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**SPECIAL ISSUE: China's Environmental Challenges and Sustainable Development**

## CONTENTS

# China's Environmental Problems and Prospects for Japanese Cooperation[1]

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## Abstract

As China's economy continues to grow, it faces a number of environmental issues, including severe air and water pollutions and land degradation. In addition, China already ranks top in the world in its emissions of carbon dioxide, which causes global warming. Along with air pollution, China's various environmental problems also include water pollution and food safety issues. This paper explores historical changes of Chinese environmental issues and discussed the limits of and potential for bilateral and regional cooperation.

## Keywords:

Chinese environmental problems, geopolitical impediments, bilateral and regional cooperation,

## 1. Introduction

According to statistics released by the World Trade Organization (WTO) in April 14, 2014, the total value of China's trade in 2013 topped that of the United States, making it number one in the world by this measure. As its economy continues to grow, China faces a number of issues to which no effective responses are yet in sight. Among these are its environmental problems, including the severe air pollution typified by high levels of PM2.5. In addition, China already ranks top in the world in its emissions of carbon dioxide, which causes global warming. It accounts for almost a quarter (24%) of the global total of such emissions. China and the United States, the second-largest source, together produce more than one-third of the world's $CO_2$ emissions. Along with air pollution, China's various environmental problems also include water pollution and food safety issues.[2] In

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[1] The original version of this article appeared on a web magazine "Nippon.com", http://www.nippon.com/ja/in-depth/a03101/ and was revised for this journal.

[2] See, for example, (i) Hidefumi Imura, *China's Environmental Problems: What Is Happening Now?*, (Kagaku-Dōjin, 2007): 224. [in Japanese]

this article, I will examine the state of these problems and discuss the limits of and potential for bilateral and regional cooperation extending beyond the framework of technical assistance from Japan in dealing with them.

## 2. A Historical Changes of Chinese Environmental Issues

### 2.1 A Pair of Shocks in the Late 1990s: The Yellow River and Yangtze River

The growth of the Chinese economy following the adoption of the reform and open door policy in 1978 became particularly pronounced from 1992 on. China's environmental problems have also occurred mainly during the 20-plus years since then. Over the course of this period, however, the nature of the problems has changed substantially.

China experienced two major environmental shocks in the late 1990s: the drying up of the Yellow River on an unprecedented scale in 1997 and the Yangtze River floods of 1998.The drying up of the Yellow River was blamed on the growth of agriculture and industry and increased urban demand for water. But the story was not that simple. According to a research project conducted by the Research Institute for Humanity and Nature (RIHN), one cause of this phenomenon was the rise in use of water accompanying the afforestation activities undertaken to counter desertification.[3] About 70% of the water drawn from the Yellow River is used for agriculture; the amount used for this purpose grew in the 1980s but did not change greatly in the latter part of the 1990s, which is when the drying up occurred.

Meanwhile, the RIHN study found that water consumption in the Loess Plateau area changed greatly after the 1980s. The afforestation activities conducted as a national project to counter desertification in this area achieved a certain degree of success, and this resulted in an increase in the amount of water used by the restored forests (through evaporation), which ended up reducing the downstream water flow. The afforestation project undertaken to fight one environmental problem, desertification, caused a different environmental problem, the drying up of the Yellow River.

As for the Yangtze River floods of 1998, unusually heavy rainfalls were probably the direct cause, but the flooding was believed to have been aggravated by rampant clearing of forests for farmland in mountainous areas. After the

(ii) Yassushi Aikawa, *Pollution in China: An Environmental Report on the" Polluted Mainland"*, (Softbank Creative, 2008): 240. [in Japanese]

[3] Yoshihiro Fukushima, *The Yellow River Dries Up: Water and Environmental Problems Relating to China's Giant River*, (Showado, 2008): 187. [in Japanese]

floods, the Chinese government responded by implementing a policy of farmland reforestation, an extremely unusual move in a country that has continued to expand its farmland as its population has grown.

### 2.2 New Environmental Problems Arising from Rapid Urban Development

As seen in the above two cases, in the period through the early 2000s China encountered various environmental problems, such as increased amounts of "Asian dust" (seasonal clouds of yellow dust affecting large areas in China and neighboring countries), water shortages, and flooding, as a result of desertification and deforestation accompanying its drive to become self-sufficient in food through increased agricultural production. But the situation changed greatly starting in the latter part of the 2000s decade as urbanization and industrialization progressed.

In Inner Mongolia, where agricultural development led to the loss of grassland and increased desertification, the mining of coal, rare earths, and other resources is now being undertaken at an intensive pace, and this process is being accompanied by rapid urban development. In the past, many of the coal mines of this region, like those in Japan, seem to have been dangerous warrens of tunnels, but now the minerals are being extracted from large-scale open-pit mines, and meanwhile the country towns of the region have been undergoing urban development reminiscent of cities in oil-rich Middle Eastern countries. Local residents no longer feel the incentive to farm, and the pressure for agricultural development is gone. I have heard Chinese researchers declare that further desertification will not occur. Open-pit coal mining is a source of further environmental problems, but mine operators are stringently required to restore the mine sites. The situation has changed greatly from the time when many Japanese nongovernmental organizations were involved in afforestation activities in this region.

### 2.3 China's Advances with Countermeasures of its Own Making

China's environmental problems are serious as seen above, but just knowing that is not enough to see the whole picture. For example, the relationship between economic growth and environmental conservation, though generally a trade-off, is now being addressed around the world with integrated policies or policy mixes aimed at achieving both growth and conservation. In China's case, the achievement of a "socialist harmonious society" was adopted as an objective during the administration of Hu Jintao in 2004, and the government has pushed ahead with environmental policies that use the market mechanism and economic incentives.

China relies on coal for about 70% of its primary energy supply, and it is the world's biggest emitter of sulfur oxides from its coal-fired power plants. The government set a target of cutting the volume of these emissions 10% by 2010.

In the first half of the 2000s the authorities used measures like the imposition of surcharges on emissions, but these failed to work. Advanced desulfurization equipment from Japan was too expensive to be widely adopted. But in the second half of the decade Chinese manufacturers developed their own desulfurization equipment and succeeded in lowering the cost by a large margin. Thanks to the rapid spread of this equipment, China just about reached its 10% reduction target.[4]

China has also been actively promoting renewable energy sources like solar and wind power generation. Japan and Germany originally led in production of the photovoltaic cells for solar power generation, but in the past two or three years Chinese manufacturers have taken the lead. China is also number one in wind power generating capacity, and three of the world's top 10 companies in this field are Chinese. When it comes to addressing environmental issues with measures that apply economic incentives, China seems to be more advanced than Japan. And as with other manufactured products, it has achieved a strong advantage in terms of cost.

### 2.4 Emerging a New Trend: Dialogue among Various Actors

In the next part, I would like to consider a different aspect of China's environmental problems by introducing the case of Lake Tai (Taihu) in the coastal province of Jiangsu. From the 1990s on, the basin of Lake Tai in Jiangsu Province became seriously polluted as a result of development, and in 2007 a major algae bloom occurred in the lake, causing serious problems, including the halt of use of water from the lake by the city of Wuxi, which relies on it for its drinking water.[5] Jiangsu Province ranks with Shanghai and Zhejiang in terms of the advanced state of its economy, and the provincial government had shown strong leadership in undertaking policies for environmental protection, having moved at an early stage to proclaim the goal of a xiaokang (moderately well-off) society as its guiding principle, aiming for harmony between economic growth and the environment.

From the latter part of the 1990s, in keeping with this guiding principle, Jiangsu came out with a series of progressive experimental environmental policies. These included the adoption of a disclosure system regarding environmental measures—an extremely unusual initiative in China—with enterprises that fail to disclose relevant information blocked from borrowing from banks, and the implementation of a pilot project for trading of emission rights for pollutants, using chemical oxygen demand as the standard for measuring the environmental impact on rivers, lakes, marshes, and ocean waters.

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4 Nobuhiro Horii ed., *Sustainable Growth in China: Can the Resource and Environmental Constraints Be Overcome?,* (Institute of Developing Economies, 2010): 287. [in Japanese].

5 Masayoshi Nakao, Xin Qian, and Yuejun Zheng, eds., *China's Water Environmental Issues: Water Shortages Resulting from Development,* (Bensei Syupan, 2009): 224. [in Japanese].

These policies have not fixed all the problems, but one move of particular note is the holding of a roundtable conference bringing together government officials, business representatives, and ordinary residents to discuss environmental policies for the area.[6] The convening of this sort of roundtable meeting was a major historical milestone for China. The move is reminiscent of Japan's creation of committees focusing on the Yodogawa basin and other rivers. It is important to get businesses, local residents, and NGOs actively involved in dealing with environmental issues so as to enhance the effectiveness and preventive power of the measures adopted. The Chinese may have started to take note of this point.

## 3. Towards Regional Cooperation in East Asia

### 3.1 Geopolitical Impediments to Regional Cooperation

On the international level, global warming has been one of the top items on the global agenda ever since the 1992 Earth Summit in Rio de Janeiro. Britain and other European countries led the international debate with their advocacy of an extremely idealistic position regarding global warming, including appeals to ethical concerns. By way of background, the Eastern European countries that had effectively joined the rest of Europe after the end of the Cold War had low levels of efficiency in terms of energy and $CO_2$ emissions, meaning that it was possible for them to improve efficiency and reduce emissions with relatively small investments. The political and economic integration brought by the enlargement of the European Union following the end of the Cold War may be seen as having given rise to a beneficial intraregional reciprocity with respect to environmental issues as well.

The regional picture in East Asia is quite different. There is an extreme lack of political and economic uniformity among the countries of this region, including China and Japan, and this lack stands in the way of reciprocity. While Japan and South Korea have market economies under democratic systems of government, China has switched to a market economy while maintaining the political dominance of the socialist-era Communist Party. This makes it difficult to achieve strategic reciprocity covering both the political and economic fronts.

With respect to environmental issues, such as the relatively recent phenomenon of PM2.5 and the Asian dust that has affected both China and its neighbors for some time, the tendency has been to think in terms of relationships "upwind"

[6] Kenji Ōtsuka ed., *China's Water Environmental Protection and Governance: Constructing a System in the Lake Tai Basin,* (Institute of Developing Economies, 2010): 287. [in Japanese].

versus “downwind”—or, in the case of maritime pollution, “upstream” versus “downstream.” In East Asia we have the highly distinctive geopolitical pairing of China as an upwind country that has many pollution-related environmental problems arising from industrial activity, including $CO_2$ emissions, and Japan as a downwind country that has some of the world’s most advanced technologies for energy conservation and prevention of pollution.

In Europe’s case, the region as a whole must face global environmental issues like global warming and acid rain as shared threats. In East Asia, by contrast, the existence of the upstream-downstream dichotomy makes it difficult to find such common ground. Also, thanks to its economic development China has now reached a point where it does not necessarily need know-how from Japan with respect to environmental technology, including such aspects as manufacturing of solar panels or desulfurization equipment. But in Japan there continues to be a strong tendency to focus on the idea of “technological cooperation” (the provision of Japanese technology to China) and a lack of thinking about a framework for real cooperation within the region.

### 3.2 Strategic Reciprocity for a Disaster-Prone Region

Is there no way of creating ties of strategic reciprocity in East Asia regarding environmental issues? One possible approach might involve the concepts of “climate security” and “environmental security” that people in countries like Britain started to discuss in the 1990s. These concepts focus on the fact that solving environmental problems contributes to regional and national political and social stability.

When we think about East Asia—as broadly defined to include Southeast Asia—it is important to note the region’s distinctive set of climatic and geological conditions. Its location on the western side of the Pacific Rim puts it in the Asian monsoon belt, and it experiences frequent volcanic eruptions and earthquakes arising from the Pacific “Ring of Fire.” The monsoon climate produces seasonal rains and also disastrous events like typhoons. And the earthquakes along the Ring of Fire are both disasters in their own right and the cause of devastating tsunamis, such as the ones experienced by Indonesia, Thailand, and other countries after the 2004 Indian Ocean Earthquake and by Japan after the 2011 Great East Japan Earthquake.

The Pacific Rim, particularly the region from East to Southeast Asia, is a part of the world that is extraordinarily prone to natural disasters. Human-caused threats, notably global warming, also pose great dangers for the people of the region. The severity of the typhoon that struck the Philippines late in 2013 is seen as a reflection of this. To deal with the threats both from human activity and from natural phenomena like volcanic eruptions and earthquakes, we probably need an international cooperative framework.[7] If the countries of East Asia could share this sort of thinking and advocate it to the rest of the world, we could hope to see the emergence of regional strategic reciprocity in the environmental field as well.

## 4. Building on the Multilateral Networks among Researchers

Even when it looks difficult for particular countries to cooperate, we see cases of joint international research in connection with environmental issues. RIHN's Amur-Okhotsk Project has been followed by a move to build cooperative ties at the level of researchers from the countries along the Amur River, which have no such ties at the government level. Researchers have set up the Amur-Okhotsk Consortium as a framework to search for common benefits while working jointly to solve environmental problems in which their countries are mutually involved, based on clarification of the need for environmental conservation efforts with respect to the Amur River and in the Sea of Okhotsk into which it flows. I believe that "second-track" initiatives of this sort, separate from governmental and economic interaction, have an important part to play in building regional trust.

Japan's environmental cooperation with China up to now has been conducted mostly on a bilateral basis. But in view of the lack of political and economic uniformity in East Asia, multilateral cooperation may be what is really required. Also, we Japanese tend to have the notion that our country is a leader in environmental technology and China is backward in this field, and so we think in terms of "technological cooperation," effectively meaning the provision of Japanese technology to China. As long as we are stuck in this mind-set, we are unlikely to achieve any progress.

The author would like to stress the importance of actively calling for joint cross-border research as an international public good. Environmental issues are a type of national security issue, and dealing with them can promote regional stability. Japan should vigorously push this line of thought and promote joint research on a multilateral basis.

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[7] Shohei Yonemoto, *The Politics of Global Change*, (Tokyo: Kobundo, 2011): 261. [in Japanese].

degree in forest hydrology from Kyoto University (1987). He was an assistant professor at Kyoto University (1987-1989), an assistant professor (1987-1996) and an associate professor (1997-2002) at Toyo University of Agriculture and Technology. He is the leader of the RIHN Initiative for Chinese Environmental Issues and RIHN's project "Designing Local Frameworks for Integrated Water Resources Management". His major publications include "Global Environmental Issues; Our Responsibility toward Unseen People and Unborn Generations" (ed. 2009), "Water Issues and Water Saving Policies in China" in Akimichi et. al. ed., Water and People -1, "Environmental History in Central Eurasia" (ed. 2012), and "Water Resources Governance and Chinese Environmental Policies" (ed. 2015).

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# Damage and Heavy Metal Pollution in China's Farmland: Reality and Solutions

*Goro TAKAHASHI*

## Abstract

The soil pollution of the farmland in China has gradually entered into a serious state. The Chinese government released an outline of national soil pollution investigation in 2014. According to this investigation, metal contamination is especially worrisome. The cadmium pollution in a rice crop district, arsenic pollution, and lead pollution are particularly severe. Soil pollution has induced the farmer's serious health impairment in various places, and the condition similar to Itai-itai disease has occurred among them. In this study, I conducted a field survey over this problem in a certain farm village in China. There, the central government, the local government, and a research institution were tackling restoration of soil pollution. Transferring the restoration technology of the soil pollution of Japan's rich experience to China and tackling cooperation of refurbishing operation are expected in the foreseeable future.

## Keywords

Soil pollution, cadmium, arsenic, lead, Itai-itai disease, contamination remediation

## Introduction

In April 2014, the Chinese government released the results of a survey concerning soil pollution across Mainland China. Despite the fact that the report was merely a general outline and was not comprehensive in many aspects, it was still a significant document and the results raised international concern. The report highlighted a few key items. For instance, the Chinese government itself displayed serious concern regarding the current state of soil pollution, and the report shed light on the fact that China's arable land is contaminated by toxic heavy metals, such as cadmium, mercury, and arsenic, and that over 19% of farmland greatly exceeded the national standard pollution levels.

Until this report was published, soil contamination surveys had only been carried out on a local scale by private researchers or regional research institutions.

Thus, the significance of the published report is that it covered the whole of China. Since China's soil contamination issue goes hand in hand with research on environmental issues of agricultural land, this paper will analyze this issue in great detail. The results of the analysis were mostly consistent with expectations; however, it also included many issues that have insufficient information, which was somewhat disappointing.

The most frustrating omissions were the lack of more detailed regional information, such as the state and the cause of contamination on at least the provincial or the autonomous region level. However, the Chinese government has not yet published this important context. Furthermore, aside from the state of soil contamination, it is extremely crucial to reveal the health hazard state caused by heavy metal pollution. As this paper has made evident, many farmers and children have suffered health effects due to their exposure to heavy metal pollution in various areas of China, and this issue has reached a point where it cannot be ignored.

This paper examines the state of health damage caused by serious levels of heavy metal pollution in China's agricultural soil, the current state and causes of the pollution, and the ongoing efforts and challenges to remediate the farmlands. Part of the paper will include information obtained from actual field surveys conducted in August 2015.

## 1. Current State of Heavy Metal Pollution in China's Arable Land

### (1) Actual Status of Health Damages

In recent years, the issues that have been attracting the attention of social reporters and environmental and agricultural researchers in China include: cases of farmers in some rural areas who suffer from symptoms similar to Itai-itai disease;[1] cases of people who have abnormally high levels of lead in their blood regardless of urban or rural locations, and among them, groups of children who have experienced sudden nosebleeds; and a rise in the number of patients who seem to have arsenic poisoning.

1) Itai-itai disease

One of the causes of Itai-itai disease is the continued consumption of agricultural and marine products that have been contaminated by cadmium. The

[1] *Caixin* Media, 14 February 2011. <http://discovery.163.com/11/ 0214/09/6SRIHSF7000125LI.html>. Big Northwest Network, 10 June 2015. <http://www.dxbei.com/dzjk/jkwq/06101686155.html>.

misery of the cadmium-caused Itai-itai disease, which was once prevalent in the watershed areas of the Jinzu River in Toyama Prefecture and Tsushima in Shimane Prefecture of Japan, is well known in the Chinese academic community.

In recent years, the southern region of China in particular has witnessed an increase in farmers who suffer from similar symptoms to Itai-itai disease. For instance, in 2015, two villages in the Guangxi Autonomous Region (Side Village in Xingping Town, Yangshuo County and Sanhe Village in Daxin County) both had cases of people who experienced similar symptoms.

