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Hidefumi Imura

Environmental Issues in China Today

A View from Japan

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CHUUGOKU NO KANKYOU MONDAI IMA NANIGA OKITEIRUNOKA

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Preface

The Chinese economy has been making remarkable progress in recent decades. As of 2012, present-day China somewhat resembles Japan in the midst of the high economic growth of the 1970s or in the following period of the bubble economy in the 1980s. People's standard of living has improved, and there is an emerging wealthy class who own cars and second homes. What interests people in that economic class are condominiums and trips abroad. While the country maintains the Communist Party regime, the philosophy of socialism no longer dominates people's thinking. Business people in coastal megacities, which have been leading China's economic growth, are eagerly committed to developing new businesses. Such privilege, however, reaches only a part of the whole population or people close to the ruling Communist Party and state-owned enterprises, and in fact the majority of people living in inner areas in the western regions and in villages remain relatively poor.

We may consider that environmental issues in China shed light on the contradictions and imbalances in Chinese society. China has become the second largest country in terms of GDP, having overtaken Japan, Germany, and the United Kingdom. It is also the largest contributor to CO_2 emissions, which are considered to be the major cause of climate change in the coming centuries. As the world's factory of the twenty-first century, the country is so eager to manufacture goods that it seems determined not to be seriously concerned with the fact that such industrial activities are polluting the air and water. In addition, environmental problems originating in China such as photochemical smog, acid rain, PM 2.5, and yellow dust affect our daily life in Japan. Government officials speak of the importance of protecting the environment and conserving resources, and laws, institutions, and administrative bodies have been created toward that end, but they exist only nominally, and the environmental management system as a whole does not function effectively.

What should we do to encourage our neighbor China to take the necessary countermeasures? Japan's experience in combating severe industrial pollution should be beneficial to China. This, precisely, was a reason Japan promoted bilateral

environmental cooperation with China, using a large amount of official development assistance (ODA) funds during the 1990s. In the new century, however, with the increasing government deficit, the conventional system under which Japan, with its financial power, provided assistance to China is no longer feasible. Meanwhile, political tensions between China and Japan have been heightened owing to the territorial issues surrounding the Senkaku/Diaoyu Islands in the East China Sea.

Looking at our neighboring country driven by dynamic energy, we of the baby-boomer generation in Japan—whose economy now is, by contrast, slowing down in this era of an aging society—naturally remember the high economic growth period that we once experienced. Japan enjoyed rapid economic growth at an annual rate of nearly 10 % in the late 1960s to the early 1970s, but at the same time, industrial pollution issues were reported in the media almost every day. Even though we witnessed both devastating damage to human health and radical student protest movements across the country, society at that time was somewhat overwhelmed by a strange kind of energy. It could be that people became somewhat irrational as they saw their income increasing literally every year. Then in 1973, our economic growth was suddenly struck by the "oil shock," and from that time Japanese society began its transformation into a matured state, providing suggestions for the future direction of China.

China and Japan are geographically separated only by a relatively narrow stretch of water. China's cultural influence on Japan has been tremendous, including language and writing systems, religion, philosophy, and technology. The relationship between the two countries has been generally peaceful although there have been some wars between them in their long history. The author, like many Japanese people, pays respect to the Chinese as our teachers. But Japan's invasions and war crimes in China during the first half of the last century and their aftereffects, China's territorial disputes with its neighbors, and the expansion of China's military budget are casting clouds over current Sino-Japanese relations.

Under these circumstances, what we could do is to lead our neighbor to realize that it is a part of the environmental community of East Asia, so that it will take environmental measures that meet its increasing economic power in harmony with Japan and other Asian countries. But how? Based on such concerns, this book attempts to picture environmental issues in China from a holistic point of view. Environmental problems are woven into the entirety of human endeavor, so it is impossible to discuss them in isolation. An environmental problem occurring today at one location does not occur independently of anything else; it is connected with politics, economy, society, culture, and history of that whole country and, in fact, the whole world. In this book, my intention was to write about environmental problems in China—not simply about the phenomena we see on the surface, but in a way that the relationship of these problems with a variety of background factors would come into view. Because of this approach, there may be sections of the book where I describe something that may at first glance seem to have little connection with environmental problems. This was my own attempt to portray the issues through many different lenses, using a three-dimensional, bird's-eye view and perspective.

