global mean sea level is projected to rise by 0.09 to 0.88 meters between 1990 and 2100, for the full range of SRES scenarios. This is due primarily to thermal expansion and loss of mass from glaciers and ice caps.

IPCC Working Group I. (1995). *Summary for Policymakers: The Science of Climate Change* (Rep.). Inter-governmental Panel on Climate Change. [Online]. Available: <http://www.ipcc.ch/pdf/climate-changes-1995/spm-science-of-climate-changes.pdf/>.

³¹ Tracy, A., Trumbull, K., & Loh, C. (2006). *The Impacts of Climate Change in Hong Kong and the Pearl River Delta* (Rep.). Civic Exchange. Hong Kong: Civic Exchange.

On page 22 of the Report, the Chinese Science Academy of Science predicted that “sea level in the PRD will rise 1 5-30 cm by 2010, 3 0-40 cm by 2030 and 40-60 cm by 2050.”

³² “HKO announces findings on long-term sea level change in HK.” (2004, June 14). [Online]. Available: <http://www.weather.gov.hk/wxinfo/news/2004/pre0614c.htm>

³³ Tracy, A., Trumbull, K., & Loh, C. (2006). *The Impacts of Climate Change in Hong Kong and the Pearl River Delta* (Rep.). Civic Exchange. Hong Kong: Civic Exchange.

³⁴ Tingting, Z. (2008, March 7). “Strategic action plan needed for biodiversity conservation.” *China Net*. [Online]. Available: http://www.china.org.cn/environment/news/2008-03/07/content_11879211.htm.

³⁵ Ibid.

³⁶ Ibid.

³⁷ Black, R. (2008, October 6). “Mammals facing extinction threat.” *BBC NEWS*. [Online]. Available: <http://news.bbc.co.uk/2/hi/science/nature/7651981.stm>.

³⁸ “Giant Panda.” (2008, May 12). *Conserving China's Biodiversity*. [Online]. Available: <http://www.chinabiodiversity.com/read.php?tid=6324>.

³⁹ “The Land of panda” (2007, August 19). [Online]. Available: http://www.panda.org/news_facts/successes/pandasuccess/area/index.cfm.

⁴⁰ “Distribution of wild animals shrank gradually in Qinghai plateau: impacted by global warming and human activities.” (2007, November 21). In *Conserving China's biodiversity*. [Online]. Available: <http://www.chinabiodiversity.com/read.php?tid=4973>.

“National Climate Change Program.” (2007, June 4). *China Net*. [Online]. Available: <http://www.china.org.cn/english/environment/213624.htm#6>.

⁴¹ “National Climate Change Program.” (2007, June 4). *China Net*. [Online]. Available: <http://www.china.org.cn/english/environment/213624.htm#6>.

⁴² Qiaomin, Z. (2004). “Coral reefs conservation and management in China (M. Ahmed, C. K. Chong, & H. Cesar, Eds.)” *Economic Valuation and Policy Priorities for Sustainable Management of Coral Reefs* (pp. 198-202). Penang, Malaysia: WorldFish Center.

⁴³ Ibid.

⁴⁴ Shah, A. (2004, December 28). “Global Threats to Coral Reefs: climate change impacts and the new emerging threat.” [Online]. Available: <http://www.globalissues.org/article/173/coral-reefs>.

⁴⁵ “JMA Index Showing El Nino and La Nina Years.” (2002). In *Global Climate Change Research Explore: Sea Surface Temperatures*. [Online]. Available: <http://www.exploratorium.edu/climate/hydrosphere/data5.html>.