In Sanhe Village, which is located near a zinc mine, 80% of the 800 farmers living in the village suffer from spinal pain, bone deformation (as pictured below), swollen knees and elbows, needle-like pain in their bones, and mouth pain.[2] It is known that the zinc smelting process produces cadmium as a byproduct, which has been verified by Japan's cadmium pollution episodes. The farmers who have symptoms similar to Itai-itai disease had been scattering cadmium-containing wastewater and waste via agricultural water directly to their farmlands.[3]

In 2009, twenty-six people from Shuangqiao Village in Zhentou Town, Liuyang City, Hunan Province, contracted and died from diseases (such as lung cancer) directly or indirectly caused by cadmium pollution.[4] Due to the fact that this incident was reported on multiple media sites, such as the Southern Metropolis Daily and the Shanghai Metals Market (SMM), a website dedicated to non-ferrous metals for merchants in the heavy metal business, it is considered credible that this occurred. According to these media reports, the results of the soil sample surveys obtained by a specialized research division of Nanjing University showed that the maximum amount of cadmium contained in the soil was 93.8 mg/kg. This value is close to approximately one hundred times the 1 mg/kg of the Level III soil (worst soil environment quality) classified using the Soil Environmental Quality Standard (GB 15618-1995). The cause of this contamination is considered to be the long-term disposal of industrial waste and wastewater from chemical plants producing zinc sulfate.

In Xinma Village in Zhuzhou City, Hunan Province, a mass cadmium poisoning episode broke out in 2006 that shook the entire nation. In this episode, two people died and it was revealed that 150 people had low-level chronic cadmium poisoning. The results of the investigation showed that no contamination was found in drinking water, but the farmland was contaminated by cadmium. This

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2 *China Times*, 19 January 2015. <http://www.chinatimes.com/cn/realtimenews/20150119002025-260409>. (The URL was deleted in late September 2015).

3 Ibid.

4 *Sothern Metropolis Daily,* 12 August 2009. <http://ngzb.gxnews.com.cn/html/2009-08/12/content_273635.htm>. Shanghai Metals Market. <http://news.smm.cn/r/2013-07-31/3467981.html>.

incident exposed that the cadmium pollution in rice greatly exceeded the standard limit.[5]

China saw nineteen incidents of cadmium pollution damage during the ten years between January 2004 and December 2013.[6] Table 1 shows twelve out of the nineteen incidents of cadmium pollution damage. As shown, most of the incidents have occurred in southern China. The reason for this is that rice paddies are spread throughout the southern region and cadmium can be easily absorbed from paddy soil via the rice stalk.

| Location Names | Remarks |
|---|---|
| Tuqiao Village, Zhentou Town, Liuyang City, Changsha, Hunan Province | 2 deaths |
| Shuangqiao Village, Qiaotou Township, Chenxi County, Hunan Province | 26 deaths |
| Hengdong County, You County, Zhuzhou, Hunan Province | |
| Xinma Village, Zhuzhou County, Hunan Province (30 km south of Changsha) | |
| Bailutangzhen, Suxian District, Chenzhou, Hunan Province | |
| Lanxi Town/Longguangqiao Town, Heshan District, Yiyang, Hunan Province | |
| Zhenghe County, Nanping, Fujian Province (5-year survey of six villages) | |
| Side Village, Xingping Town, Yangshuo County, Guangxi Zhuang Autonomous Region | Occurrences of a disease similar to Itai-itai disease in elderly people |
| Changtu District, Daxin County, Chongzuo, Guangxi Zhuang Autonomous Region | Occurrences of a disease similar to Itai-itai disease in elderly people |
| Longjiang District, Liuzhou, Guangxi Zhuang Autonomous Region | |
| Longjiang District, Yizhou, Guangxi Zhuang Autonomous Region | |
| Piaotang District, Dayu County, Ganzhou, Jiangxi Province | |

**Table 1: Main Locations of Cadmium Pollution Damage**
**Source: Information from Chinese newspapers organized by the author.**

Whether these incidents are actual cases of Itai-itai disease caused by cadmium pollution cannot be confirmed except by medical exams and tests performed by

5 <http://discovery.163.com/11/0214/09/6SRIHSF7000125LI.html>.
6 *Legal Weekly,* 25 June 2014. <http://news.china.com/finance/11155042/20140625/18585691.html>.

Japanese specialists with a great deal of experience in the field. Common ways to diagnose Itai-itai disease is to test for signs of renal tubular dysfunction or to take X-rays of bones for abnormalities. It is somewhat dubious that the information above is the result of these tests, which require experienced knowledge.

China's rice-growing regions have been confirmed to have extremely high levels of cadmium in arable land (which will be discussed later); therefore, all conditions for Itai-itai disease to occur have been met and it would not be strange if the disease actually occurred. The abovementioned were examples of cadmium pollution damage episodes obtained from news sources, but there are also a number of surveys carried out by researchers. One example of this is the survey conducted by the Public Health School of Fujian Medical University.[7] The subject of the survey was the population of six natural villages in Zhenghe County, Fujian Province (42,646 people). The survey was conducted between May and September of 2001 and the researchers gathered data by asking the people from the villages the number and causes of deaths by sex and age, going back five years from the survey period. The results showed a total of 237 deaths during the five years prior to the survey period, of which 126 were men and 111 were women.

When the number of deaths are sorted into those that occurred in cadmium-contaminated areas and uncontaminated areas, it is clear that the death rates of infants (under 1 years old) and the four age groups including youths and old age (25-39 years old, 45-49 years old, 55-59 years old, 70-74 years old) living in the cadmium-contaminated areas were significantly higher. For infants and the four age groups in the cadmium-contaminated areas, the data shows that the mortality rates were 61.8% for infants (14.5% in uncontaminated areas), 1.9% for ages 25-29 (1.5% in uncontaminated areas), 4.5% for ages 30-34 (2.0% in uncontaminated areas), 3.3% for ages 35-39 (2.0% in uncontaminated areas), 8.0% for ages 45-49 (6.3% in uncontaminated areas), 9.9% for ages 55-59 (9.4% in uncontaminated areas), and 67.9% for ages 70-74 (62.9% in uncontaminated areas).

The number one cause of death is cancer for all age groups; therefore, this survey concluded that there is a close causal relationship between cadmium pollution and cancer deaths.However, since this survey used people's memories of the past five years as a data source, it is necessary to keep in mind that the analysis is limited.

2) Lead Poisoning and Pollution

In many parts of China in recent years, there has also been an unusual elevation in children's blood lead levels. In particular, there have been high blood lead

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7 Wu Siying, et al. "Analysis on Resident's Spectrum of Disease and Death in Cadmium-Polluted Area." *Chinese Journal of Public Health* 19.1 (2003).

levels in Shaanxi Province, Henan Province, Hunan Province, Fujian Province, Guangdong Province, Sichuan Province, Jiangsu Province, and Shandong Province. The number of major lead poisoning incidents in China over the ten years between January 2004 and December 2013 was forty-four.[8]

China's national standard for blood lead levels are divided into high lead blood disease (100-190 mg/L), mild lead poisoning (200-249 mg/L), moderate lead poisoning (250-449 mg/L), and high level lead poisoning (over 450 mg/L). Fifty-four percent of 23,000 children in Chenzhou City in Hunan Province had blood lead levels that exceeded 100 mg/L and 300 children were close to having lead poisoning.[9] The blood lead levels of five people out of a six person household exceeded the standard limit, and in the case of the spouse of the head of the household, the blood lead level was 549 mg/L, which is an exceptionally high number.[10]

Dapu Town in Hangdong County, Hunan Province discovered that 300 children from the town had blood lead levels of over 486 mg/L from a test result conducted in 2012, which resulted in an outcry.[11] The people from the town consider the cause of high blood lead levels to be the soil pollution caused by the zinc processing plant in the area.

According to the Ministry of Health of Xinyang City in Loushan County, Henan Province, in the village of Tianyan in Nangan Town (population: approximately 40,000), the blood lead levels of 44 children exceeded the national limit. Out of those, 38 children had blood lead levels of 100-199 mg/L, 3 children had blood lead levels of 200-249 mg/L, and the remaining 3 children had blood levels of 250-449 mg/L. In the case of adults, 81 people had blood lead levels of 400-600 mg/L and 15 people had 600 mg/L.[12] The main cause is considered to be the external leakage of wastewater and waste from lead smelting plants, which result in the contamination of farmland and air. In Chaoyang Village in Yiyang County, Jiangxi Province, approximately 30 children had abnormal lead levels in their blood.[13] Out of the 30 children, 12 had blood lead levels of over 100 mg/L. The cause of this abnormality is suspected to be the non-ferrous metal recycling plant and battery processing plant in the area. In this village, 3 children had moderate

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8 *Legal Weekly*, 25 June 2014. <http://news.china.com/finance/11155042/20140625/18585691.html>.

9 Chenzhou blood lead poisoning incident.<http://baike.baidu.com/link? url =xfI-AGL_BalP9mtX4Si7pdOCLCyW938-TtgVb0FONIYgfVPeoSeB6_rQzgoC2G18sVs7zsXz6wF6od6JiDOLj9a>.

10 *Henan Television* (Zhengzhou), 04 December 2014. <http://henan.163.com/14/1204/10/ACK7M6H4022705A5_all.html>.

11 Southern Weekly, 16 June 2014, <http://www.infzm.com/content/101556>.

12 Henan Television (Zhengzhou), 04 December 2014. <http://henan.163.com/14/1204/10/ACK7M6H4022705A5_all.html>.

13 *Southern Weekly*, 21 August 2014. <http://www.infzm.com/content/103425>.

lead poisoning, at least 15 adults had high level lead poisoning, and 81 people had moderate to high level of lead poisoning.

It is thought that the lead poisoning incidents that have frequently occurred in recent years were, such as the aforementioned cadmium poisoning incidents, mainly caused by the contamination of agricultural products through the contamination of the soil.

3) Arsenic Poisoning and Pollution

In September 2014, it was revealed that every year, 700 people in Shimen County in Changde City, Hunan Province are infected with arsenic poisoning, which is thought to lead to cancer. The results of a physical exam conducted on 600 people living in the village in this area also revealed 24 people who already had arsenic poisoning.[14] Seven smelting plants for Asia's largest arsenic mine are located near the village, which is considered to be the culprit.

Over a long period of time, arsenic contaminated the soil and between 1951 and 2013, three thousand people from the areas near the mine suffered from arsenic poisoning. As of 2013, the number of patients who remain with arsenic poisoning is 1,304.[15] The biggest cause is thought to be that the wastewater from the arsenic mine flowed through a flood control facility with insufficient treatment and accumulated in agricultural soil, which led to widespread arsenic poisoning.

Another incident of arsenic poisoning occurred in Dawang Village in Yangxin County, Huangshi City, Hubei Province in November 2013. It resulted in one death and some cases of growth inhibition was recorded. Test results revealed that ten out of ten people had arsenic poisoning and thousands of residents protested daily. The residents think the cause lies in exhaust, wastewater and such from a Gary Metal smelting plant that operates 24 hours.[16] There have also been reports of multiple arsenic poisoning episodes in Guangdong Province and Guizhou Province.[17]

**(2) Types of Heavy Metals in China's Contaminated Farmlands**

One of the causes of food contamination in China is the heavy metal contamination of farmland. Once the agricultural land is contaminated by heavy metals, they are absorbed through roots and stalks of the plants and into the leaves

14 *China Daily*, 24 September 2014. <http://cnews.chinadaily.com.cn/2014-09/24/content_18651252.htm>.

15 Ibid.

16 Bbz.zyw521.com. <http://bbs.zyw521.com/thread-1048998-1-1.html>. Xinhua News Agency, 27 December 2014. <http://news.xinhuanet.com/ttgg/2014-12/27/c_1113798934.html>.

17 *China News Service*, 26 September 2013. <http://www.yuqingol.com/a/dftj/gzhou/2013/0926/11998.html>.

and fruits. If the amount of heavy metals exceeds a certain limit[18] and is absorbed by human bodies via food over a long period, it greatly affects the health of a person.

Each country is free to determine their own limit of exposure for heavy metals; however, in most cases, the limit lacks rigorous scientific underpinnings. Certain amounts of heavy metals exist in the natural world, which are called naturally derived heavy metals. However, it is difficult to scientifically measure the quantity of naturally derived heavy metals. One of the reasons for this is the unclear differentiation between man-made pollution and natural pollution for a particular country or region.[19] It is crucial to be aware of the naturally derived heavy metals. Nonetheless, it would be more important to be conscious of the fact that even if the heavy metals are naturally derived, they are still one of the causes of contamination in agricultural land.

Some argue that heavy metals have a positive effect on human health as if to lessen the severity of heavy metal contamination in agricultural soil; however, this is a dangerous stance to take. If this type of argument becomes extreme, it might lead to a misunderstanding that heavy metals are actually safe.

The issue of heavy metal pollution in agricultural soil has been picked up by specialists in the field and media in China in recent years. The serious health effects that can be inflicted by heavy metal pollution in the agricultural and fishery industries have traveled to China through Japan's experience with mercury and cadmium pollution. Furthermore, China has been much more aggressive, compared to Japan, in developing and mining mineral resources in many parts of the country, which has raised questions among some environmentalists about the degree of severity of agricultural pollution. Another reason for concern among specialists is that China is the largest consumer of chemical fertilizers and pesticides in the world.

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[18] Each country is free to choose the limit of heavy metal exposure for each agricultural product. The standard set by the Codex Alimentarius do not bind other countries. China abides by a national standard as follows: The Environmental Quality Standard for Soils (GB15618-1995) (currently under revision), the Environmental Quality Evaluation Standard for Farmland of Greenhouse Vegetables Production (HT/T333-2006), and the Environmental Quality Evaluation Standard for Farmland of Greenhouse Vegetables Production (HJ/T332-2006). The European Union (EU) has its own standards for heavy metals in food for the member states to follow.

[19] In Japan, the standard for naturally derived heavy metals is as follows: cadmium 1.4 mg/kg, arsenic 39 mg/kg, mercury 1.4 mg/kg, and lead 140 mg/kg. <http://heavymetals-fuyouka.com/nature/>.

## 2. The Actual Status of Agricultural Pollution

As previously mentioned, details on the actual status of China's agricultural pollution is unknown, which is due to the Chinese government's lack of transparency. The "Survey of the State of National Soil Pollution" published in April 2014 by the Ministry of Environmental Protection (MEP) and the Ministry of Land and Resources (MLR) is the only nationwide survey report on heavy metal pollution, but the content is merely an outline.

However, at this point, there is no other option but to rely on this report. The survey was conducted nationwide on agricultural land, forestland, and grassland. Data was gathered on the contamination state of eight types of heavy metals, including cadmium, mercury, arsenic, copper, lead, chromium, zinc, and nickel. The result of this survey revealed that 16.1% of the total soil surveyed exceeded the standard pollution level. The breakdown shows that 11.2% of soil registered minor pollution, 2.3% light pollution, 1.5% moderate pollution, and 1.1% serious pollution. When studied by land pattern, 19.4% of arable land, 10.0% of forestland, and 10.4% of grassland failed to meet the standards of soil environment quality, with the arable land having the worst contamination rate. When considering the types of heavy metal pollution conditions, 7.0% of soil is contaminated by cadmium, 1.6% by mercury, 2.7 % by arsenic, 1.5% by lead, and 0.9% by zinc. The worst pollutant in the soil is cadmium.

The report also includes the general characteristics by region, such as how the southern region has a higher contamination rate than the northern region. In particular, the Yangtze River Delta, the Pearl River Delta, and the Northeast heavy industry area have the worst contamination levels. Southwest China and South Central China also have a widespread heavy metal pollution problem, which shows that the contamination levels of four types of heavy metals (cadmium, mercury, arsenic, and lead) increase from northwest to southeast and from northeast to southwest. This report contains the results of the first nationwide survey and lacks information in many aspects; however, the fact that it shed light on cadmium in soil being the highest pollutant and 19.4% of agricultural soil being contaminated by heavy metals is worth noting. More detailed surveys and publications are desired in the future.

In this section, a few soil sample surveys of various regions conducted by researchers will be considered. First is the survey result of a lead-zinc mining area in Nanjing conducted in 2008, showing the average value of the 44 soil samples collected.[20] Heavy metals that were tested for included cadmium, lead,

[20] Chu Bin-bin, Luo Li-qiang. "Evaluation of Heavy Metal Pollution in Soils from Nanjing Qixiashang Lead-Zinc Mines." Rock and Mineral Analysis 29.1 (2010).

copper, and zinc. The detected levels in the vegetable farms were 3.66 mg/kg of cadmium (standard level: 0.2 mg/kg), 637.15 mg/kg of lead (standard level: 35 mg/kg), 74.48 mg/kg of copper (standard level: 35 mg/kg), and 684.91 mg/kg of zinc (standard level: 100 mg/kg). The area being a mining area is thought to affect the levels of heavy metals preset in soil, nevertheless, extremely high levels of pollutants were detected. In particular, the detected level for cadmium is high due to cadmium being produced as a byproduct in the zinc smelting process.

Another example is the results of a survey from 2014, which studied typical agricultural soil of vegetable farms along the Yangtze River in Nanjing (63 soil samples).[21] There are no mines in this area. The heavy metals that were tested for included cadmium, lead, and zinc, but cadmium will be considered here. The average value of cadmium pollution from this survey was 0.33 mg/kg (standard level: 0.2 mg/kg), while the highest value was 0.58 mg/kg and the lowest value was 0.19 mg/kg. Therefore, the average exceeded the standard level, and in the case of the highest value, it resulted in nearly three times the pollution concentration of the standard level.

The last example is a survey focusing on arsenic.[22] This survey was conducted in Dongguan City, Guangdong Province in 2008, with 118 soil samples. Soil samples were collected from four areas and results show that the western region had the worst contamination. The detected arsenic level for area A (46 soil samples) was 7.54-28.87 mg/kg with an average of 17.26 mg/kg (standard level: 15.0 mg/kg). The detected arsenic level for area B (27 soil samples) was 1.41-21.60 mg/kg with an average of 10.49 mg/kg. The detected level for area C (31 soil samples) was 0.40-28.77 mg/kg with an average of 9.11 mg/kg. Lastly, the detected arsenic level for area D (which is designated as an environmentally protected zone by the municipal government) (14 soil samples) was 5.82-22.67 mg/kg with an average of 12.04 mg/kg.

As shown from these results, even under a fixed land area such as an administrative region, heavy metal pollution levels tend to vary greatly by region. Excluding the naturally derived causes, the cause for this variation is the disparity in economic and social conditions, such as the presence of a mining industry, farmland utilization, and roads.

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21 Dong Lurui, et al. "Nánjīng Yánjiāng Diǎngxíng Yěcài Shēngchǎn Xītǒng Tǔrǎng Zhòngjīnshǔ Yìcháng de Yuán Jiěxī [Sources of Heavy Metals in Soils of a Typical Vegetable Production System along Yangtze River in Nanjing]." Acta Pedologica Sinica (2014).

22 Cai Li-mei, et al. "Dōngguǎn-shì Nóngyè Tǔrǎng hé Yěcài Pīshuāng Hánliàng jí Qí Jiànkāng Fēngxiǎn Fēnxī [Arsenic Concentrations in Vegetables and Soils in Dongguan and Potential Risk to Human Health]." Environmental Science & Technology 33.1 (2010).