In 1995, I coedited a Japanese book the title of which, in translation, was *Environmental Problems in China*. It was an attempt to present an overview of the environmental problems in China at that time. But in the ensuing 10 years or more, the situation in China and political and economic relations between Japan and China changed dramatically, and I published another book in 2007. Subsequently, I wished to publish this material in English. Again, at this point I cannot avoid realizing the many changes that have occurred in the last 5 years or so, and I have tried to use as much new data as possible in this English version. Whatever the case, however, no matter how fresh the information is at the time of publication, in a short time it will be out-of-date. This is especially true of a country like China, where change occurs so rapidly. Within a few years, revisions will become necessary, but I hope that this book helps readers deepen their understanding of current environmental issues in China, especially in the context of the Japan–China relationship. Despite my best efforts, I am keenly aware of the difficulties in covering everything in one single volume. My lack of knowledge and understanding in some areas left me with many issues for which I could not provide adequate coverage.

The sources of the data and information in this book include statistics published by the Chinese government, publications by other authors, academic papers, newspaper articles, and television programs, as well as my own notes and recollections of field studies. For statistical data in this book, I tried to use the latest figures available as of 2012, but wherever that was not possible, I used older data.

In closing, I would like to express my heartfelt appreciation to Michio Hashimoto, Kazuo Hishida, Senro Imai, Hideaki Koyanagi, Hitoshi Kometani, Miao Chang, and many others, who taught me so much about environmental problems in China and the factors behind them. For English translation, I am very grateful to Randal Helten and Kazuko Watanabe for their valuable help and advice.

Yokohama, Japan Hidefumi Imura

Contents

Chapter 1
Environmental Problems: Borderless

Abstract This chapter discusses the environmental interdependence between China and Japan from two viewpoints: transboundary pollution due to geographical and meteorological conditions and transaction of environmental loads through trade in goods and services. *Kosa*, or yellow sand, originating from the northern part of China has been a regular phenomenon observed in Japan in the springtime every year. Along with economic growth, atmospheric concentrations of air pollutants such as sulfur dioxide, nitrogen oxides, ozone, and PM 2.5 are still significant or even increasing in China. The jet stream carries these pollutants to Japan, contributing to the occurrence of photochemical smog, acid rain, and high concentration of PM 2.5 in areas where there are not large emissions from domestic sources. Meanwhile, the linkages through trade between Japan and China have complex economic and environmental implications. Many Japanese manufacturers shifted their production basis to China, reducing energy and raw materials input in Japan, while the demand of these resources is rapidly increasing in China. Various types of wastes generated in Japan are exported to China as resources to be recycled there, and primitive recycling activities accompany health risks due to hazardous substances.

Keywords Economic and environmental interdependence • Jet stream • Transboundary air pollution

1.1 Continental Effects

1.1.1 Japan's Photochemical Smog and PM 2.5: Now Made in China?

Beijing summers are very hot. Streets lined with tall buildings overflow with exhaust-emitting vehicles. A white mist hangs in the air, and visibility is poor. This very much resembles the state of the atmosphere in Tokyo during the 1970s. It seems

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clear that photochemical smog is being generated. The Chinese government's annual report on the state of the environment, however, does not make much mention about it (Ministry of Environmental Protection 2012). People have got accustomed to it and accept it as normal without noticing something out of the ordinary. In the run-up to the Summer Olympics in 2008, the air pollution became a serious concern, and people were worried that air quality problems would affect athletes in the marathons and other competitions being held in the city. This pushed Beijing City government to take measures against air pollution more seriously than before, but still much effort should be made to clean up the sky in Beijing.

On May 8, 2007, I happened to be on my way to Kitakyushu City in Japan. To my surprise, upon my arrival I was greeted by a "photochemical smog alert" from the environmental office of the city. Photochemical smog is symbolic of the environmental problems Japan experienced during the 1970s. It occurred frequently in summer in those days, under the strong ultraviolet rays of the sun, and was accompanied by sore eyes and throat, headaches, and other health effects. A white haze would hang in the air, reducing visibility. At one time there were tens of thousands of sufferers each year, and photochemical smog became a huge public issue, but the situation has been largely improved in recent years.

In fact, Kitakyushu had experienced serious industrial pollution in the past, but thanks to stricter factory regulations, the city is famous today for having achieved dramatic improvements in the condition of its environment. The city had tightened up its regulations for emissions of vehicle exhaust—one source of photochemical smog—and had reduced the number of local smoke-emitting factories. On this particular day, at first I was at a loss to understand how I could possibly be experiencing photochemical smog years later, so early in May and before summer had even begun. The next day, on May 9, photochemical smog alerts were issued in 22 other prefectures nationwide. These alerts were now rare thanks to the introduction of tougher air pollution legislation. And how could it be that photochemical smog—which normally occurred only under the scorching sun in the middle of summer—was now here even before the summer began?