-
- ⁴⁶ Bruno, J. (2008, August 26). "Coral reefs and climate change." In *The Encyclopedia of earth*. [Online]. Available: http://www.eoearth.org/article/coral_reefs_and_climate_change#climate_change_and_coral_loss.
- ⁴⁷ Wilkinson, C. (n.d.). *Status of Coral Reefs of the World: 2000* (Rep.). Global Coral Reef Monitoring Network. [Online]. Available: http://www.usaid.gov/our_work/environment/water/tech_pubs/coral.reef.report.sections/04.coral_reef_report.2002.global_status.pdf.
- ⁴⁸ Bruno, J. (2008, August 26). "Coral reefs and climate change." In *The Encyclopedia of earth*. [Online]. Available: http://www.eoearth.org/article/coral_reefs_and_climate_change#climate_change_and_coral_loss.
- ⁴⁹ Ibid.
- Hoegh-Guldberg, O. (2007). "Coral Reefs Under Rapid Climate Change and Ocean Acidification." *Science*, 318, 1737-1742.
- ⁵⁰ Spalding, M. D., Ravilious, C., Green, E. P., & World Conservation Monitoring Centre. (2001). *World Atlas of Coral Reefs*. Berkeley, CA: University of California P.
- ⁵¹ Wells, S., Hanna, N., & Greenpeace USA. (1992). *The Greenpeace Book of Coral Reefs*. Sterling Pub Co Inc.
- ⁵² BBC News. (n.d.). *Summary for Policymakers of the Synthesis Report of the IPCC Fourth Assessment Report* (Rep.). [Online]. Available: http://news.bbc.co.uk/2/shared/bsp/hi/pdfs/17_11_07_ipcc4.pdf.
- ⁵³ "Chinese Environment Overview in 2004: Climate and natural disasters." (2006, January 24). *China Net*. [Online]. Available: <http://big5.china.com.cn/chinese/zhuanti/hjgb/1103917.htm>.
- ⁵⁴ "China warns more extreme weather to come." (2008, October 29). *China Net*. [Online]. Available: http://www.china.org.cn/environment/news/2008-10/29/content_16686581.htm.
- ⁵⁵ "China warned of severe sandstorms, droughts." (2008, February 21). *China Net*. [Online]. Available: http://www.china.org.cn/environment/news/2008-02/21/content_1243411.htm.
- ⁵⁶ Saiget, R. J. (2006, August 14). "Global warming implicated in China's killer typhoons." *Agence France-Presse*. [Online]. Available: <http://www.cosmosmagazine.com/news/553/global-warming-implicated-chinas-killer-typhoons>.
- ⁵⁷ Blanchard, B. (2007, August 1). "China blames climate change for extreme weather." *Reuters*. [Online]. Available: <http://www.alertnet.org/thenews/newsdesk/pek358550.htm>.
- ⁵⁸ "Unbalance of atmospheric circulation is the cause of flooding in Northeastern China." (2007, July 10). *China Net*. [Online]. Available: http://big5.china.com.cn/environment/2007-07/10/content_8501855.htm.
- ⁵⁹ "Rainstorm in Sichuan caused 102 deaths and 25 missings." (2004, September 8). *China News*. [Online]. Available: <http://www.chinanews.com.cn/news/2004/2004-09-08/26/482000.shtml>.
- ⁶⁰ BBC News. (n.d.). *Summary for Policymakers of the Synthesis Report of the IPCC Fourth Assessment Report* (Rep.). [Online]. Available: http://news.bbc.co.uk/2/shared/bsp/hi/pdfs/17_11_07_ipcc4.pdf.
- ⁶¹ Ibid.
- ⁶² "Drought in Northern China became severe." (2004, June 11). *The Central News Agency*. [Online]. Available: <http://www.epochtimes.com/b5/4/6/11/n566265.htm>.

⁶³ “Chinese Environment Overview in 2004: Climate and natural disasters.” (2006, January 24). In *China Net*. [Online]. Available: <http://big5.china.com.cn/chinese/zhuanti/hjgb/1103917.htm>.

⁶⁴ Changqing, S. (2004, October 19). “Prediction: Droughts will be more severe in the next decade.” *Xinhua News Agency*. [Online]. Available: http://news.xinhuanet.com/newscenter/2004-10/19/content_2111006.htm.

⁶⁵ “Choking on Growth.” (17 Apr. 2008). *New York Times*. [Online]. Available: http://www.nytimes.com/interactive/2007/09/28/world/asia/choking_on_growth_2.html#story4.