## 3. Causes of Heavy Metal Pollution in Agricultural Soil

The abovementioned contamination of arable land in China is caused by various factors. As mentioned, wastewater and waste products from mines are the biggest pollutants. China has an abundance of mineral resources and reserves of these minerals are spread through the entire nation. Depending on the method of mining, cleanup, and processing of wastewater and waste products, major contamination could be ignored. Meanwhile, extensive processing and cleanup require a certain level of technology and cost.

Heavy metal pollution in arable land caused by heavy metals such as cadmium can be due to the excessive use of chemical fertilizers and poor soil maintenance. China is a major agricultural nation, accounting for approximately 25% of the world's grain production every year. As a result, China is also a large consumer of chemical fertilizers, accounting for approximately 40% of the world's consumption of chemical fertilizers. This in turn means that China cannot sustain the production of grains unless it uses this amount of chemical fertilizers. In other words, the chemical fertilizer efficiency is extremely poor. The major ingredients of the large volume of chemical fertilizers are nitrogen, phosphoric acid, and potassium. Among them, phosphorus fertilizer is an ingredient that is likely to turn into cadmium through chemical reaction.[23]

China also uses sewage sludge fertilizer on farmlands. In many cases, sewage sludge contains a large amount of phosphoric acid. This is because sewage sludge fertilizers are made mainly from human waste, which contains a large amount of phosphorus. Under the same principle as the phosphoric acid in the chemical fertilizers, phosphorus in the sewage sludge fertilizers cause cadmium contamination in farmlands.

Cadmium contamination can also spread through wastewater and soil waste produced in the cadmium smelting process and from zinc mines. China has the world's largest cadmium (atomic number 48) reserve of 92,000 tons.[24] The production volume for cadmium in 2012 was approximately 7,000 tons, which is also the largest production volume in the world.[25] Aside from the fact that China is the top nation in the world for cadmium reserves, processes such as zinc smelting and chemical changes of chemical fertilizers contribute to the worsening of China's cadmium pollution.

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[23] Pérez, Angela L., and Kim A. Anderson. "DGT Estimates Cadmium Accumulation in Wheat and Potato from Phosphate Fertilizer Applications." *Science of The Total Environment* 407. (2009): 5096-5103.
[24] Data from 2013 U.S. Geological Survey (USGS).
[25] Same as above.

Furthermore, lead has a wide range of use in batteries, cable coating, and lead tube sheets, and the production of lead has rapidly increased with the development of China's industrial sector. The world's lead production volume in 2014 was 11.29 million tons with China as the number one producer resulting in 5.07 million tons, accounting for 45% of world's production.[26] Similar to cadmium, the wastewater and soil waste produced in the lead smelting process is used as irrigation water, which results in the direct contamination of agricultural land from lead mines.

Another cause of heavy metal contamination in soil is the pollution that occurs in the process of manufacturing industrial products, the deterioration and the processing of facilities, and the elimination of unwanted resources and substances. There have also been many incidents in which old factory sites with contaminated soil are damaged by rain and wind and contaminate rivers and atmosphere, which causes soil contamination.

Industrial waste, household waste, and deposits and spillage from waste treatment facilities are also serious causes of soil contamination. Some industrial waste and household waste is often buried underground; however, after a long period of time, toxic heavy metals that seeped out deep in the ground could affect farmlands via the groundwater.

China's amount of industrial waste in 2013 reached 3.28 billion tons, of which 430 million tons were deposited untreated.[27] It is not known how much toxic heavy metal material is contained in this amount, but the number is certainly high. Air pollution and automobile exhaust also contribute to heavy metal pollution. Particulate matter 2.5 (PM2.5), which has been attracting attention in recent years, is also thought to have a large amount of heavy metal particles mixed in. Exhaust also contains heavy metals, including lead. These contaminated substances fall onto the ground and pollute arable land. Depending on the location, season, and time, the concentration of the elements varies. There is not a huge difference in the elements between China and Japan, but the quantity of each element varies. Since Osaka Prefecture in Japan has been conducting an in-depth survey of the elements, using that as a reference, nearly thirty inorganic elements have been detected. Pollutants of heavy metal pollution in agricultural soil that have been detected include cadmium, arsenic, lead, copper, and zinc.[28]

There are two types of sources of PM2.5: man-induced and naturally occurring. Agricultural soil could fall under either of these causes. In other words, the contamination of agricultural land by PM2.5 could be due to the practice of

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[26] International Lead and Zinc Study Group (ILZSG), 2014.
[27] Ministry of Environmental Protection of the People's Republic of China. *2013 Environmental Statistical Annual Report*.
[28] Osaka Prefecture, "Particulate Matters (PM2.5) Element Analysis Results." 2014.

agriculture itself. China also suffers from heavy metal pollution in agricultural land with the long-term use of contaminated irrigation water. Contaminated water spreads to both surface water and groundwater and leads to the contamination of farmland through irrigation.[29]

## 4. Current State and Challenges against Heavy Metal Pollution

The Chinese government and the related ministries are not idle spectators of the heavy metal pollution described previously. There have been cases in which contamination remediation companies in Japan, which is a leading nation in measures against heavy metal pollution in soil caused by cadmium and mercury, have entered China. Japan-China joint ventures that specialize in contamination remediation are also playing an active role in China. For instance, a Japanese company with a main office in Hokkaido has teamed up with a Chinese company in Taojiang County in Hunan Province for soil improvement work. Another Japanese company with a main office in Ibaraki Prefecture has partnered with a Chinese company in Hubei Province to sell fertilizers effective for soil improvement. Until now, common chemical fertilizers and organic fertilizers did not have any effects that would remediate the contamination of soil.

These soil contamination remediation activities has led to businesses gradually operating independently, which also creates a virtuous cycle that encourages the entry of more remediation businesses and which raises hopes for the future.

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[29] Takahashi, Goro. *Nicchu Shokuhin Osen* [Japan-China Food Contamination]. Bungei Shunju, 2014.


**Photo 1: Model rice paddy for soil remediation in Jiangsu Province.**
**Source: Photographed by the author in August 2015.)**

In the summer of 2015, I had the chance to study a contamination remediation test area of a paddy field contaminated by zinc, cadmium, and mercury produced by a battery manufacturer in a region of Jiangsu Province. The Ministry of Agriculture (MOA) and the local government are working together to remediate the contaminated paddy soil while improving the remediation technology (see photo 1).The size of this test area is approximately five hectares. Different types of rice species were being grown in various sizes of paddy fields in a large flooded area and preparations were being made to test the growth conditions and the rice grains that would eventually be harvested. Heavy metals build up in rice grains from soil through the root and the stalk. Among the various dietary plants, it is common knowledge in plant pathology that rice grains absorb the highest amount of heavy metals. This is the leading cause of frequent episodes of cadmium-contaminated-rice in southern China where rice is the main grain. The paddy fields that have risks of contamination account for an immense area covering Jiangnan.

It is imperative to completely and rapidly remediate the contaminated paddy fields, since they may have these types of risks. Some Chinese people are proactively asking Japan, which has experienced heavy metal pollution in soil and is a leading nation for remediation technology, for further assistance in tackling this issue.

## About the Author

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# Developing Environment and Health Policy in China

*Kenji OTSUKA*

## Abstract

This paper reviews the development of health policy related to environmental pollution in China and discusses tasks for further policy development. In the last decade the Chinese government has more actively responded to environmental health issues. For example, it has established a new office of environmental health monitoring, conducted an epidemiological survey on the relationship between water pollution and cancer mortality in a river basin, and issued an action plan for the environment and human health. People's concerns about health risks from smog, drinking water pollution, heavy-metal contamination in the soil, and food contamination as its consequences have also been increasing due partly to news reports by official media and sensational disclosure by social media. These environmental health risks seem to have finally become important targets for Chinese policy. This paper outlines the possibilities and limitations in tackling these issues through the lens of recent policy developments. In order to secure people's health and well-being under persistent environmental pollution, it is necessary to develop *health-centered* policies as soon as possible.

## Keywords

China's environmental policy, policy development, health risks, environmental pollution, environment and health

## Introduction: Environmental Policy and Health Issues in China

China has enjoyed rapid economic growth for several decades. Simultaneously, China has faced serious environmental pollution with a lack of effective control for many decades, and it seems that China is following the road of "polluting on one hand, while treating it on the other hand," which has resulted in frequent pollution-related accidents and conflicts. Persistent environmental pollution has caused ecological crises in both urban and rural areas and, in the worst cases, caused serious health hazards to local communities.

Environmental policies in China date to the early 1970's, when serious environmental pollution problems began to emerge. Central and local governments responded to conflicts between polluting factories and farmers due to unregulated economic development. Although the view that environmental problems could not occur in socialist states was still dominant in the late period of the Cultural Revolution, official delegates were sent to the UN Conference on the Human Environment in Stockholm in 1972 at the initiative of Premier Zhou Enlei, who was anxious about the seriousness of environmental deterioration in China. This event pushed environmental policy development forward at the First National Conference of Environmental Protection in 1973. The Third Plenum of the Eleventh Central Committee of the Chinese Communist Party (CCP) held in December 1978 was known as an epoch launching the reform and open-door policy that spread environmental policy nationwide. The first official document focusing on the environment issued by the CCP stated, "We should not follow such a winding road as construction first, treatment later," implicating lessons learned from developed countries that had previously faced serious environmental deterioration. At the Second National Conference of Environmental Protection held from December 1983 to January 1984, it was declared that environmental policy, as well as family planning, were basic state policies and that it was essential to harmonize economic development with environmental protection. In 1979, China's Environmental Protection Law was enacted tentatively, and in 1989 released officially, stipulating that "any citizen has the right to supervise, impeach, and accuse organizations and individuals that pollute and destroy the environment," and that "environmental protection agencies could charge polluters for damages." In 1984, the National Environmental Protection Agency (NEPA) was set up under the Ministry of Urban Construction Environment, and in 1988, reformed as an independent administrative organization under direct control of the State Council. Since then, development of environmental laws and administrations has been accelerated.[1]

In the last decade the Chinese government has more actively responded to environmentl health issues. For example, it has established a new office of environmental health monitoring, conducted an epidemiological survey on

[1] Kenji Otsuka, "Environmental Policy under Multi-Stakeholder Governance in China: Focusing on Implementation of Industrial Pollution Control," in Tadayoshi Terao and Kenji Otsuka, eds. *Development of Environmental Policy in Japan and Asian Countries* (Chiba: IDE-JETRO, 2007), 199-226.

the relationship between water pollution and cancer mortality in a river basin, and issued an action plan for the environment and human health. People's concerns about health risks from smog, drinking water pollution, heavy-metal contamination in the soil, and food contamination as its consequences have also been increasing due partly to news reports by official media and sensational disclosure by social media. These environmental health risks seem to have finally become important targets for Chinese policy.

This paper asks how China has responded to health issues caused by environmental pollution in its environmental policy development, and what the possibilities and limitations are in implementing these policies. Starting with the next section, this paper will follow the path of health policy development since the 1970's.

## 1. Responses to Health Problems Caused by Environmental Pollution

Focusing on the field of environment and health,[2] both political and social responses to issues had already spread throughout the country in the early stage of environmental policy development.[3] First, according to the report by the Deputy Director of Ministry of Health at the Second National Conference, environmental monitoring, standard setting, impact assessment, and health studies on environmental pollution had already been launched. Second, cases of severe health hazards caused by environmental pollution, such as heavy-metal poisoning, respiratory diseases, cancer, and death, were sporadically reported in official documents, although no comprehensive science reports could be found. Third, environmental health hazards had already spread from polluters' vicinities to a wider range of the environment, such as with air pollution in the form of smog and water pollution along the river basin. Fourth, people affected by environmental health hazards sometimes protested against industrial polluters by

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[2] In this paper, *environment and health* means the health impacts and risks caused by environmental pollution. See Jennifer Holdaway, "Environment and Health Research in China: The State of the Field," *The China Quarterly*, Vol. 214, 2013: 255-282.

[3] Two anthologies of official documents on China's environmental policy from the 1970's to the early 1980's were issued by the Central Environmental Administrative Organization. The first is of documents issued from 1973 to 1978 (Guojia Huanjing Baohuju Bangongshi, *Huanjing Baohu Wenjian Xuanbian [Selected Collection of Documents on Environmental Protection] 1973-1978* (Beijing: Huanjing Kexue Chubanshe, 1988)). The other is of documents issued at the Second National Conference of Environmental Protection held from the end of 1983 to the beginning of 1984 (Cheng Xiang Jianshe Huanjing Baohubu Huanjing Baohuju, *Zhongguo Huanjing Baohu Shinian [China Environmental Protection, Ten Years] 1973-1983* (Beijing: Huanjing Kexue Chubanshe, 1985).

escaping from heavily polluted workplaces and disputing about pollution. Thus, the serious situation of environmental pollution and its health impacts had already been recognized by state leaders and bureaus, provincial and local governments, enterprises, and scholars in that period. However, nothing targeting health issues directly in this period could be found at the policy level.

## 2. Boosting Top-Down Inspections and Campaigns

As environmental laws and administrative organizations were established, the Chinese government paid more attention to how they could effectively prevent and reduce environmental pollution. In the 1990's, facing growing domestic pressure and international agreements on environmentally sustainable development, such as the UN Conference on Environment and Development (UNCED) held in Rio de Janeiro, China stepped forward to strengthen its environmental policy enforcement. Just several months after UNCED, Secretary General Jiang Zemin of the CCP listed "enhancement of environmental protection" as one of main tasks of the open-door policy, reform, and modernization of China during the 1990's in his report at the Fourteenth National Congress of the CCP.[4] A year later, the National Inspection for Environmental Law Enforcement and the Century Walk for Environmental Protection in China were launched jointly by the State Council Committee on Environmental Protection (SCCEP), managed by NEPA, and the Committee on Environmental Protection in the National People's Congress, which was set up the same year and renamed as the Committee on Environment and Natural Resource Protection (CENRP) in 1994.

The National Inspection for Environmental Law Enforcement was conducted to enable environment and resource protection laws, including Environmental Protection Law, Air Pollution Control Law, and Water Pollution Control Law, to function effectively. The Century Walk for Environmental Protection in China was conducted as a series of environmental protection campaigns to arouse public opinion through national and local newspapers, radio, and TV to help urge problems disclosed by the media to be resolved. These top-down measures succeeded in revealing thousands of violations and misconducts of environmental pollution and destruction and put political and social pressure on

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[4] Zhonggong Zhongyang Wenxian Yanjiushi [Office of Document Research of the CCP], *Shiyijie Sanzhongquanhui Yilaide Lice Quangguo Daibiao Dahui Quanhui Zhongyang Wenjian Xuanbian* [*Collection of Important Documents of the Central General Meeting of Historical National Representative Meetings since the Third General Meeting of the 11th Representatives*, Second Volume], (Beijing: Zhongyang Wenxian Chubanshe, 1997), 183-184.

local governments and polluters.[5] Inspections and campaigns have continued in various ways and at various timings up to the present although cat-and-mouse games between inspectors and polluters often occur.

A case concerning health problems caused by heavy water pollution was revealed when the campaign started. In October 1993, China Central TV (CCTV) reported on heavy-water pollution in two tributaries of the Huai River Basin, where all fish and shellfish were dead from effluent from pulp plants and other industries. The report discussed deaths from cancer and birth defects among residents drinking the well water near the polluted rivers. It was reported that the local and central governments had received appeals from people along the river to resolve the problems. However, they had not taken any effective action. It is noted that the news program mentioned the scientific research results of an epidemiological survey on the death and health of people along one tributary conducted by a team of medical doctors at Henan Medical University. This is considered the first case disclosed nationwide on TV about health damages caused by environmental pollution since the launch of environmental policies in the 1970's. It is said that this disclosure pushed Premier Li Peng to take stricter measures to control water pollution in that river basin.[6]

Being that this incident occurred in the main tributary of the Huai River, nearly 1.5 million residents were forced to obtain an alternative source of clean drinking water, and the central government was pushed to take a series of measures to strengthen water pollution regulations in the basin. In 1995, the State Council issued the Tentative Regulation of Water Pollution Control in the Huai River, and in the following year approved the Ninth Five-Year Plan (1996-2000) of Water Pollution Control in the River Basin. Under this regulation and plan, small chemical pulp plants that used wheat straw as a raw material and had a production capacity of less than 5,000 tons were ordered to be shut down by the end of June 1996, and all manufacturing industries were required to comply with the effluent standard in the river basin by the end of 1997.[7] It is noted that the news media's revealing of serious environmental health hazards was one of the triggers that pushed forward water environmental policy in the river basin. Even though health problems from environmental pollution later became important factors in policy development, it is difficult to find any direct measure of remedies for health damages in official documents. In the case of the Huai River pollution in 1994, investment in a fresh drinking water supply for residents could be found as the

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[5] Kenji Otsuka, *op. cit*.

[6] Zhe Fu, *Zhongguo Dangan[China Documents],first volume(* Beijing: Guangming Ribao Chubanshe), 70-76 .

[7] Kenji Otsuka, *op. cit*..

only expected contributor to their health recovery.[8]

## 3. A Health-Concerned Turn in Inspections and Campaigns

According to statements by CCP leaders, since the 2000's national inspections and campaigns have come to emphasize the importance of people's health and environmental protection. At the Environmental Propaganda Work Meeting held in 2002, Wang Yuqing, Deputy Director of the State Environmental Protection Bureau (SEPA, reformed from NEPA in 1998) remarked about "environmental alarming education" (huajing qingshi jiaoyu), which was raised by Premier Zhu Rongji at the Fifth National Conference of Environmental Protection, and insisted that environmental pollution currently influencing human health should be disclosed.[9] It is said that the concept of environmental alarming education appeared in his remarks for the first time when Premier Zhu visited the Sino-Japan Friendship Center for Environmental Protection in 2001. Therefore, it may have been inspired by Japanese experiences with pollution-related diseases.[10] Also, national inspections conducted jointly by SEPA, State Development and Reform Commission (SDRC), Ministry of Inspection (MoI), State Industry and Commercial Bureau (SICB), Ministry of Justice (MoJ), and State Safety Supervise and Management Bureau (SSSMB) in 2003 focused explicitly on illegal development projects and polluting industrial productions that had threatened people's health.[11]

Resonating the health-concerned turn in leaders' statements, major news media also became more courageous about disclosing local cases of health hazards considered to be caused by heavy environmental pollution. Cancer village was a buzzword spread by media nationwide to arouse people's concern and anxiety about emerging environmental health hazards. Although it is not clear when usage of this term started, one famous cancer village in Guangtong Province appeared in the mining industry newspaper first in 2001. This province was once famous for

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8 Shuilibu Huaihe Shuili Weiyuanhui [Huai River Water Resource Commission of the Ministry of Water Resources], *Zhihuai Huikan (Nianjian)* [*Collection of Documents of the Huai River Control*], 1995, 144-155.