We can only explain this mystery by examining the relationship between Japan and the neighboring continent. The causes of photochemical smog are nitrogen oxides (NOx) and hydrocarbons (unsaturated hydrocarbons in particular) emitted from such sources as automobiles, factories, and business establishments. Through a photochemical reaction under sunlight (ultraviolet rays) they generate photochemical oxidants as a secondary pollutant: ozone is one component of photochemical oxidants, but this is also mixed with chemicals such as peroxyacetyl nitrate, formaldehyde, and acrolein.

Meanwhile, from December 2012 to January 2013, Beijing was shrouded in high level of air pollution and heavy haze. The data released by the US Embassy in Beijing showed a harmful level of PM 2.5, fine particulates that are two- and- one-half microns or less in width. Incidentally, many Japanese cities observed increases in PM 2.5 concentrations, suggesting that it was related to air pollution in Beijing and other cities in China. China decided to release hourly monitoring data of PM 2.5 and other air pollutants to respond to people's concerns about air pollution.

Along with China's economic growth, atmospheric concentrations of NOx from factory and vehicle emissions are increasing today, and the jet stream carries photochemical smog precursors and particulate matters generated from those sources to Japan. The particular smog event I experienced in Kitakyushu could probably be explained logically this way: pollution in the atmosphere over China on May 6 arrived over northern Kyushu Island on May 7 and then spread over the main island of Honshu on May 8 and 9.

1.1.2 Yellow Dust and Acid Rain

When Japanese hear about photochemical smog from the Asian continent, many will probably associate it with what they know as *kosa* or yellow dust (or yellow sand). As a child in the 1950s, I lived in a city in Japan's Hokuriku district, along the Sea of Japan. This was in the days before sealed aluminum sash windows, and in early spring we would often find fine dust throughout the house on tables and *tatami* mats and even inside the cupboards. This was also before most people owned electric vacuum cleaners, so it was quite a lot of work to wipe or sweep the dust away. We eventually learned that the yellow dust was a regular phenomenon in the springtime every year. Clothes drying outside and cars may have gotten dirty from the dust, but it was not really recognized as an environmental problem.

In recent years, however, Japan Meteorological Agency has been issuing "yellow dust alerts," because the yellow dust flies in spring at exactly the same time as the outbreak of hay fever—a common affliction in Japan—and this drew attention to allergic reactions, respiratory problems, and other impacts caused by yellow dust. What should be noted about the yellow dust alerts is that it is not only the regions of Japan closest to the Asian continent that are affected but also a large area of the Japanese archipelago, including the Tokai, Kanto, and Tohoku districts. Figure 1.1 is an example of real-time online alert maps of yellow sand distribution.

Another issue affected by the continent is acid rain (United States Environmental Protection Agency 2012). This rain is highly acidic, as it contains sulfuric and nitric acid that has been transformed from sulfur oxides (SOx) and NOx emitted into the atmosphere as pollutants from factories and automobiles. Acid rain first became an issue during the 1970s in places like northern Europe and Germany, and it was also observed in various locations in Japan starting in the 1980s. One might tend to assume that acid rain in the Kanto area around Tokyo would be caused by air pollutants emitted from automobiles and factories in the Tokyo metropolitan area. But how could one account for strong acid rain also being observed in areas like Japan's Sanin region (west northern part of Honshu Island facing Japan Sea and mainly Tottori and Shimane prefectures), which have very few sources of these pollutants? The source—or at least one source—is probably the Asian continent.