9 Guojia Huanjing Baohu Zongju Bangongting [Secretariat Office of SEPA], *Huangjing Baohu Wenjian Xuanbian* [*Collection of Documents of Environmental Protection, 2002*, First Volume], (Beijing: Zhongguo Huanjing Kexue Chubanshe, 2003), 313.

10 *Zhongguo Huanjing Nianjian* [*China Environment Yearbook, 2002*], (Beijing: Zhongguo Huanjing Nianjian Chubanshe, 2003), 321.

11 Guojia Huanjing Baohu Zongju Bangongting [Secretariat Office of SEPA], *Huangjing Baohu Wenjian Xuanbian* [*Collection of Documents of Environmental Protection, 2003*, Second Volume], (Beijing: Zhongguo Huanjing Kexue Chubanshe, 2004), 494-496.

fish and rice until the cancer rate began to increase due to mining wastewater.[12]

Another cancer village is located in Henan Province at a tributary in the Huai River Basin, where the environmental situation was broadcast by CCTV in 2004. Just before the broadcast, a large-scale water pollution accident re-occurred in the river basin under similar conditions to the accident ten years before. There had been a severe drought upstream of the Sha Yin River that had condensed the industrial and urban effluent pollutants in the river water. A sudden intense rainfall caused the floodgate to be opened, which consequently dumped all the condensed pollutants downstream. The length of the section of polluted water was reported to be 150 kilometers long, resulting in aquaculture economic losses of over 30 million RMB in the Honze Lake in Jiangsu Province downstream from the main Huai River. CCTV was one of the active media outlets focusing on the failure of water pollution control in the Huai River Basin over the previous decade. CCTV aired its documentary program *The River and Villages* focusing on the cancer village on 9 August 2004 just after the accident. The program reported a high death rate from cancer in one village along the river and called for urgent action to remedy the health hazard and to improve water conditions.

## 4. *Environment and Health* Policy Development

After the SARS (Severe Acute Respiratory Syndrome) disaster, President Hu Jintao and Premier Wen Jiabao became more concerned about public health issues. At the National Meeting on Population, Resources, and Environment held in March 2004, President Hu raised the “scientific concept of development” (or interpreted as “scientific outlook on development”) (kexue fazhan guan) as the leading concept in policies on population, resources, and the environment. This outlook included the idea of “putting people before everything” (yiwei ren ben) to emphasize the improvement of human well-being while pursuing economic development.[13]At the Third General Meeting of the Tenth National People’s Congress held in March 2005, Premier Wen also emphasized the importance of

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12 Chen Ajiang et al., eds. ‘*Aizhengcun’ Diaocha* [*Research on ‘Cancer Villages’*], (Beijing: Zhongguo Shehui Kexue Chubanshe, 2013), 5. In the paper, Yu Jialin and Zhang Shiqiu, “Zhongguo Aizhengcun Xianxiang ji Zheshechu de Huanjing Jiankang Xiangguan Wenti Fenxi” [Analysis on the Phenomenon of the Chinese Cancer Village and Its Lighting Issues on Environmental Pollution Related Health], *Zhongguo Huanjing Kexue Xuehui Xueshu Nianhui Lunwenji*, 2009: 880-889, it is mentioned that the phrase *cancer village* appeared in some articles in 1980’s. However, the author could not find these articles through web search engines including Google, Baidu, and Wikipedia (accessed on 11 December 2015).

13 The article was released on 4 April 2004 at Xinhua online, <http://news.xinhuanet.com/english/2004-04/04/content_1400323.htm>

people's livelihood (minsheng) by saying, "We should struggle further in enabling people to drink clean water, breathe fresh air, and enjoy a better work and living environment."[14]

Responding to the disclosure of cancer villages and other health issues through environmental campaigns, it is said that Premier Wen Jiabao asked the Ministry of Health (MoH), SEPA, Ministry of Water Resources (MWR), SDRC, and the riparian provinces to investigate local sites in 2004, and the State Council dispatched a research team organized by the Ministry of Health's China Center for Disease Control (CCDC) to three counties in the Huai River Basin, including two counties in the upper and middle stream where news media had reported cancer villages with heavy water pollution. By researching 30 years of population statistics and conducting site visits with each family in the targeted area, it was found that the two counties previously reported as having low cancer death rates actually had high cancer death rates as water pollution became heavier. This was the first epidemiological survey on the relationship between water pollution and cancer mortality in that river basin conducted by the governmental initiative. However, the survey results had not yet been made public when the team leader revealed the main findings in an interview with Zaijing.net in 2010.[15]

Through another research project funded by the Ministry of Science and Technology (MST) in June 2013, the CCDC research team along with the China Academy of Science Institute of Geography and Resource Science published a digital atlas of mortality from cancer of the digestive system from water pollution in the Huai River Basin.[16] A few months before this publication, the Ministry of Environment Protection (MEP, reformed from SEPA in 2008) finally admitted in an official document that cancer villages exist due to heavy water pollution.[17]

In 2005 organizational reform enabled China to incorporate human health as part of its environmental policy focus, and SEPA established the Environment and Health Monitoring Section under the Department of Science and Standards. It is worth noting that this reform happened just one year after the epidemiological survey led by CCDC in the Huai River Basin mentioned above. In 2007 the first national action plan focusing on the environment and health was published with

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[14] The article was released on 7 March 2005 at MEP, <http://gjs.mep.gov.cn/gjzzhz/200503/t20050307_64918.htm>

[15] *Zhongguo Weisheng Nianjian* [*China Health Yearbook*], 2006: 181-182. The article in the *Zaijing Wang* was released on 27 December 2010, and the author's interview with the former Deputy Director of the CCDC was in January 2013.

[16] Yang Gonghuan and Zhuang Dafang, eds. *Huaihe Liuyu Shuihuanjing yu Xiaohuadao Zhongliu Siwang Tuji* [*Atlas of the Water Environment and Digestive Tract Cancer Mortality in the Huai River Basin*], (Beijing: Zhongguo Ditu Chubanshe, 2013).

[17] "Huanjing Baouhubu Wenjian" [Document of MEP], No. 20, released on 7 February 2013.

a target year set at 2015. This action plan was drawn up by MoH, SEPA, NDRC, MST, Ministry of Finance (MoF), Ministry of National Land and Resources (MNLR), Ministry of Construction (MoC), MWR, Ministry of Agriculture (MoA), Ministry of Commerce (MoC), the State Radio, Cinema and TV Agency (SRCTA), State Statistics Bureau (SSB), State Safety Inspection and Management Agency (SSIM), the Law Office of State Council (LOSC), State Weather Bureau (SWB), and State Chinese Medicine Agency (SCMA). The major strategies in this plan are stipulated as writing laws and developing management systems, building a monitoring network, forecasting risks and developing emergency measures to sudden events, building information-sharing and support systems, and enhancing propaganda and inner- and international exchange of related knowledge. In order to secure these strategies, the action plan requires the prioritization of a health agenda, building of an administrative organization, and institutionalization of an administrative coordination mechanism. As seen in Table 1, the Administration on the Environment and Health is expected to be led by MoH and SEPA (now reformed as MEP), and a variety of fields are to be managed by other organizations.

| **Administrative Organization** | **Roles** |
|---|---|
| *Ministry of Health (MoH)* | Lead state environment and health administration; Organize and coordinate state environment and health administration, institution of related laws and standards, environment and health monitoring, information management, risk evaluation and emergency responses to sudden public incidents. |
| *State Environmental Protection Agency (SEPA)* | |
| *State Development and Reform Commission (SDRC)* | Institution building for macro-management and policy coordination of balanced development of environment and health. |
| *Ministry of Education(MoE)* | Program on knowledge related to environment and health and its incorporation in professional education; Development of propaganda and education on environment and health. |
| *Ministry of Science and Technology (MST)* | Incorporate state science and technology projects into state science and technology plans and programs. |
| *Ministry of Finance (MoF)* | Arrange funds for environment and health administration, enhancement of its management, and inspection. |
| *Ministry of National Land and Resources (MNLR),* | Geological environment protection, monitoring and inspection of underground water pollution and over-extraction. |

| | |
|---|---|
| *Ministry of Construction (MoC)* | Urban and rural planning for environment and health development, protection of urban water supply, inspection and management of urban environment sanitation, enhancement of instruction and inspection for urban wastewater treatment. |
| *Ministry of Transportation (MoT)* | Development planning of transportation to promote environmental and health protection and policymaking. |
| *Ministry of Water Resources (MWR)* | Develop water resource protection plan; Demarcate water functional areas; Wastewater effluent control in drinking water source areas; Integrate water resource management, monitoring, and inspection; review water course environmental capacity; Submit opinions on total control of wastewater effluent. |
| *Ministry of Agriculture (MoA)* | Monitor agricultural environment and biosafety. |
| *Ministry of Commerce (MoC)* | Trade development plan and policy on environment and health development. |
| *State Radio, Cinema, and TV Agency (SRCTA)* | Propaganda administration of radio and TV on the environment and health. |
| *State Statistics Bureau (SSB)* | Build database and information-sharing platform. |
| *State Safety Inspection and Management Agency (SSIMA)* | Develop and implement plan on environment and health protection. |
| *Law Office of State Council (LOSC)* | Conduct study on laws related to issues of environment and health through cooperation with related departments. |
| State Weather Bureau (SWB) | Weather monitoring and forecast; Joint prevention of severe weather disasters; Forecast air quality; Organize weather-related studies and submit related materials. |
| State Chinese Medicines Agency (SCMA) | Conduct applied studies on Chinese medicine in the field of environment and health. |

**Table 1. The Role of China's Administrative Organizations on Environment and Health**
**Source: Compiled by the author from the State Action Plan on Environment and Health (2007-2015).**

In 2011, the State Environmental Protection Twelfth Five-Year Plan on Environmental and Health Administration was issued. This is the first five-year plan on environmental and health administration developed by MEP. In this plan, MEP admits: "Intensive environmental problems that appeared in developed countries after ten decades have emerged in only three decades; Health problems have occurred frequently in recent years, including 56 cases and 19 collective incidents caused by environmental pollution within the period of the Eleventh Five-Year Plan." MEP also characterizes environment and health issues in China as follows: "There is serious complex pollution, a wide-range of pollution, and large exposure to the population; Exposure time to pollution is long and the pollution level is high; It is difficult to eliminate health problems caused by protracted accumulation of pollution in the near future; There is a clear distinction in the type of issues affecting urban areas, which mainly suffer from air pollution, and rural areas, which mainly suffer from water pollution; There are increasing human health risks caused by environmental pollution due to industrialization and urbanization in addition to unresolved issues due to a lack of basic sanitary accommodations (toilets, etc.).” MEP also points out that basic data on the environment and health survey, laws, standards, effective management systems, and the basic capacity of the administration on environment and health are lacking.

The *Twelfth Five-Year Plan* raises five fields of focus: investigation, risk management, scientific study, capacity building, and propaganda and education. Three mechanisms for effectively securing these fields are raised, including the enhancement of organization and leadership, coordination, and increased funding. It is noticed that this five-year plan covers a full range of environment and health issues. Also, before the launch of this five-year plan, the China Council for International Cooperation on Environment and Development (CCICED) submitted its research report, Environment and Health Management System and Policy Framework to push the Chinese government to build a new framework to combat the severe situation, citing experiences and lessons learned from developed countries like Japan. However, it seems that the top priority in the five-year plan is still on investigation, which receives over 70 percent of the total budget (about 1,850,000,000 RMB of the total 2,532,000,000 RMB).

As the policy framework for dealing with the health impacts and risks of environmental pollution has developed, some actions have come into practice to protect people’s health. Emergency response to heavy smog in cities is such a case. Beijing is one of worst cities in terms of smog occurrence with particulate matter (PM) 2.5 in recent years, which indicates the amount of micro-particles mixed with a variety of pollutants that easily absorb into the alveoli of the lung. The particulate matter included in PM 2.5 in outdoor air pollution is recognized to be a major cause of cancer according to a literature survey by the International Agency for Research on Cancer of the World Health Organization (IARC-WHO).[18] For example, from 7 to 10 December 2015, when COP 21 of the UN Framework Convention on Climate Change was being held in Paris, the Beijing Municipal Government had to declare “red alert” under persistent heavy smog with a “very unhealthy” reading from the Air Quality Index. This was the first ever red alert since the four-tiered (red, orange, yellow, and blue) alarm system was introduced temporarily in 2013 and officially in 2015. Under this alert, a series of strict

[18] Press release on 17 October 2013.

measures to mitigate air pollution and human health risks are taken, such as banning half the cars running in the city, ordering factories to close, and allowing schools and offices to close.[19] This action was based on the Beijing Heavy Air Pollution Emergency Plan released on 16 March 2015 by the Beijing Municipal Government.[20]

## 5. Further Development of *Environment and Health* Policy

China has come to focus more and more on people's health and risks under persistent environmental pollution. However, much work still needs to be done in this area. First, although investigations of local sites and studies in the field have come into practice under the Eleventh Five-Year Plan, disease from environmental pollution is considered too sensitive a topic for the party and government, who fear the rise of "social unrest" and the increasing number of protests. Journalists, NGOs, and even scientists seem reluctant to tackle this issue directly. Indeed, the results of investigations and studies have been disclosed only partly, and whether results should be open to the public depends wholly on the party and government.[21] As the five-year plan of the environment and health administration admits that scientific studies have not contributed to actual policy development, it is inevitable that an information-sharing system will be built to close the gaps between research and policy and between policy and society.

Second, although further reductions of pollutants are required by new state action plans on air and water pollution control issued in 2013 and 2015, it is unclear how health impacts and risks will be reduced by implementing these action plans. The need to introduce evidence-based policy in the environment and health field has become recognized widely by experts in both government and academic institutions,[22] so many mutually cooperative possibilities exist for

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[19] BBC News China article released on 8 December 2015, <http://www.bbc.com/news/world-asia-china-35026363>
Posted the same day at ChinaDialogue.net, <https://www.chinadialogue.net/blog/8419-Beijing-issues-first-ever-red-alert-on-smog/en>

[20] <http://zhengwu.beijing.gov.cn/yjgl/yjya/t1384974.htm>

[21] Information disclosure of original data of pollution-related diseases (*gonghaibing*) is discretionary to the government due to 2004 revisions of Regulations of State Secrecy concerning the Environmental Protection Work. See Guojia Huanjing Baohu Zongju Bangongting [Administrative Office of SEPA], *Huanjing Baohu Wenjian Xuanbian* [*Collection of Documents of Environmental Protection*], (Beijing: Zhongguo Huanjing Kexue Chubanshe, 2005), 299.

[22] There were more than a few voices calling for evidence-based policy at the International Senior Health Policy Seminar on China and the Global Burden of Diseases held on 15-16 April 2013 in Beijing, which was hosted jointly by the Peking Union Medical College (PUMC) and the China Medical Board.

reforming and crafting the policymaking system toward one that is evidence-based. It is also noted that *evidence* can be found not only in the laboratory but also in the field at local sites. In this sense, it is necessary to promote collaboration between academic scientists and grass-rooted practitioners including local NGOs and residents. In the case of the epidemiological survey on cancer mortality with water pollution in the Huai River Basin, the CCDC consulted with a local NGO on how to effectively conduct a survey in the area. This NGO had much social and ecological knowledge on cancer villages due to its continuous observations and practices.[23]

Third, in terms of the policymaking framework, it will be necessary to turn from *health-concerned* policies to *health-centered* policies to secure human health and well-being. China developed a concept for dealing with the contradictory relationship between economic development and environmental protection as a slogan at the Second National Conference: unification of economic interests, social interests, and environmental interests（jingji xiaoyi, shehui xiaoyi, he huanjing xiaoyi de tongyi）. Through Japan's experience of *kogai* (environmental disruption) in the era of rapid economic growth from the 1950's to the early 1970's, it transformed its development strategy in the 1970's from balancing the coordination of economic development and environmental conservation to prioritizing people's health and life while pursuing economic development when victims and their supporters won lawsuits against polluters.[24] However, the dichotomy of development and the environment has been maintained in China as the concept of *coordinated development* even in the revised Environmental Protection Law of 2014. Based on Japan's experience with *kogai*, human health consequences could only be prevented with health-centered or health-first policies. It should be noted that the three key interests were also written as "multi-wins between environmental, economic, and social effects and interests" (huanjing xiaoyi, jingji xiaoyi yu shehui xiaoyi duoying) in the State Action Plans on Air and Water Pollution in 2013 and 2015. It should be examined how this wording change could reflect a *turn* in environment and health policy in terms of securing human health and improving the natural environment in China.

Finally, it is also urgent to determine how to tackle the accumulation of unresolved problems resulting from persistent environmental pollution. According to experiences and lessons learned in developed countries like Japan, it would require huge economic and social costs to recover polluted water and land and to remedy the illnesses and diseases of people who have been exposed to heavy

23 Interviews with the former leader of the CCDC team in January 2013.

24 Ken'ichi Miyamoto, *Sengo Nihon Kogaishiron* [*History of Environmental Pollution in Post War Japan*], (Tokyo: Iwanami Shoten, 2014). See also the discussion in Shigeto Tsuru, *The Political Economy of the Environment* (London: the Athlone Press, 1999), 24-26.

pollution for long periods of time. Increasing numbers of disputes and lawsuits related to such problems also cannot be avoided. The situation will take a long time to resolve unless the government and polluters face the facts and evidence that victims raise as in the tragedy of Minamata disease in Japan.[25]

## Conclusion

Japan's experience with *kogai* is often referred to as "pollute first, clean up later." The CCP pointed out in its first official document focusing on environmental policy, "We should not follow such a winding road as construction first, treatment later," implicating lessons to be learned from developed countries that have faced serious environmental deterioration. Jun Ui, who was the leader of environmental pollution research in Japan, pointed out that rapid economic growth in Japan had been realized due to *kogai* rather than accompanied by *kogai*.[26] This means that rapid economic growth could only be realized by sacrificing the ecological environment and human health. It seems that China has followed the same road of Japan.

China has stepped forward to focus on the environment and health in the last decade, and agendas to be addressed in this field have already been written in its action plan and five-year plan. Some actions, including emergency responses to persistent heavy smog in cities, have come into practice. The five-year plan admits that the environmental and health problems accumulated so far cannot be resolved soon and that there will be an increasing human health risk caused by current environmental pollution. Much work is to be done to accomplish a *health-centered turn* in environmental policy.

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[25] Masazumi Harada. Translated by Sachie Tsushima and Timothy S. George. *Minamata Disease* (Minamata: Minamata disease Patients Alliance and Kumamoto Nichinichi Shinbun Culture & Information Center, 2004); Social Scientific Study Group on Minamata Disease, *In the Hope of Avoiding Repetition of the Tragedy of Minamata Disease: What We Have Learned from the Experience* (National Institute for Minamata Disease, 2001), < http://www.nimd.go.jp/syakai/webversion/SSSGMDreport.html>; Takashi Yorifuji, Toshihide Tsuda and Masazumi Harada. "Minamata disease: a challenge for democracy and justice." In European Environment Agency, "Late lessons from early warnings: science, precaution, innovation" (2013), <http://www.eea.europa.eu/publications/late-lessons-2/late-lessons-chapters/late-lessons-ii-chapter-5>.

[26] Jun Ui, *Watashi no Kogai Toso* [*My Battle against Environmental Pollution*], (Tokyo: Ushio Shuppanshe, 1971). See also Jun Ui eds., *Industrial Pollution in Japan* (Tokyo: United Nations University Press, 1992), for a historical perspective of Japanese experiences and lessons.

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# Financially Stricken China's Environment and Energy Problems: A Comparison of Japan and China

*Masaharu OSAWA*

## Abstract

China has now emerged into the world's largest consumer of energy that might account for a quarter of the world's carbon dioxide emissions. As a result, it tugs on the global energy market and may draw out vast results from introducing energy. In order to solve the various energy problems, it is important above all things for China to maintain good relations in common with the other countries of the world diplomatically, economically and socially. It may be said that the stability of international relations and characteristic openness of using energy domestically is the first step to solving energy problems. In fact, there are many places that are not sufficiently maintained in the global energy market. In order to maintain such, should the world not be expecting China to pour out its power? This issue goes beyond Japan and China, but the whole world needs to deal with.

## Keywords

Energy balance, utilization of coal resources, fairness and nationality in the world energy market, "contributor" and "oppressor" in the world energy market, the stability of international relations

## Introduction

If somehow the earth were to turn into an Arctic winter and lose its light, we would certainly search for electric energy for light so that all mankind, plants and animals could live. As we would need electricity not only at night, but during the daytime as well, we would have to produce more than twice electricity as we have up to now from energy sources. One must realize that the difficulty of our current energy problems would double.

Returning to reality, the illumination from light during the daytime is covered by the benefits of energy from the sun above, more than what is needed from electricity for mankind, plants and animals. We fully receive the benefits of solar energy in heating and electricity, beyond that of illumination from using energy. No matter how difficult it is living somewhere too hot or too cold, it would be even more difficult to live if mankind, plants and animals lost the heat from the sun. Along with energy, the water required to live is a gift from the sun.

Economists consider the basic energy problem to be the distribution of resources, but the issue of distributing resources related to commercial energy, a part of the energy we use, is applicable, and we also use non-commercial energy that cannot be distributed, as public goods. I would lie to state that increasing our field of vision in this way is important and healthy in considering the energy problem.

It is often said that we could not live without energy, and we worry that fossil energy sources are limited and that they will disappear in the future. However, the reality is that we have still not yet acquired the technology to smoothly and environmentally manage enormous amounts of energy, such as that from solar energy. This is the reason the author think that more composure is necessary when facing the energy problem. At this point I would like to consider the environmental problems in China. That is to say, China's environmental problems and energy problems are in a situation close to these two being almost synonymous. After all, we cannot consider the environmental problems without the energy problems in these times.

## 1. What We Can Learn by Comparing the Environment and Energy in both Japan and China

| Factor | Unit | China | Japan | Year of Data Source | Data Source |
|---|---|---|---|---|---|
| Land area | 10,000km | 956 (25.2) | 38 (1) | 2013 | World Bank, World Development Indicators Online 2015.3 |
| Popula-tion | 1,000,000 persons | 136 (10.5) | 13 (1) | " | " |
| Energy consump-tion | Oil equivalent in millions of tons | 1814.06 (5.8) | 311.41 (1) | 2013 | Energy Balances (OECD) |
| Carbon dioxide emissions | $CO_2$ equivalent in millions of tons | 9067 (7.4) | 1220 (1) | 2012 | *Handbook of Japan's & World Energy & Economic Statics* (The Institute of Energy Economics, Japan) |

**Table 1: Comparison of Scales between Japan and China, ( ): Index for comparison**

China uses approximately 5.8 times as much energy as Japan does now. How should this difference in energy consumption scales be evaluated? Economists focus on the rise in energy consumption and its relation to the growth of the economic scale, but we should not forget the relationships to population and land area. Naturally, if you have more people moving around a larger land area, the transportation facilities used to move things is going to use a lot of energy, and those people will consume larger quantities of energy for living in the form of food, clothing and shelter.

The difference in energy consumption has not yet been clarified as has the difference in scales of population and land area of both countries. Not to mention, taking into consideration the differences in growth periods, that is, compared to China's continuing economic development, Japan's economy seems to have reached its top, it is thought that the difference in energy consumption scales between the two countries is certain to continue widening at a frightening pace.

Normally (and in this manuscript as well), I rely on data like that shown in Table 1 (and data that will be explained in this article later) when speaking of energy consumption. In other words, I consider only commercial energy as value and economic goods, without including non-commercial energy, as the public goods mentioned above are used freely, such as solar heat and solar light. If we take for granted that the basics are to restrict commercial energy to only these kinds of economic goods, the point of view of that energy consumption scales exert an influence on the distribution of limited world energy resources (particularly, fossil fuel energy resources) is important.

China's energy consumption scales now have exceeded those of the USA, and the country that consumes the most energy in the world on a per country basis is China. Currently, China's energy consumption is on a scale in line with the total of every country in Europe (including Russia). This point is directly connected to environmental problems as is. Therefore countries all around the world pay attention to China, the world's largest consumer of energy.

Furthermore, another issue that should be noticed here is that however big a country China is, the ratio of its economy in the world (see "Real GDP" in Table 2) is smaller than its ratio of energy consumption in the world (see "Primary energy consumption" in Table 2). If primary energy consumption and the economy continue to grow at this pace, instead of being seen as a "contributor" to the development of the world economy, it will be seen as a "oppressor" against the world's environmental conservation and resource distribution.

| Item / Country | Primary energy consumption ($CO_2$ equivalent in millions of tons) | | Population (in millions of people) | | Real GDP (Value in 2010 US dollars: billions of dollars) | |
|---|---|---|---|---|---|---|
| | 1973 | 2012 | 1973 | 2012 | 1973 | 2012 |
| China | 427 [100] | 2894 [678] <22%> | 882 [100] | 1351 [153] <19%> | 220 [100] | 6978 [3172] <10%> |
| Japan | 320 [100] | 452 [141] <13%> | 108 [100] | 128 [119] <2%> | 2293 [100] | 5550 [242] <8%> |
| USA | 1730 [100] | 2141 [124] <16%> | 212 [100] | 314 [148] <4%> | 5484 [100] | 15658 [286] <23%> |
| All areas of Europe (including the former Soviet Union, Russia) | 2318 [100] | 2939 [127] <22%> | 757 [100] | 895 [118] <13%> | 9286 [100] | 20644 [222] <30%> |
| The world | 6106 [100] | 13371 [219] | 3913 [100] | 7033 [180] | 21830 [100] | 68244 [313] |

[ ]: Using 1973 as an index of 100
< >: Ratio of the world's (2012)

**Table 2: Changes in Energy Consumption Scales**
**Source: Handbook of Japan's & World Energy & Economic Statics. The Institute of Energy Economics, Japan, 2012.**

## 2. Income Gap Corrections, Environmental Conservation and Security

China is a major power in the world. However, it is for this reason that the risk is so large of losing its impulsive force as a country if it takes excessive energy saving policies in order to deny it is an "oppressor" in the world's energy distribution as a major consumer of energy. Therefore, it is thought that while it is an "oppressor" on one side, it shows the world that it has the face of a "contributor," or in other words, it is on a path where "neutralization policies" are desirable.

It is hoped that consuming energy and increasing results will raise its degree of contribution to the world. That would also lead to a reduction in environmental problems. Figure 1 shows the influence energy consumption has on a nation, its economy, and the environment. We can infer the degree of contribution from this influence.

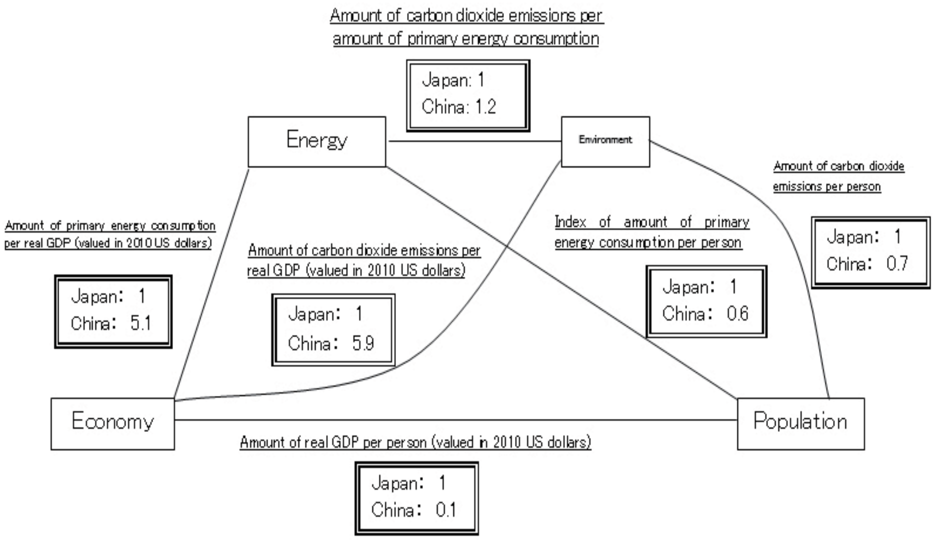


**Figure 1: Reciprocity of Energy, the Economy and Population**
**Source: Author's calculations from data in "Handbook of Japan's & World Energy & Economic Statics" 2012**

For example, let's look at the relationship between energy and the environment. I will focus on the amount of carbon dioxide emissions, considered to be a cause of global warming, as an index of the environment. As China's energy consumption per the Environment are greater than those of Japan. If Japan's environmental measures and the relationship of between consuming and utilizing energy, as well as the organization of energy consumption, is adopted, carbon dioxide emissions can be reduced while consuming the same amount of energy in China. This can contribute to measures against global warming around the world.

To this end, it can be pointed out that the compatibility of energy policies and environmental measures must be focused on in China. Energy consumption per real GDP indicating the relationship between energy and economics is an index that shows how much energy is being injected and consumed for a single economic unit. It is a reality that if China does not infuse energy five times than Japan, it could not obtain the same economic results.

In order to improve this situation, it is necessary to focus on entering the process from injecting energy to obtaining results and improving energy productivity (improving energy efficiency). If the process from injecting to consuming energy is reviewed, an even larger economic contribution can be made for the world with the same amount of energy consumption. Improvements in energy productivity should not simply be reviewed as energy injection, but by realizing improvements in actions by the people who utilize energy, and by improving technology as a society.

In the case of China, we can see from Figure 1 that the economy that can be enjoyed by the nation from the relationship between the economy and the people is not even one-tenth that of Japan. We can consider it important to arrange for a societal rise and societal stability in China premised on obtaining a sustainable economic development.

Kuznets argues that when the economy develops, inequality in society increases, but that once development reaches a certain stage, inequality decreases. Looking at China's Gini coefficient, there is still a serious issue of an income gap between agricultural villages and cities in China. The effects of policies to correct the income gap in China plan for the stability of society, and it can be surmised that effects linked with improved energy efficiency are high.

In order for China to increase its contribution of economic results to the world with the same energy consumption, it is important for the social policies of domestic China to use technology which is highly energy efficient. As for worldwide energy problems, the coexistence of environmental measures and social measures entering the domestic process in China is the key. In addition, expectations for China contributing to the world, is a contribution to ensuring safety around the world.

The utilization of energy by people requires technology that controls the enormous energy in energy resources. In China, proud to be the world's largest energy consumer, the stability of such technology is what the world expects most, and the indisputable realization itself of such is a "contribution" to the world.

Such indisputable realization depends on whether a process for utilizing any supplied energy is made and controlled. Therefore, the presentation of preventative measures through inspection of China's energy utilization and those results is important. In particular, as the dependency on nuclear energy as an energy supply, bringing peace of mind to the world, is the path to becoming a "good oppressor" in the world's energy distribution, through reliable contributions to securing safety through nuclear nonproliferation policies common around the world.

## 3. Comparing the Energy Balance of Japan and China

Table 3 and 4 show the structure of supply and demand of energy in Japan and China in the fiscal year of 2013 concluded by Organization for Economic Co-operation and Development (OECD). The real situation of what kind of energy is being used, and for what purpose, can be learned.

A breakdown of the types of energy can be read horizontally, while those of the procurement of energy resources, the state of energy processing, and energy consumption can be seen vertically. In fact, attention is required because energy resources and the forms of energy processed for consumers from resources are equal in the same line within types of energy. [1] In addition, (+) in this table represents energy that can be used by that country, and (-) represents energy that cannot be used by that country.

Energy is requisite for the economy and for daily life. Energy resources for this demand are arranged, and energy processed for easy consumption is drawn out and consumed. As for the supply and demand of energy, rather than thinking supply derives from demand, we should basically consider that supply adapts to demand. That being said let us compare energy demands in China and Japan from Table 3 and 4, paying special attention to energy consumption (TFC).

When looking at the ratio of energy consumed in the form of electricity, or in other words, the rate of electricity at the base of demand (electricity / TFC total), it was 21% for China and 26% for Japan in 2013. We should consider that as there is a tendency for the ratio of electricity to generally develop the economy and increase, the increase in scale of energy supply and demand in China has a special meaning for the expansion of electricity consumption. It is said that the power of electric energy processed from energy resources, namely, electricity, is inefficient at the point called effective utilization (energy efficiency) of resources. Therefore, whether the current conditions (2013) in which there is a difference in energy efficiency on a country basis (TFC/TPES) of 60% for China and 68% for Japan will expand or not is a problem to be focused on for important energy policies that have a large influence on the efficient use of energy and energy resource distribution on a worldwide level.

Next, comparing China and Japan concerning the breakdown of energy consumption, 50% in China is for the industrial sector (approximately 70% of consumed electricity is for the industrial sector). By contrast, that same

[1] "Oil products," "electricity" and "heat" are processed energy. One can learn which resources they are processed from, from the date between TPES and TFC data.

50% is used in the consumer sector such as household and public business use (approximately 70% of electricity is for the consumer sector) in Japan. It is thought that the energy demands in the consumer sector in Future China definitely will contribute to an increase in energy demands from tendencies for flexibility in general economic development and increases in energy demands. Increases from the transportation sector due to the wide area of the country are also suggested. In confirming this, the selection of highly energy efficient transportation and saving energy in the industrial sector are expected as measures to mitigate the energy problem in Future China.

Incidentally, the demand for consuming energy is up to each country itself, but what should be focused on is where it is processed. Energy resources are drawn to the energy demands within the country, and it is easy to imagine cases for processing within the country. However, one can also imagine cases of processing overseas and importing the processed energy, as well exporting energy processed within the country for overseas energy demand.

You should understand the ratio of self-sufficiency in energy while considering such various cases. Among energy supply, the ratio of domestic production[2] in China is a little under 90%, while in Japan it is a little under 10%. However, it is not desirable to consider this to be the ratio of energy self-sufficiency and jump to conclusions on the energy problem.

Even if you take on the concept of self-sufficiency ratio in energy in this way, you should not think that the self-sufficiency ratio in energy lends a decisive restriction to that country's energy problem. It is a concept that you should give flexible interpretations concerning the self-sufficiency ratio in energy through how to go about global energy trading and how to fix a value on energy, a topic we will come to later. Rather, I would like to consider that energy measures cover a myth of the self-sufficiency ratio in energy. In China, which is thought to be abundant in coal and oil resources, these domestically produced resources, along with imported resources, are utilized.

In addition, we see from these charts that oil products (such as heavy oil and gasoline), which are products processed from crude oil in domestic refineries, are consumed domestically and traded for export on the international market. We can also learn from Table 4 the fact that even in Japan where most energy is imported, oil processed at domestic refineries is exported. Even though there are facilities for processing energy such as refineries within the country, it is more effective to import than to increase their rate of operation. Depending on the functions of the energy market and energy measures, the procurement of energy resources and

[2] As it is possible for nuclear power to reuse spent nuclear fuel domestically, Energy Balance classifies it as energy that can be produced domestically.

processed energy changes, and this has an influence on the ratio of self-sufficiency in energy.

One should not simply be led to the conclusion that because coal resources are abundant in China, dependence on coal as an energy supply is high at about 70%. At present, coal supplies in China include imported portions, and this should be thought of as a result of energy markets and measures in China.

From Table 4 we can read about Japan's energy supply after the Great East Japan Earthquake in 2011. Although the rate of operation of nuclear power plants is extremely low, we can see that stability of overall energy consumption in Japan is being obtained. However, from Table 4 we learn that dependence on fossil fuel energy resources exceeds 90% of energy supply in Japan, and it can be surmised that energy measures will be intensified as a measure against global warming.

Current conditions in China are that they are slightly less dependent on fossil fuel energy resources than Japan. However, considering that the global warming problem from $CO_2$ emissions is an environmental problem on a global scale, it can be said that China, which has the biggest absolute volume of burning fossil fuel energy resources, is being pressured for measures against global warming. From Japan's perspective, while currently not operating nuclear power plants, we cannot think it is fine for our country to simply put a focus on environmental problems in the issue of global warming, but call for an energy policy that meets the needs for support in China's measures against global warming and at the same time recognizes this as a serious issue.

Next, concerning the distribution ratio to introduce supply of energy resources, it is easy to say that one should lower the ratio of fossil fuel energy resources as a measure against global warming, but it is important to think about how it can actually be carried out. It costs both time and money to maintain energy supply facilities. The ratio of energy supply cannot be changed instantaneously.

In addition, as the classifications of energy required from characteristics of the basic process for industrial production and energy usage are inherent, it is not at all easy to change the classification of energy received from supply. Electricity alone can have its energy resources chosen for it, but it is necessary to either refit the power stations that use the required energy resources, or to put in place measures to change the fuel.

Even considering this restriction, we cannot but focus on switching fuels for electricity in order to change the ratio of energy resources. The ratio of resources introduced for electricity generation has compliance restrictions to changes in the electricity load, and is a result of the power extended on the economy and energy policies based on the wholesale market of electricity generation. Whereas in Japan, even if the rate of operation of nuclear power decreases, we aim for the best mix of energy resources used for generating electricity to maintain a balance, China will lean towards coal. It may be said that the major topics of energy production in China will be considering the future ratio for introducing energy resources for generating electricity, and in particular, considering the position of coal fired power generation. It may also be said that topics deserving attention are energy policies for the ratio of resources introduced for electricity generation considering a balance between the situation of China's energy resource reserves and measures against global warming.

What we need to be careful of here is to aim for the best mix of lowering the ratio of using coal for generating electricity and not to come to simple conclusions. It is necessary to consider the circumstances of importing coal despite China having an abundance, the collection of fixed costs for investing in power stations (and avoided costs that cannot be collected), trends in fuel costs in the energy market, and the introduction of technology to reduce the load on the environment that coal brings.