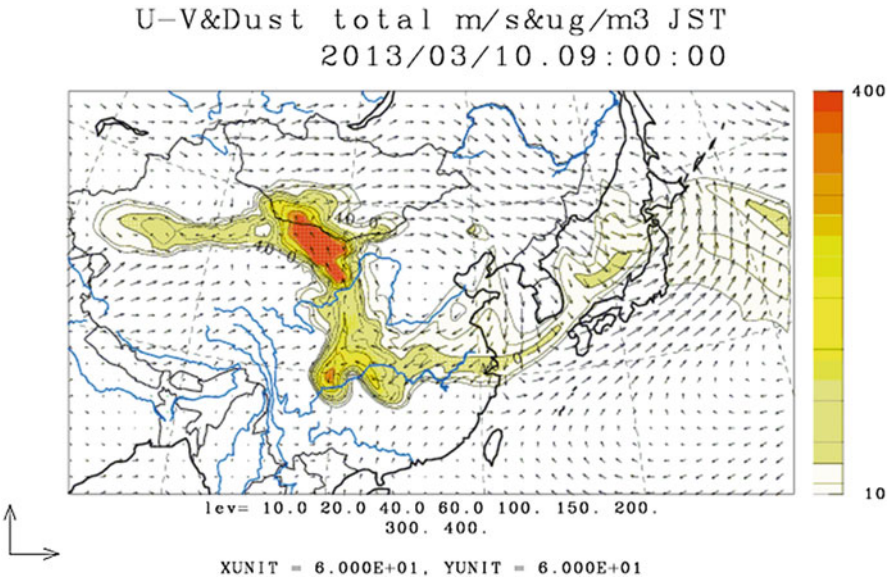

Fig. 1.1 Forecast of yellow sand distribution, averaged from surface-1000m height. *Note*: This is an example of real-time forecast accessible on the web (*Source*: Institute for Applied Mechanics, Kyushu University and National Institute for Environmental Studies (http://www-cfors.nies.go.jp/~cfors/index-j.html)

1.1.3 Jet Stream

Photochemical smog, yellow sand, and acid rain in Japan all have something in common: something generated on the Asian continent is carried by air currents over to the Japanese archipelago. Yellow sand consists of soil and mineral particles from arid and semiarid regions inland in China like the Taklamakan Desert, the Gobi Desert, and the Loess Plateau, which are blown by the wind to heights of thousands of meters and then carried by the jet stream toward Japan, where they are suspended in the atmosphere or fall to the ground.

The negative impacts of yellow sand are actually becoming more severe in both China and Korea. During the spring, yellow sand sometimes reduces visibility in Beijing to a few tens of meters, frequently closing highways and airports. I have experienced times when my flight could not land in Beijing and was turned away, and yellow sand frequently closes the airport in Seoul. Yellow sand has been a problem since long ago, but in recent years, its scale and frequency has been increasing, and Chinese uses terms equivalent to "violent sand storm" to describe its decisive power and impact. These kinds of words would normally be used to evoke the image of an intense sandstorm. Some suggested that causes of the yellow sand include a loss of grassland cover due to the increase of livestock grazing in Inner Mongolia and elsewhere, the loss of topsoil when grasslands are converted to cultivated land, and the increased vulnerability of these lands to wind erosion.

Acid rain and photochemical smog, and PM 2.5 (fine particles with width less than 2.5 μm) which is calling attention due to the severe air pollution in Beijing in the winter of 2012–2013, have similar causes. Because of economic growth, the amount of coal and oil being combusted in factories, households, and automobiles is rising rapidly, consequently increasing the amounts of the SOx, NOx, hydrocarbons, and other pollutants generated. Where in China are they coming from? To answer this, research must be conducted using detailed meteorological simulations, but one could make some general assumptions by looking at a map. Places such as northeastern China, large cities as Beijing and Tianjin, and the Shandong Peninsula have large industrial belts and high population densities; the amount of coal used here is large, and vehicle traffic volumes are increasing rapidly. Thus, there is a rational basis to believe that the air pollutants generated from these areas are being transported to the Japanese archipelago in the form of acid rain, photochemical smog, and PM 2.5.

1.1.4 Marine Pollution

Japan's territorial waters are in contact with China at the East China Sea. This sea has become a political issue between China and Japan concerning Senkaku/Diaoyu Islands and oil and gas field developments. If oilfield development here goes full speed ahead, the threat of marine oil pollution will also increase. Because China is a continental country that possesses a huge expanse of hinterland, pollutants contained in wastewater settle onto the soil or flow into rivers, and whatever flows into rivers ultimately will flow into the sea.

China's economic development is concentrated in the shape of a sideways letter "T," consisting of the eastern coastal area and the Yangtze River basin. Land-based productive activities such as agriculture and industry, together with consumption activities in cities, result in the emissions and discharge of a variety of substances, such as nutrients like phosphorous and nitrogen, organic sludge, heavy metals, and endocrine disruptors, and they flow in great quantities into the Yellow Sea and the East China Sea. Marine pollution of the Bohai Sea is also becoming a problem. It is located at the inner reaches of the Yellow Sea and is somewhat confined by the narrowing of land between the Liaodong Peninsula and the Shandong Peninsula, making it easier for pollutants to reside here longer. Coastal pollution is worsening here because wastewater is flowing into the area from large cities such as Dalian on the Liaodong Peninsula, Tianjin on the North China Plain, and Beijing.