An important thing is to add viewpoints on global energy resource distribution pointed out in the beginning, under China's deliberated energy policies. As for Japan, under the assumption of stability between relations of Japan and China, while expecting China's domestic energy market to be maintained, it is important to add energy policies from Japan with a diplomatic view on how to get involved in China's state problems and how to build a supporting networks.

## Table 3: China's Energy Balance (2013)

Units: Oil equivalent in millions of tons

| From supply to consumption of energy \ Energy resource | | Fossil fuel energy resource: Coal | Crude oil | Oil products | Natural gas | Nuclear power | | | Heat | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Produced | | 1943.0 | 210.1 | — | 101.1 | 29.1 | 330.4 | — | — | 2613.7 |
| Imported | | 174.2 | 282.1 | 51.2 | 41.5 | — | — | 0.6 | — | 549.6 |
| Exported | | -7.1 | -1.6 | -33.7 | -2.5 | — | — | -1.6 | — | -46.5 |
| Other (inventory adjustments, etc.) | | -65.2 | -9.5 | -20.3 | 0.1 | — | — | — | — | 94.9 |
| Amount of supply (TPES) | | 2044.9 | 481.1 | -2.8 | 140.2 | 29.1 | 330.4 | -1.0 | — | 3021.9 |
| Electricity supplied | | -925.8 | -0.1 | -1.5 | -22.0 | -29.1 | -108.7 | 466.3 | — | -620.9 |
| Oil refining | | — | -473.2 | 459.7 | — | — | — | — | — | -13.5 |
| Other (Domestic consumption by energy industry, other) | | -515.9 | -6.8 | -21.9 | -24.2 | | -1.6 | -79 | 76.2 | -573.4 |
| Amount of consumption (TFC) | | 603.2 | 1.0 | 433.5 | 93.8 | — | 220.1 | 386.3 | 76.2 | 1814.1 |
| TFC (Breakdown) | Industry | 474.0 | 0.2 | 61.0 | 29.5 | — | 0.2 | 261.0 | 52.1 | 878.0 |
| | Transportation | 3.3 | — | 223.1 | 12.5 | — | 1.7 | 4.9 | — | 245.5 |
| | Housing, lifestyle | 54.2 | — | 26.2 | 27.7 | — | 214.2 | 58.1 | 20.0 | 400.4 |
| | Commercial, public | 13.5 | — | 16.5 | 8.1 | — | 3.1 | 22.8 | 1.8 | 65.8 |
| | Agriculture, fishery | 10.2 | — | 16.1 | 0 | — | 0.6 | 9.5 | — | 36.4 |
| | Other | 48.0 | 0.8 | 90.6 | 16 | — | 0.3 | 30 | 2.3 | 188.0 |

TPES: Total Primary Energy Supply TFC: Total Final Consumption Source: Energy Balances (OECD)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Composition of power supply | 85% | 0% | -2% | 3% | 10% | 466.3 [Heat equivalent of generated electricity] | | 620.9 [Heat generated to generate electricity] |

466.3 + 620.9 = 1087.2

Ratio for generating electricity = $\frac{466.3}{1087.2}$ = 43%

Earnings and expenses for oil products

<Procurement>

| Oil production | Oil imports | Imported oil products | Inventory adjustments |
|---|---|---|---|
| 210.1 | 282.1 | 51..2 | -29.8 |

<Uses>

| Generating electricity | Uses of oil products: Industry | Transportation | Commercial and home use | Other (Domestic consumption by energy industry, other) | Export |
|---|---|---|---|---|---|
| 1.6 | 61.0 | 223.1 | 58.8 | 133.8 | 35.3 |

(Note) It is thought that 459.7 refined in domestic refineries is equivalent within "Oil product production," but it is added as an import of crude oil, so it is not included in the total "Oil product production" in order to avoid a double count.

## Table 4: Japan's Energy Balance (2013)

Units: Oil equivalent in millions of tons

| Energy resource / From supply to consumption of energy | | Fossil fuel energy resource | | | | Nuclear power | | | Heat | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Coal | Crude oil | Oil products | Natural gas | | | | | |
| Produced | | | 0.6 | | 2.8 | 2.4 | 22.2 | — | — | 28.0 |
| Imported | | 127.2 | 181.8 | 47.1 | 103.7 | — | — | — | — | 454.8 |
| Exported | | -0.9 | — | -16.9 | — | — | — | — | — | -17.8 |
| Other (inventory adjustments, etc.) | | 0 | -0.1 | -10.0 | -0.2 | — | — | — | — | -10.3 |
| Amount of supply (TPES) | | 121.3 | 182.3 | 20.2 | 106.3 | 2.4 | 22.2 | — | — | 454.7 |
| Electricity supplied | | -69.7 | -10.0 | -20.3 | -72.1 | -2.4 | -18.7 | 89.3 | — | -103.9 |
| Oil refining | | — | -177.3 | 178.0 | — | — | — | — | — | -0.7 |
| Other (Domestic consumption by energy industry, other) | | -25.7 | 5.3 | -12.5 | -0.2 | 0 | 0 | -7.6 | 0.6 | -40.1 |
| Amount of consumption (TFC) | | 25.9 | 0.3 | 165.4 | 34.0 | 0 | 3.5 | 81.7 | 0.6 | 311.4 |
| (TFC Breakdown) | Industry | 25.1 | 0.0 | 23.0 | 7.5 | — | 3.1 | 23.2 | — | 82.0 |
| | Transportation | 0.0 | — | 71.8 | 0.1 | — | — | 1.6 | — | 73.5 |
| | Housing, lifestyle | — | — | 12.3 | 8.8 | — | 0.3 | 24.5 | 0.0 | 45.9 |
| | Commercial, public | 0.5 | — | 17.6 | 17.2 | — | 0 | 31.1 | 0.6 | 67.0 |
| | Agriculture, fishery | — | — | 3.6 | — | — | 0.1 | 0.1 | — | 3.8 |
| | Other | 0.3 | 0.3 | 37.1 | 0.4 | — | — | 1.1 | — | 39.2 |

TPES: Total Primary Energy Supply TFC:Total Final Consumption Energy Balances (OECD)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Composition of power supply | 36% | 16% | 37% | 1% | 10% | 89.3 [Heat equivalent of generated electricity] | | 103.9 [Heat generated to generate electricity] |

89.3 + 103.9 = 193.2
Composition of power supply 100%
Ratio for generating electricity = 89.3 / 193.2 = 46%

Earnings and expenses for oil products

<Procurement>

| Oil production | Oil imports | Imported oil products | Inventory adjustments |
|---|---|---|---|
| 0.6 | 181.8 | 47.1 | -10.1 |

<Uses>

| Generating electricity | Uses of oil products | | | Other (Domestic consumption by energy industry, other) | Export |
|---|---|---|---|---|---|
| | Industry | Transportation | Commercial and home use | | |
| 30.3 | 23.0 | 71.8 | 33.5 | 43.9 | 16.9 |

(Note) It is thought that 178.0 refined in domestic refineries is equivalent within "Oil product production," but it is added as an import of crude oil, so it is not included in the total "Oil product production" in order to avoid a double count.

## 4. Towards a Solution of Environmental / Energy Problems: A Summary

China has gradually transformed into the world's largest consumer of energy. Therefore, it tugs on the global energy market and may draw out vast results from introducing energy. On the other hand, it accounts for a quarter of the world's carbon dioxide emissions.

In this report, I have used expressions such as "contributor" and "oppressor" but as a conclusion to this report, in addition to the great expectations the world has for China, it is necessary for the world to continue watching China closely. In order to solve the various energy problems in consideration of these things, it is important above all things for China to maintain good relations in common with the other countries of the world, diplomatically, economically and socially. Considering this important thing, Japan is one country in the world, and I am afraid that perhaps the kind of thinking that maintaining a special partnership for the reason that China is a neighboring country is a bit illogical.

So how should Japan cooperate with China over the arena of energy issue? Is it possible for all the countries of the world to reach cooperation with China? What can an open and honest Japan do for contribution? "Agreement with all the countries of the world" refers to fairness and rationality in the world's commercial energy market. Fairness and rationality in the world's commercial energy market is built upon relationships of mutual trust between the two parties behind the commerce, and it is realized with assumptions as to how the energy being traded will be used.

It may be said that the stability of international relations and characteristic openness of using energy domestically is the first step to solving energy problems. In fact, there are many places that are not sufficiently maintained in the global energy market. In order to maintain such, should the world not be expecting China to pour out its power? This issue goes beyond Japan and China, but the whole world needs to deal with.

## About the Author

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# Assessment of China's Greenhouse Gas Emission Reduction Target for 2030: Possibility of Earlier Peaking

*Jusen ASUKA*

## Abstract

Whether China's Greenhouse Gas (GHG) emission reduction target "to peak around 2030" is "fair, ambitious and adequate" or not depends on how much emphasis be placed on the historical responsibilities. However, China's peak in coal consumption may come earlier than expected, thereby advancing the peak of $CO_2$ emission to come before 2030. In fact, the calculation based on the recent data from the National Bureau of Statistics of China released indicates that its coal consumption and $CO_2$ emission (from fossil fuels) have almost flatted in 2014. Moreover, National Bureau of Statistics of China has upwardly adjusted the data for energy consumption and coal consumption in 2013, which led to confusion in its interpretation. Although it is difficult to say anything definite at this moment, the issue of upward adjustment of statistical data until 2013 and the recent declining trend of coal consumption and, possibly $CO_2$ emission (from fossil fuels) can be discussed separately. All things considered, it seems more appropriate to assume that, in China, the coal consumption and $CO_2$ emission are not likely to show significant increases in the future.

## Keyword

Climate change, China, greenhouse gas, INDC, $CO_2$ emission, coal consumption, air pollution, data adjustment

## 1. Introduction

On November 12, 2014, the Chinese Government pledged that "China intends to achieve the peaking of $CO_2$ emissions around 2030 and to make best efforts to peak early" in its joint statement of US-China summit. On 30 June 2015, China submitted its Intended Nationally Determined Contribution (INDC) to the United

Nations Framework Convention on Climate Change (UNFCCC) secretariat, including the target to peak $CO_2$ emissions by 2030 at the latest, lower the carbon intensity of GDP by 60% to 65% below 2005 levels by 2030, increase the share of non-fossil energy carriers of the total primary energy supply to around 20% by that time, and increase its forest stock volume by 4.5 billion cubic metres, compared to 2005 levels.

Several research institutes have already conducted the assessment of this China's target and have concluded that "to peak around 2030 will not be sufficient to conform to 2 degrees Celsius target, which is the target to limit the global temperature rise within 2 degrees Celsius since industrial revolution".[1]

Counterarguments to such conclusions are expected on the basis of the advancement in various measures to promote energy conservation and low-carbon energies, intensity improvement, and the way to share Greenhouse Gas (GHG) emission reduction efforts. Furthermore, China's peak in coal consumption may come earlier than expected, thereby advancing the peak of $CO_2$ emission to come before 2030. In fact, the calculation based on the data from the Chinese Government released on February 26, 2015,[2] indicates that China's coal consumption and $CO_2$ emission (from fossil fuels) have actually decreased in 2014. According to more recent data, $CO_2$ emission has not decreased but has almost flattened [3].

In consideration of the above situation, this paper discusses China's GHG emission reduction target with focuses on the conformity with 2 degrees Celsius target, fairness/ambitiousness, anticipated counterarguments and possibility of moving up the targets. In the following part, Section 2 introduces actual assessment reached by several research institutes in the world. Section 3 reviews possible counterarguments to such assessment results. Section 4 discusses the most recent arguments and current situation of the peak year of coal consumption and $CO_2$ emission in China. Finally, Section 5 summarizes the paper.

[1] For example, Climate Action Tracker, "China and US increase climate ambition: Improvements needed in 2015," *Policy Brief* (12 November 2014), at <http://climate-actiontracker. org/news/166/China-and-US-increase-climate-ambition-Improvements-needed-in-2015.html>(Accessed Feb 10, 2015).

[2] National Bureau of Statistics of China, "Statistical Communiqué of the People's Republic of China on the 2014 National Economic and Social Development", (February 26, 2015), at<http://www.stats.gov.cn/english/PressRelease//201502/t20150228_687439.html>(Accessed Mar. 10, 2015).

[3] China Statistical Abstract 2015 and China energy statistical year book 2014.

## 2. Assessment by Research Institutes

The Climate Action Tracker, which is the association of research institutes to review the GHG emission reduction targets of various countries, has assessed China's target to peak $CO_2$ emission by 2030 announced by the Chinese Government, and has concluded that "to peak around 2030 is not sufficient for 2 degrees Celsius target."[4] Their reasons include: 1) GHG emission trajectory estimated on the basis of peaking $CO_2$ emission around 2030 is placed above the GHG emission trajectory of "Benchmark 450 scenario" in LIMITS Project, which is an international project to compare multiple number of models;[5] and 2) the resultant GHG emission reduction is less than those achievable with the introduction of the best available technologies (BATs). Moreover, the analysis of Höhne et al.[6] which has reviewed more than 40 studies and specified the GHG emission reduction targets of 10 regions under various effort-sharing methods, implies that the China's emission in 2030 need to be almost equal to its emission in 2010 under several effort-sharing methods such as "equal per capita emission". In addition, the staff working paper of EU Commission[7] to justify EU's 2030 target (40% reduction from year 1990) suggests that what EU Commission considered the "fair and ambitious GHG emission reduction target of China" should be "to peak GHG emission around year 2023."

## 3. Anticipated Counterarguments

Against such assessments and criticisms from the international society, some may develop the following counterarguments.

First, some researchers will likely to point out China's progress in the enforcement of concrete policies and measures. For example, China has drastically increased its investment in renewable energies in recent years.

4 Climate Action Tracker, *op. cit.*

5 LIMITS, Policy Brief on policy analysis (January 2013), at <http://www.feem-project.net/limits/docs/limits_policy%20brief%20on%20policy%20analysis_en.pdf>(Accessed Mar. 10, 2015).

6 Höhne, Nicklas, Michel Den Elzen, and Donovan Escalan, "Regional GHG reduction targets based on effort sharing: a comparison of studies," *Climate Policy* (Vol. 14 No. 1, 2014): 122–147, at <http://dx.doi.org/10.1080/14693062.2014.849452>.

7 Commission of the European Unions, "Commission Staff Working Document" Accompanying the document "Communication from the Commission to the European Parliament and the Council," *The Paris Protocol - a blueprint for tackling global climate change beyond 2020* {COM (2015) 81 final}, at <http://ec.europa.eu/priorities/energy-union/docs/paris-swd_en.pdf> (Accessed Feb 10, 2015).

According to Renewable Energy Policy Network for the 21st Century,[8] in the year 2013, China has become the world's largest investor in renewable energies, with 21% share in terms of global investment amounts. China invested more in renewable energy than all of Europe did in 2013. In the same year, China has introduced 12 GW solar energy facilities, which is 50% greater than any one nation's single year investment in the past. For wind power, China is the number one country in the world since 2009, in terms of its accumulated wind power capacities. In the aspect of institutions, China has already introduced, though in a pilot phase, GHG emission trading systems in seven of its cities/regions, with the scale second to EU's Emission Trading Scheme (EU ETS). Their energy taxation system has been reformed in a way to promote energy conservation.

Second counterargument can be based on the international comparison of intensity improvements. To peak GHG emission by 2030, China assumes 4.5 % per year reduction in its energy consumption per GDP.[9] No developed countries had ever reduced energy intensities at such rate during their economic development stages. (Many developed countries had the economic growth rate of around 3% per year at their peak of GHG emission.) Actually, China did reduce their energy intensity by 19.1% during the period of 2006 to 2010, which was much higher than those of any other emerging countries.

Thirdly, some may criticize the "un-equitable" methodologies of GHG emission reduction efforts sharing used in the models referenced by the Climate Action Tracker (2014) and the EU Commission. As the calculated values of such models are based on the methodology to calculate GHG emission reduction effort sharing under the concept of "equal marginal abatement cost" to minimize the global cost of GHG emission reduction cost-effectively, it will be disadvantageous to emerging countries like China with less historical emission. It is also important to know that "marginal abatement cost curve" to be used for calculating cost differ widely from model to model due to different assumptions on technology, cost, discount rates, etc..[10]

Whether above counterarguments have sufficient persuasive power or not, the views will differ. For the first counterargument, China's introduction of various

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[8] Renewable Energy Policy Network for the 21st Century, "Renewables 2014 Global Status Report" (2014), at <http://www.ren21.net/portals/0/documents/resources/gsr/2014/gsr2014_full%20report_low%20res.pdf>(Accessed Mar. 10, 2015).

[9] (i) Tsinghua University, Energy, Environment, Economy Research Institute, "China and New Climate Economy" , (2014), at<http://newclimateeconomy.report/china/> (Accessed Mar. 10, 2015). (ii) According to National Bureau of Statistics of China (2015), assumption of the GDP growth rate is 4 to 5 %/year, and energy consumption growth of 1.5 to 2%/year. China's GDP intensity was reduced by 4.8% from the previous year in 2014.

[10] Hanaoka T. and Kainuma M., "Low-carbon transitions in world regions: comparison of technological mitigation potential and costs in 2020 and 2030 through bottom-up analyses," *Sustainability Science* (Volume 7, Issue 2, 2012): 117-137.

measures is easy to understand, but, when asked whether these measures are sufficient enough or not, many will likely answer that they are not (whatever their own emission reduction efforts are). For the second counterargument, certainly there has been no other country in the history of the world that has realized the scale of intensity reductions China has done. Still, the history is a thing of the past and, in consideration of the new global challenge to achieve 2 degrees Celsius target, the international community may find difficulty in accepting the China's claim that their global warming measures of today will be wholly sufficient. For the third counterargument, the author consider it having a certain degree of persuasiveness, in consideration of the descriptions of equity in GHG emission reduction effort sharing stated in IPCC's Fifth Assessment Report, as well as Höhne et al. However, it is necessary to note that the other methods of effort sharing (for example, equalizing per capita emission) in the same Höhne et al. and Jiang et al.[11] have also indicated the need to peak emission before 2025 in China, in order to achieve global 2 degrees Celsius target. In other words, the assessment of China's GHG emission reduction targets largely depends on how strongly historical responsibility is considered as the indices of equity.

## 4. Possibility of Early Peaking

### 4.1. Coal Consumption Peak and $CO_2$ Emission Peak

In the case of China, today's focus would be whether $CO_2$ emission can peak "before" 2030, rather than "around" 2030. According to aforementioned "Statistical Communiqué of the People's Republic of China on the 2013 National Economic and Social Development", [12] it was actually possible to calculate that $CO_2$ emission (from fossil fuels) has "peaked" in 2013. Though noted as provisional data, this bulletin describes the actual data of year 2014 for energy consumption, coal consumption, natural gas consumption, crude oil consumption, electric power consumption, shares of coals and renewables in final energy consumption, and others in comparison to those of year 2013. For example, coal consumption in 2014 was 2.9% less than that in 2013. When calculated based on

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[11] Jiang K., X. Zhuang, R. Miao and H. Chenmin, "China's Role in Attaining the Global 2 Target," *Climate Policy* (Volume 13, Supplement 01, 2013), at < http://www.tandfonline.com/doi/abs/14693062.2012.746070>. Jiang et al. (2013) used "equal per capita emission" as the methodology to share GHG emission reduction efforts.

[12] According to National Bureau of Statistics of China (2015), "Statistical Communiqué of the People's Republic of China on the National Economic and Social Development" is an annual bulletin to be published at the end of February every year.

these data, the $CO_2$ emission (from fossil fuels) has peaked in 2013, or at least has decreased in 2014.[13]

According to more recent data (*China Statistical Abstract 2015* and China energy statistical year book 2014), $CO_2$ emission has not decreased but has almost flattened. However, coal consumption has clearly decreased.[14]

The main reasons for coal consumption decrease can be attributed to the effects of various governmental measures implemented as air pollution mitigation actions and the measures to change industrial structures. Economic downturn can also be one of the reasons. More specifically, those measures include: 1) tightened regulation of coals and promotion of energy conservation; 2) reforms of taxation systems and protection measures; and 3) increases in renewable and nuclear power generation. The actual contributions of these factors will be analyzed in the future.

### 4.2. Adjustment of the Energy Consumption and Coal Consumption Data

In fact, there is another noteworthy fact in National Bureau of Statistics of China (2015). That is the upward adjustment (modification) of data for energy consumption and coal consumption in 2013 (Table 1).

| | 2014 | 2013 (After adjustment) | 2013 (Before adjustment) | Difference (%) |
|---|---|---|---|---|
| Energy consumption (Mtce) | 4260 | 4168 | 3750 | 11.1 |
| Coal consumption (Mt) | 3940 | 4054 | 3465 | 17.1 |
| Share of coals (%) | 66.0 | 69.5 | 66.0 | - |

**Table 1. Energy Consumption, Coal Consumption and Share of Coals (before and after adjustment)**
Source: National Bureau of Statistics of China (2015) and National Bureau of Statistics of China (2014)[15]

[13] Based on the National Bureau of Statistics of China (2015) released on February 26, 2015, Glen Peters at CICERO (Center for International Climate and Environment Research) in Norway quickly calculated that total $CO_2$ emissions from fossil fuels and cement production in China has decreased by 0.7% in 2014 from 2013. <https://twitter.com/Peters_Glen/status/570929352831066112/photo/1>

[14] US Energy Information Administration , "Coal use in China is slowing," *Today in Energy*, (September 17, 2015), at <https://www.eia.gov/todayinenergy/detail.cfm?id=22972 >(Accessed Jan. 4, 2016).

[15] National Bureau of Statistics of China, "Statistical Communiqué of the People's Republic of China on the 2013 National Economic and Social Development" (February 24, 2014), at <http://www.stats.gov.cn/english/PressRelease/201402/t20140224_515103.html>(Accessed

As long as the author knows, some researchers were already aware of the possibility of the Chinese Government making upward adjustment of its energy consumption and coal consumption data before the publication of National Bureau of Statistics of China (2015) on February 26, 2015. It is also well known that China's National Bureau of Statistics did modify their data of coal consumption in the past. For example, the drastic reduction in coal consumption reported for the period of 1998 to 2002 was later modified due to the correction to raise the number of coal consumption. The reason for such correction at that time was said to be the error in the statistics of small coal mine. Even in more recent statistics, researchers indicated some discrepancies between the total coal consumption of the nation and the sum of sectoral coal consumptions in China.[16]

This time, the direct cause or background of upward adjustment in energy consumption and coal consumption can be: 1) statistical "under-reporting" of local governments and enterprises, in response to the central government's tightening of regulations for air pollution and energy conservation measures, 2) improvement of the stringency of the census.[17] Until more detailed analysis is done, however, no clear-cut conclusion can be drawn. Still, it is fairly certain that statistics of coals has some problems.

From the historical viewpoint, however, the Chinese Government has gradually improved the accuracy of statistical data to some extents, as they develop and establish various systems of relevancy. Moreover, it is also true that they now have better capacity to verify the accuracy and reliability of statistical data through multiple methods.

As for the future development, the Chinese Government is likely to continue further its industrial re-structuring, and the enforcement of more strict air pollution measures, while unlikely maintaining rapid economic expansion. Their power generation capability in renewable and nuclear has actually increased. On March 21, 2015, the Shen Hua Group, a major coal supplier in China, published their forecast that "coal sales in 2015 will decrease by 10% from 2014".[18] Moreover, according to the Reuters, in 2014, utilization rates at China's thermal power

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Mar.10, 2015).

16 Shinji Horii, "Update on China's coal demand and supply and perspective on future air pollution problem in China", presentation for the Northeast Asia: Air policy and climate policy symposium, Tohoku University Tokyo branch (March 6, 2015).

17 In China, a veto by one vote system has been implemented, in which the achievement of environmental and energy conservation targets becomes the key indices in evaluating the performances of local government officials. Therefore, these officials feel strong pressures to meet such targets. In 2010, the heating energy supply was forcibly stopped in some places to meet energy conservation targets under the 11th Five-Year plan (for 2006 to 2010), causing serious problems in the society.

18 http://reneweconomy.com.au/2015/more-signs-of-peak-coal-as-chinas-shenhua-forecasts-10-sales-decline-35119

generators fell to a lowest-ever 53.7 percent, down from 57.3 percent in 2013 and resulting in coal for power use dropping 1.3 percent compared with 2013. In addition, utilization rates at thermal power plants - nearly all coal-fired - have dropped to 52.2 percent in the first two months of 2015, Reuters calculations based on monthly power generation and consumption figures show. If that rate holds for the full year, it would be a new annual low.[19]

There are two important factors to be addressed regarding future coal consumption. First factor is how coal-to-gas and coal-to-oil projects will develop in the future since these projects are the biggest source of additional coal demand outside the power sectors.[20] However, the economic environment to invest on these projects is not so favorable currently and massive water supply required in these projects may cause another environmental problem in water-scarce China. Second factor is the possibility of Chinese Government introducing measures to stimulate the economy if very serious economic downturn continues, which may result in the increase of the coal consumption.

Therefore, although some uncertainty remain, coal consumption is not likely to increase significantly but rather decrease in the near future, making it necessary to consider the problem of upward adjustment in the statistical data of 2013 or before, separate from the trend of coal consumption decrease in 2014 and afterward.

As shown in Table 2 below, recent studies and reports published from several international research institutes and market analysts indicate that China's peak of coal consumption will come unexpectedly earlier. Moreover, many researches listed in Table 2 assume some time laps of two to 10 years between the peak of coal consumption and that of $CO_2$ emission.[21]

In other words, whether China's coal consumption really hit the peak in 2013 or not, it is possible that China's coal consumption peak before year 2020, if the current domestic and international situation in politics and economy continues,

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19 http://www.reuters.com/article/2015/03/26/china-coal-idUSL3N0WL32720150326

20 Lauri Myllyvirta, "China's Coal Consumption Fell in 2014," *The Energy Collective* (Jan 28, 2015), at <http://theenergycollective.com/lauri-myllyvirta/2187741/it-s-official-china-s-coal-consumption-fell-2014> (Accessed Mar. 10, 2015).

21 For the coal consumption peaking issues, including the trends of Chinese energy policies, refer to (i) Zhidong Li, "Peak Coal in China: Rethinking the Unimaginable," *China's Energy Crossroads: Forging a New Energy and Environmental Balance NBR Reports* (Nov 2014), at <http://www.nbr.org/publications/element.aspx?id=792> (Accessed Mar. 10, 2015). (ii) Shuo Li and Lauri Myllyvirta, "The End of China's Coal Boom– 6 facts you should know," *Greenpeace Asia* (April 2014), at <http://www.greenpeace.org/eastasia/Global/eastasia/publications/reports/climate-energy/2014/The-End-of-Chinas-Coal-Boom-Briefing.pdf>(Accessed Mar.10, 2015). (iii) Lauri Myllyvirta, "China Coal Use Can Peak this Decade: What Did the IEA Miss?", *The Energy Collective* (December 22, 2014), at < http://theenergycollective.com/lauri-myllyvirta/2174746/china-coal-use-can-peak-decade-what-did-iea-miss>(Accessed Mar. 10, 2015). (iv) Lauri Myllyvirta (2015), *op. cit.*

according to the projections made by many researchers and market analysts. With due consideration to a time lag in peaking time, it means that $CO_2$ emission will likely peak well before 2030.

| Study names | Scenario names | Peak year of Coal consumption | Peak year of $CO_2$ emission | Notes |
|---|---|---|---|---|
| Zhou et al. (2011)[1] | Continued Improvement | 2030 | 2032 | Research group of Lawrence Berkeley National Laboratory of US |
| | Accelerated Improvement | 2019 | 2027 | |
| IEA WEO (2013)[2] | New Policies | 2025 (flattening) | NA | |
| Citi Research (2013)[3] | Transition | 2017 | NA | Market analysis by a private company in the US |
| | Deep Transition | 2015 | NA | |
| IEA WEO (2014)[4] | Current Policy | After 2040 | After 2040 | New Policies scenario considers the effect of $PM_{2.5}$ measures to some extent |
| | New Policies | 2030 | 2030 | |
| | 450 ppm | 2020 | 2018 | |
| Chinese Academy of Engineering (2011)[5] | | 2030 (peaking) | NA | |
| Tsinghua University Energy Environment Economy Research Institute (2014) | Continued Effort | 2035 | 2040 | A part of global Climate New Economy Project |
| | Accelerated Effort | 2020 | 2030 | |
| Bernstein Research (2014)[6] | | 2015 | NA | Market analysis by a private company in the US |
| Deutsche Bank (2014) | | 2016 | NA | Market analysis by a private company in Germany |
| China National Coal Association (2014)[7] | | 2020 | NA | Association of the companies in the industry |
| Li (2014) | | 2015-2019 | 2025-2030 | Research by a professor at Nagaoka University of Technology in Japan |

| | | | | |
|---|---|---|---|---|
| Zhang *et al.* (2014)[8] | No Policy | After 2050 | After 2050 | Joint research work between researchers of MIT and of Tsinghua University in China |
| | Continued Effort | 2030 | 2040 | |
| | Accelerated Effort | 2020 | 2030 | |
| Jiang *et al.* (2013) | Baseline | NA | 2040 | Research using the integrated assessment model by researchers at Energy Research Institute under the National |
| | Low Carbon | NA | 203 (flattening) | |
| | Enhanced Low Carbon | 2020 (peaking) | 2030 | |
| | 2 degree | NA | 2020 | |
| Yang (2014)[9] | Energy Conservation | 2030 | NA | Result of China Coal Consumption Cap Project, a joint research project between NRDC (US's research institute) and several Chinese researchers |
| | Coal-Control | 2020 (flattening) | NA | |
| | 2 degrees | 2020 (peaking) | NA | |

**Table 2: Assumed Peaks of Coal Consumptions and $CO_2$ Emission of China in Various Studies**

Note: "Peaking" means decrease starts. "Flattening" means increase stops.

In terms of the $CO_2$ emission, the Chinese government may revise conversion rate to calculate $CO_2$ emission from fossil fuel combustion due to change of the contents of the fuels, which may result in increasing the $CO_2$ emission. It seems that the Chinese Government was considering all issues mentioned above and has made the INDCs public in June 2015, in Nov. 2014.

The joint statement of the US and China did refer to the 2 degrees Celsius target, while describing that the current target is not fixed. If the peaking of coal consumption before 2020 becomes quite apparent, or the peak in 2013 is ascertained to some extents, it is possible that the Chinese Government may advance the peak year of GHG emission reduction earlier at some point.

## 5. Conclusions

To assess China's GHG emission reduction target for 2030 may influence the assessment of other countries' GHG emission reduction targets. This is because there may be some countries that would try to justify their targets "in comparison to China." In this respect, also, the assessment of China's GHG emission reduction target for 2030 has special significance.

Now, if we are to consider 2 degrees Celsius target, and do not place much emphasis on historical responsibilities, then not many research institutes will evaluate China's GHG emission reduction target "to peak around 2030" as "fair and ambitious" target. Undoubtedly, some will try to make various counterarguments against such assessments, but the author is skeptical of some of their persuasiveness. Depending on how much importance being placed on historical responsibilities, the assessment of China's targets can be varied widely.

In addition, China has upwardly adjusted its statistical data of energy and coals as discussed in the latter half of this paper which made many researchers troubled to find appropriate interpretation of such adjustment as well as $CO_2$ emission peak. As long as the author knows, many of those involved in China's energy and climate change policy issues were already aware of the upward adjustment of statistical data with the decrease in coal consumption and possible $CO_2$ peak. Because the peaking comes much earlier than assumed, and probably because of a tactical reason for international negotiation, not many officials and relevant researchers would claim that the decrease of $CO_2$ emission will continue as is. It seems that quite a few recognize the high possibility of coal consumption decrease, while taking "wait and see" attitude towards $CO_2$ emission decrease.

Moreover, the data adjustments mentioned in this paper simply make the international community more doubtful in the reliability of Chinese data, which may, in some degree, strengthen criticisms to China's GHG emission reduction commitment and its climate policy itself.

Still, several international research institutes as well as market analysts have indicated the possibility of China's coal consumption peaking much earlier than expected, since several years ago. There is little doubt that China is experiencing many structural changes in its energy mix and industrial structures because of many reasons including air pollution mitigation. In this sense, the issue of upward adjustment of statistical data until 2013 and the declining trend of coal consumption in 2014 and later are discussed separately. And it seems more appropriate to assume that coal consumption and $CO_2$ emission are not likely to show significant increases in the future.

In conclusion, the shrinking of global carbon budget due to China's data adjustment is a "bad news", but it will be better and, probably, more appropriate to accept the possibilities of much earlier peaking in China's coal consumption and $CO_2$ emission as a "good news".

## About the Author

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# Healthy Environment and Healthy Living in Urban China: An Emerging Field in Research

*Lin LIN and Hongwei JIANG*

## Abstract

Chinese urban lifestyle has been drastic transformed due to the rapid urban expansion and motorization. Due to the decrease of physical activity and increase intakes of fat and animal foods, the prevalence of overweight and obesity and related health problems in China has risen. As a result, considerable public health concerns have started to manifest. Experts urge that both central and local governments should allocate more resources to create environments that enhance physical and emotional quality of life, in particular to build healthy physical environments conducive to walking and bicycling. This paper reviews this emerging research field in China, focusing on physical activities, diet, obesity, and their relations with environmental building.

## Keywords

environmental building, healthy city, healthy living

## 1. Current Urban Lifestyle Issues in Chinese cities

Due to the rapid urban expansion and motorization, Chinese urban lifestyle has been drastic transformed, and contributed to considerable public health concerns.[1] More than three decades' economic reform and open policy in China have resulted in rapid economic development, expeditious urbanization and urban expansion,

[1] (i) Barry M. Popkin, "Urbanization, Lifestyle Changes and the Nutrition Transition," *World Development* 27 (11) (1999): 1905–1916. (ii) A. Colin Bell, Keyou Ge, and Barry M. Popkin, "The Road to Obesity or the Path to Prevention: Motorized Transportation and Obesity in China," *Obesity Research* 10 (4) (2002): 277–283.

and substantial improvements of Chinese people's material well-being. With more than half of population living in urban areas, China is now the second largest economy in the world, and the largest automobile market. From the "Bicycle Kingdom" in the 1980s and 1990s to the largest automobile market in the world now, biking and walking have instantly given away to driving in Chinese cities. Intakes of fat and animal foods increased quickly after the economic reforms occurred.[2] Thanks to decrease of physical activity and increase consumption of energy-dense foods, the prevalence of overweight and obesity and related health problems in China has been increased. Average weekly physical activity among Chinese adults declined by 32% between 1991 and 2006.[3] At the same time, the proportion of dietary energy derived from fat in the adult diet increased from 19% in 1989 to 28% in 2004.[4] Meanwhile, from 1992 to 2002 the prevalence of adult overweight increased by nearly 40% and that of obesity doubled.[5] Chinese children are also getting fatter. In 2010, it was estimated that 9.9% of Chinese school-aged children and adolescents were overweight and that an additional 5.1% were obese, representing an estimated 30.43 million individuals.[6] Another recent study finds that the emergence of cardio-metabolic disease risk in Chinese children and adults was associated with changes in diet, decrease in physical activity and increase in obesity.[7]

With chronic diseases now accounting for an estimated 80% of deaths in China,[8] China also seeing a large increase in nutrition-related causes of death,[9] and physical inactivity alone responsible for more than 15% of the medical and non-

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[2] (i) Shufa Du, Bing Lu, Fengying Zhai, and Barry M. Popkin, "A New Stage of the Nutrition Transition in China," *Public Health Nutrition* 5 (1A) (2002): 169–174. (ii) Fengying Zhai, Huijun Wang, Shufa Du, Yuna He, Zhihong Wang, Keyou Ge, and Barry M. Popkin, "Prospective Study on Nutrition Transition in China," *Nutrition Reviews* 67 Suppl 1 (May 2009): S56–61.

[3] Ng, Shu Wen, Edward C. Norton, and Barry M. Popkin, "Why Have Physical Activity Levels Declined Among Chinese Adults? Findings from the 1991–2006 China Health and Nutrition Surveys," *Social Science & Medicine* 68 (7) (2009): 1305–1314.

[4] Zhai,Wang, Du, He, Wang, Ge, and Popkin, *op. cit.*

[5] Yangfeng Wu, Rachel Huxley, Ming Li, and Jun Ma, "The Growing Burden of Overweight and Obesity in Contemporary China," *CVD Prevention and Control*, A focus on China, 4 (1) (2009): 19–26.

[6] Cheng Ye JI and Tian Jiao CHEN, "Empirical Changes in the Prevalence of Overweight and Obesity Among Chinese Students from 1985 to 2010 and Corresponding Preventive Strategies," *Biomedical and Environmental Sciences* 26 (1) (2013): 1–12.

[7] L. S. Adair, P. Gordon-Larsen, S. F. Du, B. Zhang, and B. M. Popkin, "The Emergence of Cardiometabolic Disease Risk in Chinese Children and Adults: Consequences of Changes in Diet, Physical Activity and Obesity," *Obesity Reviews* 15 (January 2014): 49–59.

[8] Longde Wang, Lingzhi Kong, Fan Wu, Yamin Bai, and Robert Burton, "Preventing Chronic Diseases in China," *The Lancet* 366 (9499) (2005): 1821–1824.