Coastal zones of the Bohai Sea and Yellow Sea also have extensive areas of shallow water, providing many wetlands that serve as habitat for migratory birds. Due to human developments in the coastal areas, however, these wetlands are being reduced. On the other side of the Yellow Sea is Korea, so pollution of the Yellow Sea is also an international issue between Korea and China.

Air pollution comes to the Japanese archipelago from the continent, carried by the jet stream, while marine pollutants are carried close to the Japanese archipelago by the Kuroshio Current as it flows northwards. It is quite common for garbage

dumped in coastal waters near China to wash up on Japanese shores. The water flow of a great river like the Yangtze is huge and has the power to push a variety of substances from the mouth of the river further out to sea. The nutrients that run off from the land to the sea help to create good fisheries, but if there is too great of an increase of pollutants flowing into the sea, the result will be a marine pollution problem. These days, even in announcements from the Chinese government, there has been an increasing frequency of red tides in the Bohai Sea, East China Sea, and Yellow Sea. The large outbreaks of Nomura's jellyfish (*Nemopilema nomurai*) that have become a problem in the coastal waters of Japan may also be related to pollution in the East China Sea and Yellow Sea.

1.2 Resources: Essential for China's Development

1.2.1 Recycled Resources: Wherefore Art Thou?

Air and marine pollution are borderless. Meteorological and marine conditions cause pollutants generated on the Asian continent to flow toward the Japanese archipelago to the east with wind and ocean currents. This phenomenon is referred to as transboundary pollution, and it is becoming an issue around the world. The international linkages of environmental problems are rooted in these types of geographical relationships between countries as well as natural conditions, but one additional aspect is that they also function through economic relationships. One example of this is the issue of resource circulation caused by international trade.

Along with China's economic growth, trade between Japan and China is expanding. One noticeable change since the beginning of this new century is the expansion of exports of materials and resources to China. There have been many reports about the rapid expansion of steel demand in China and the associated positive business results for Japanese steelmakers (International Monetary Fund 2010). Another topic that stirred up the media recently was repeated incidents of the theft of metal. The construction boom in China before the 2008 Olympics in Beijing and before Expo 2010 in Shanghai created a shortage in metal for use in construction. As a result, iron and other types of metal scrap from Japan was exported to China and sold at high prices. Evidently, these factors were related to frequent incidents of the theft of metals in Japan. It was not only the price of metals but also the price of used paper that rose. There has been a rapid increase in demand for cardboard boxes in China, for products to be exported from China; the increase in used paper prices in Japan was due to the start of exports of used paper from Japan to China for use as a raw material to make cardboard. In the not-so-distant past, Japanese community groups and schools that had toiled to collect used paper could find no buyers for it; not only could they not give it away, they often had to pay someone to take it away. But that situation has changed dramatically due to demand from China.

There were similar situations with exports to China increasing for waste plastic and plastic beverage bottles. Used electric appliances, personal computers, mobile

phones, and other electronic devices (or "e-wastes"), and even automobiles that can no longer be used in Japan are also being exported to China these days. Japan has declared the goal of transforming itself into society with sound material cycles as a major objective of official environmental policies; governments have been moving forward with changes in legislation to promote resource recycling and have strengthened programs to collect different types of garbage separately in municipalities, and the private sector has been constructing recycling facilities. Citizens are making the effort to recycle and are cooperating with the separated-garbage collection programs. If Japan is unable to recycle these resources within the country and instead they flow overseas to China or elsewhere, the outcomes will be far from the original intentions of the policies. There is also a severe problem with recycling facilities operating seriously in the red because they are unable to secure the amount of business originally expected.

1.2.2 China's Transformation into a Resource-Hungry Giant

China's average annual growth in gross domestic product (GDP) from 1980 to 2012 was 9.94 %. Per capita GDP in 2012 surpassed 6,000 US dollars (or 38,545 yuan) (The Energy Data and Modelling Center 2012). Per capita income in large cities such as Shanghai and Beijing was even higher, surpassing 10,000 US dollars in Shanghai. China became the factory of the world, exporting textile products, home electronics, and other variety of products. Surging forward with the building of its national infrastructure of urban buildings, roads, and so on, it increasingly requires the essential ingredients for this economic growth: resources such as iron, nickel, copper, aluminum, paper and pulp, cement, and plastic. It is also a major challenge for the country to provide enough food to feed its population of more than 1.3 billion people (Brown 1995).