[9] Barry M. Popkin, "Will China's Nutrition Overwhelm Its Health Care System and Slow Economic Growth?," *Health Affairs* (Project Hope) 27 (4) (2008): 1064–1076.

medical yearly costs of the main Non Communicable Diseases in the country,[10] the Chinese government issued obesity prevention guidelines and policies, such as the Guidelines for Prevention and Control of Overweight and Obesity of Chinese Adults in 2003, and the School-age Children and Teenagers Overweight and Obesity Prevention and Control Guidelines in China in 2007, the Nutrition Improvement Work Management Approach in 2010. Overweight and obesity prevention-related policies were added to national planning for disease prevention and control.[11] What is more, the Chinese government recently declared to pursue "Healthy China 2020" program, much of which centers on chronic disease prevention, and promoting better lifestyle choices and eating habits.[12] In addition to government policies, public health and urban planning experts in China and abroad have urged that both central and local governments should allocate more resources to create environments that enhance physical and emotional quality of life, in particular to build healthy physical environments conducive to walking and bicycling.[13] To achieve this aim, a research field related to healthy environment and healthy living, has emerged in China recently. This paper reviewes the recent development of this emerging research field in China, focusing on physical activities, diet, obesity, and their associations with built environment.

## 2. Current research on Physical Activity, Diet, Obesity and Urban Environment Building in China

With the global rise in obesity prevalence, obesity has become a global pandemic.[14] Many developed countries, in particular the United States, have carried out extensive research to understand how shifts in the physical and social environments affect changes in dietary intake, physical activity patterns and

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[10] Juan Zhang, and Jad Chaaban, "The Economic Cost of Physical Inactivity in China," *Preventive Medicine* 56 (1) (2013): 75–78.

[11] Huijun Wang, and Fengying Zhai, "Program and Policy Options for Preventing Obesity in China," *Obesity Reviews : An Official Journal of the International Association for the Study of Obesity* 14 (02) (2013): 134–140.

[12] Chen Zhu, *Healthy China 2020: Strategic Research Report* (Beijing, China: People's Medical Publishing House, 2013).

[13] (i) F B Hu, Y Liu, and W C Willett, "Preventing Chronic Diseases by Promoting Healthy Diet and Lifestyle: Public Policy Implications for China," *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity* 12 (7) (2011): 552–559.
(ii) Rui Wang, "City Building and Public Health: Threats and Opportunities in China," *China Health Review* 4 (2) (2013), at <http://review.chpams.org/article/view/14973>.

[14] Boyd A Swinburn, Gary Sacks, Kevin D Hall, Klim McPherson, Diane T Finegood, Marjory L Moodie, and Steven L Gortmaker, "The Global Obesity Pandemic: Shaped by Global Drivers and Local Environments," *The Lancet* 378 (9793) (2011): 804–814.

weight change.[15] As an emerging phenomenon, research on built environment and public health in Chinese cities is catching up.

**1) Physical Activity, Obesity, and Environment Building**

The first research project on environmental building and physical activity was founded by National Science Foundation of China in 2010.[16] Then several studies have been published since.[17] Xu and colleagues investigated the association between self-reported recreational physical activity time of high school students and the residential density of ten urban districts in Nanjing, China.[18] They found that residential density was significantly negatively associated with recreational physical activity time for students from the higher tertile of residential density compared to those from the lower tertile. Zhou and colleagues recruited parents of students at two junior high schools in Shanghai, one downtown and the other in the suburbs to participate in the study to determine the association between the perceived neighborhood environment variables and physical activity in urban areas in China. Participant's physical activity was measured using accelerometers. This study found that participants from downtown areas were more positively associated with transportation Physical Activities (PA) and leisure-time PA than respondents living in the suburbs. Different from what Xu and colleagues found in Nanjing, perceived residential density was found to be a significant positive predictor of recreational or leisure-based PA. Street connectivity was negatively associated with leisure time PA for respondents. Yet, there were no significant associations between subjective environmental factors (e.g., residential

[15] Barry M. Popkin, Kiyah Duffey, and Penny Gordon-Larsen, "Environmental Influences on Food Choice, Physical Activity and Energy Balance," *Physiology & Behavior,* Purdue University Ingestive Behavior Research Center Symposium, Dietary Influences on Obesity: Environment, Behavior and Biology, 86 (5) (2005): 603–613.

[16] Ying Zhang, and Xiquan Weng, "The Past, Present and Future of the Relationship Between Built Environment, Physical Activity and Health," *Journal of Sports and Science* 35 (1) (2014): 30–34. [Chinese]

[17] (i) Fei Xu, JieQuan Li, YaQiong Liang, ZhiYong Wang, Xin Hong, Robert S. Ware, Eva Leslie, Takemi Sugiyama, and Neville Owen, "Associations of Residential Density with Adolescents' Physical Activity in a Rapidly Urbanizing Area of Mainland China," *Journal of Urban Health* 87 (1) (2010): 44–53. (ii) Rena Zhou, Yang Li, Masahiro Umezaki, Yongming Ding, Hongwei Jiang, Alexis Comber, and Hua Fu, "Association Between Physical Activity and Neighborhood Environment Among Middle-Aged Adults in Shanghai," *Journal of Environmental and Public Health* (2013): 1–7.
(iii) Mariela Alfonzo, Zhan Guo, Lin Lin, and Kristen Day, "Walking, Obesity and Urban Design in Chinese Neighborhoods," *Preventive Medicine*, Supplement: Active Living Research - Niche to Norm, 69, Supplement (December 2014): S79–S85. (iv) Meng Su, Ya-yun Tan, Qing-min Liu, Yan-jun Ren, Ichiro Kawachi, Li-ming Li, and Jun Lv, "Association Between Perceived Urban Built Environment Attributes and Leisure-time Physical Activity Among Adults in Hangzhou, China," *Preventive Medicine* 66 (September 2014): 60–64.

[18] Xu, Li, Liang, Wang, Hong, Ware, Leslie, Sugiyama, and Owen, *op. cit.*

density and street connectivity) and transportation PA. Alfonzo and colleagues examines the connections among the design of the built environment, walking, and obesity in six neighborhoods with different built environment qualities in Hangzhou and Shanghai, China. The findings reconfirmed results found in other countries that neighborhoods with more "walkable" built environment features were associated with higher rates of walking. In addition, this study offers a methodological advancement in that it examines features of the built environment that are uncommon in western countries, such as obstruction of sidewalks by vendors and overhead pedestrian bridges.[19] Su and colleagues randomly selected 1440 participants aged 25–59 from 30 neighborhoods in three types of administrative planning units in Hangzhou. Both subjective and objective built environmental variables were measured. The study found that male residents who perceived higher scores on access to physical activity destinations reported more involvement in leisure-time physical activity. Higher scores on perception of esthetic quality, and lower on residential density were associated with more time in leisure-time walking in women.

### 2) Diet, Obesity, and Environmental Building

Shifting towards a high-fat, high-energy-density and low-fiber diet,[20] Chinese face an up-hill battle with obesity. Recent studies in China have demonstrated that dietary patterns of adults and children have strong associations with the risks of overweight and obesity.[21] Studies in the US have shown that environmental factors not only influence physical activity, but also diet and obesity.[22] The latest studies

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[19] Keshia M. Pollack, Erualdo R. González, Erin R. Hager, and James F. Sallis, "The Active Living Research 2014 Conference: 'Niche to Norm'," *Preventive Medicine* 69 (December 2014): S1–S4.

[20] Du, Lu, Zhai, and Popkin, *op. cit.*

[21] (i) Xianwen Shang, Yanping Li, Ailing Liu, Qian Zhang, Xiaoqi Hu, Songming Du, Jun Ma, et al., "Dietary Pattern and Its Association with the Prevalence of Obesity and Related Cardiometabolic Risk Factors Among Chinese Children," *PLoS ONE* 7 (8) (2012). (ii) Long Shu, Pei-Fen Zheng, Xiao-Yan Zhang, Cai-Juan Si, Xiao-Long Yu, Wei Gao, Lun Zhang, and Dan Liao, "Association Between Dietary Patterns and the Indicators of Obesity Among Chinese: A Cross-Sectional Study," *Nutrients* 7 (9) (2015): 7995–8009. (iii) Canqing Yu, Zumin Shi, Jun Lv, Huaidong Du, Lu Qi, Yu Guo, Zheng Bian, et al., "Major Dietary Patterns in Relation to General and Central Obesity Among Chinese Adults," *Nutrients* 7 (7) (2015): 5834–5849. (iv) J. G. Zhang, Z. H. Wang, H. J. Wang, W. W. Du, C. Su, J. Zhang, H. R. Jiang, F. Y. Zhai, and B. Zhang, "Dietary Patterns and Their Associations with General Obesity and Abdominal Obesity Among Young Chinese Women," *European Journal of Clinical Nutrition* 69 (9) (2015): 1009–1014. (v) Jiguo Zhang, Huijun Wang, Youfa Wang, Hong Xue, Zhihong Wang, Wenwen Du, Chang Su, et al., "Dietary Patterns and Their Associations with Childhood Obesity in China," *The British Journal of Nutrition* 113 (12) (2015): 1978–1984.

[22] (i) Popkin, Duffey, and Gordon-Larsen, *op. cit.*
(ii) Engler-Stringer *et al*., "The community and consumer food environment and children's diet: a systematic review," BMC Public Health 14 (2014):522.

on China started to incorporate built environmental factors or food exposure measurements. Wang and Shi used subsets of the China Health and Nutrition Survey (CHNS) of 2004 and 2006 and found a positive impact of traditional wet markets on the children's nutritional intakes in urban areas of China.[23] Zhou and colleagues also included continuous distance variables in kilometers (km) for distance to the nearest grocery store and to the nearest free market in their analysis.[24]

**3) Obesity Interventions**

Given the dramatic rise of overweight and obesity among Chinese children, obesity intervention programs have been carried out in China recently.[25] In 2009, a total of 9750 primary students (grade 1 to grade 5, aged 7-13 years) were recruited from 30 schools in six cities in China to participate in a randomized cluster controlled trial to investigate the cost effectiveness of a nutrition-based comprehensive intervention study on childhood obesity in China.[26] This intervention study found that the comprehensive intervention, a combination of nutrition and physical activity, significantly lower BMI increment than that of the control groups, and it was also cost-effective to implement the school-based integrated obesity intervention program for children in urban China.[27] Between May 2010 and December 2013, another cluster randomized controlled trial on a school-based comprehensive lifestyle invention against obesity was carried out in

[23] Rui Wang, and Lu Shi, "Access to Food Outlets and Children's Nutritional Intake in Urban China: a Difference-in-difference Analysis," *Italian Journal of Pediatrics* 38 (1) (2012): 30.

[24] Yijing Zhou, Shufa Du, Chang Su, Bing Zhang, Huijun Wang, and Barry M. Popkin, "The Food Retail Revolution in China and Its Association with Diet and Health," *Food Policy* 55 (August 2015): 92–100.

[25] (i) Liping Meng, Haiquan Xu, Ailing Liu, Joop van Raaij, Wanda Bemelmans, Xiaoqi Hu, Qian Zhang, et al., "The Costs and Cost-Effectiveness of a School-Based Comprehensive Intervention Study on Childhood Obesity in China," *PLoS ONE* 8 (10) (2013). (ii) Yongqing Gao, Yuee Huang, Yongjun Zhang, Fengqiong Liu, Cindy Xin Feng, Tingting Liu, Changwei Li, et al., "Evaluation of Fast Food Behavior in Pre-School Children and Parents Following a One-Year Intervention with Nutrition Education," *International Journal of Environmental Research and Public Health* 11 (7) (2014): 6780–6790. (iii) Yajun Chen, Lu Ma, Yinghua Ma, Haijun Wang, Jiayou Luo, Xin Zhang, Chunyan Luo, et al., "A National School-based Health Lifestyles Interventions Among Chinese Children and Adolescents Against Obesity: Rationale, Design and Methodology of a Randomized Controlled Trial in China," *BMC Public Health* 15 (March 2015). (iv) Fei Xu, Robert S. Ware, Eva Leslie, Lap Ah Tse, Zhiyong Wang, Jiequan Li, and Youfa Wang, "Effectiveness of a Randomized Controlled Lifestyle Intervention to Prevent Obesity Among Chinese Primary School Students: CLICK-Obesity Study," *PLoS ONE* 10 (10) (2015): e0141421.

[26] Yanping Li, Xiaoqi Hu, Qian Zhang, Ailing Liu, Hongyun Fang, Linan Hao, Yifan Duan, et al., "The Nutrition-based Comprehensive Intervention Study on Childhood Obesity in China (NISCOC): a Randomised Cluster Controlled Trial," *BMC Public Health* 10 (May 2010): 229.

[27] Meng, Xu, Liu, Raaij, Bemelmans, Hu, Zhang, et al., *op. cit.*

Nanjing, China.[28] The results of the intervention were effective: the intervention group was more likely to decrease their BMI, increase the frequency of jogging/running, decrease the frequency of TV/computer use and of red meat consumption, change commuting mode to/from school from sedentary to active mode, and be aware of the harm of selected obesity risk factors.[29] Another community-based intervention study was conducted in 2012 to assess a nutrition education intervention on western style fast food consumption among Chinese children and parents.[30] This nutrition education intervention modified the parents' western style fast food behavior, although it did not change significantly in children. Between September, 2013 and June, 2014, a national multi-centered cluster randomized controlled trial involving more than 70,000 children and adolescents aged 7–18 years from 7 provinces in China was implemented.[31] Yet, the effectiveness of the intervention is still under evaluation.

## 3. Discussion

Extensive studies in the US have been carried out on built environmental correlates of diet, activity, and obesity. However, China started this area of research at a recent time. Overall, four studies since 2010 identified investigated the associations between physical activities, obesity, and urban built environment in Chinese cities. Two studies examined the relationship between dietary patterns and built environment.

For studies on physical activity, obesity, and built environment, Zhou and colleagues measured built environmental features subjectively using revised questionnaire surveys developed in the US or Australia. Alfonzo and colleagues conducted an environmental audit of their study area and obtained semi-objective built environmental variables. Xu and colleagues used district census data to calculate residential density, an objective built environmental variable. Su and colleagues measured environmental building both subjectively and objectively. It should be noted that few studies implemented GIS technology to obtain objective built environmental variables in Chinese cities. Involving more geographers in the studies might help acquiring spatial information of the study areas in digital formats and deriving environmental attributes needed. As for the outcome,

[28] Fei Xu, Robert S Ware, Lap Ah Tse, Zhiyong Wang, Xin Hong, Aiju Song, Jiequan Li, and Youfa Wang, "A School-based Comprehensive Lifestyle Intervention Among Chinese Kids Against Obesity (CLICK-Obesity): Rationale, Design and Methodology of a Randomized Controlled Trial in Nanjing City, China," *BMC Public Health* 12 (June 2012): 316.

[29] Xu, Ware, Leslie, Tse, Wang, Li, and Wang, *op. cit.*

[30] Gao, Huang, Zhang, Liu, Feng, Liu, Li, et al., *op. cit.*

[31] Chen, L Ma, Y H Ma, Wang, Zhang, Luo, et al., *op. cit.*

physical activity, both subjective and objective measures were obtained in the studies reviewed. Using survey questionnaires relying on participants' recollection to gather physical activity information is economical yet imprecise. Equipping participants with accelerometers and GPS devises will not only provide objective physical activity data, but also travel activity location information. However, the cost is still high. Adults were the research subjects for three out of four studies. Only one study[32] focused on adolescents. Studies in the US and other developed countries showed that built environmental attributes might have different impacts on adults and children. Given the high prevalence of overweight and obesity among Chinese children, more studies should be conducted on children in the Chinese context. Accordingly, more research funding has been awarded to conduct investigations on physical activity of school age children recently.

It should be noted that many nutrition and diet related studies on China used the China Health and Nutrition Survey (CHNS), a nationwide, ongoing, open cohort study that was initiated in 1989 and have been subsequently implemented. With careful sampling design, the CHNS is conducted in nine diverse provinces from the Northeast to the Southwest (Heilongjiang, Liaoning, Jiangsu, Shandong, Henan, Hubei, Hunan, Guizhou, and Guangxi) and three politically autonomous megacities (Beijing, Shanghai, and Chongqing).[33]

Few studies in China have been conducted on built environmental correlates of diet. With rapid economic changes along with the transforming of urban landscape, exposures to foods have been reshaped. For example, traditional wet markets have been gradually replaced by supermarkets where processed foods are composed big part of their sale products.[34] Western style fast food outlets have been rising in China.[35] Access and exposure to processed foods and high-fat, high-energy-density foods have arisen, which in turn could have impacts on dietary patterns. More empirical studies need to be carried to understand the built environmental correlates of diet to devise effective policies and intervention programs.

Regional and nationwide intervention programs on obesity have been carried out in China to prevent and decrease obesity among children. Yet, all intervention programs in China reviewed here were school-based and predominantly educational. Based on Frieden's health impact pyramid, educational interventions

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32 Xu, Li, Liang, Wang, Hong, Ware, Leslie, Sugiyama, and Owen, *op. cit.*

33 Barry M. Popkin, "Synthesis and Implications: China's Nutrition Transition in the Context of Changes Across Other Low and Middle Income Countries," *Obesity Reviews : an Official Journal of the International Association for the Study of Obesity* 15 (0 1) (2014).

34 J. He, "A comparison of 'converting free markets into supermarkets' across large and middle-sized cities [Dazhong Chengshi 'Nonggaichao' Moshi Bijiao]," *Business Time* 31 (2006):11–12

35 Gao, Huang, Zhang, Liu, Feng, Liu, Li, et al., *op. cit.*

are the least effective type of intervention.[36] Widely accepted by many public health professions in the US, the health impact pyramid of public health action proposed by Frieden stated that the impacts of change the environmental context to make healthy options the default choice, regardless of education, income, service provision, or other societal factors are more profound than long-lasting protective interventions, clinical interventions, or counseling and education. Hence, public health professions in the US have been collaborating with urban planners and transportation planners to identify built environmental factors that support healthy behaviors.[37] Future obesity intervention programs in China might look into modifying transportation related policies and urban built environment to support healthy living.

Surprisingly, limited empirical studies published in Chinese were identified. This might be due to the fact that the faculty evaluation system in Chinese universities favors peer reviewed English journal articles over Chinese academic journal articles.

Researchers from public health, sports and exercise, and urban planning in China are working in this emerging research field: environment building and healthy lifestyle. Given the complex nature of overweight and obesity and the interdisciplinary nature of this research field, geographers and transportation planners are expected to join and expand the area of research. More interdisciplinary collaborations should be carried out in China.

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[36] Thomas R. Frieden, "A Framework for Public Health Action: The Health Impact Pyramid," *American Journal of Public Health* 100 (4) (2010): 590–595.

[37] (i) Susan L. Handy, Marlon G. Boarnet, Reid Ewing, and Richard E. Killingsworth, "How the Built Environment Affects Physical Activity: Views from Urban Planning," *American Journal of Preventive Medicine* 23 (2 Suppl) (2002): 64–73.
(ii) Popkin, Duffey, and Gordon-Larsen, *op. cit.*

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