If China were able to continue at an annual economic growth rate of 8 %, it would increase fivefold in just 20 years. If China were to consume resources at the same level as developed countries, in proportion to its population and size of the economy, it could not avoid having a huge impact on worldwide demand for resources, including oil, iron ore, uranium, food, and more. China has become active since the beginning of the new century in securing resources from overseas, especially from Africa, the Middle East, and Central Asia.

1.2.3 The Challenge of Climate Change

China's energy consumption is rising rapidly, together with its economic growth. The country's emissions of carbon dioxide (CO_2)—one major source of global warming—is the largest in the world, accounting for 23.7 % of global emissions in 2009 as shown in Table 1.1. In 2006, China surpassed the United States to become

Table 1.1 Primary energy consumption and Carbon dioxide emissions by country

		China	USA	India	EU27	Russia	Japan	ASEAN9	Other countries	World total
1973 total	GDP (billion US dollars)	120	4,322	124	4,514	227	2,091	136	2,821	14,355
	Population (million people)	882	212	586	445	133	108	302	1,234	3,902
	Primary energy consumption (Mtoe)	266	1,730	64.3	N.A.	N.A.	320	43.6	3,131	5,555
	CO_2 emissions (Mt-CO_2)	976	4,701	207	N.A.	N.A.	891	129	9,061	15,965
2009 total	GDP (billion US dollars)	2,940	11,357	900	9,472	398	4,817	925	9,166	39,975
	Population (million people)	1,331	307	1,155	501	142	128	579	2,594	6,737
	Primary energy consumption (Mtoe)	2,056	2,163	512	1,649	642	472	397	3,295	11,186
	CO_2 emissions (Mt-CO_2)	6,975	5,258	1,624	3,486	1,476	1,079	998	8,185	29,081
1973 per capita	GDP (US dollars)	136	20,398	212	10,143	1,707	19,343	451		3,679
	Primary energy consumption (toe)	0.301	8.16	0.110	N.A.	N.A.	2.96	0.145		1.42
	CO_2 emissions (t-CO_2)	1.11	22.2	0.354	N.A.	N.A.	8.24	0.426		4.09
2009 per capita	GDP (US dollars)	2,208	36,993	779	18,917	2,808	37,766	1,598		5,934
	Primary energy consumption (toe)	1.54	7.05	0.443	3.29	4.53	3.70	0.686		1.66
	CO_2 emissions (t-CO_2)	5.24	17.1	1.41	6.96	10.4	8.46	1.72		4.32
1973 per GDP	Primary energy consumption (toe/million US dollars)									
	CO_2 Emissions (t-CO_2/million US dollars)									
2009 per GDP	Primary energy consumption (toe)									
	CO_2 emissions (t-CO_2/million US dollars)									

Source: "Energy & Economic Statistics 2012" (The Energy Data and Modelling Center, Sho-Energugi-Sentaa)
GDP Real GDP in terms of constant 2,000 US dollar, *toe* tons of oil equivalent

the top emitter. China's total emissions are more than six times those of Japan. Japan's per capita emissions are still two times those of China, but the gap is rapidly diminishing.

The solution to global warming problems requires the world's cooperation, though it must be noted that the CO_2 emissions of the United States and China—the top two emitters—account for about 41.6 % of the world total (2009). Cooperation between these two countries to reduce emissions is critical to solving the problem.

It was in 1992 at the Earth Summit in Brazil that the United Nations Framework Convention on Climate Change (UNFCCC) was adopted by a decision reached requiring each country to cooperate in tackling the problem of climate change. And it was with the Kyoto Protocol in 1997 that countries agreed to legally binding emission reduction targets. Nevertheless, it was only the United States, European Union, Japan, and other developed countries to which the reduction targets applied; no targets were imposed on developing countries such as China. Thereupon, the Bush Administration of the United States, dissatisfied that no reduction obligations were imposed on China and other developing countries, used that arrangement as an excuse to withdraw from the Kyoto Protocol in 2001. Climate change became a major theme at the G-7 economic summit in Germany in 2007, when leaders discussed the idea of cutting greenhouse gases emissions in half by the year 2050. The leaders had an awareness that in order to achieve this, a new international framework was required—one that included countries like China and India.

China adopted a tough bargaining approach to international negotiations on climate change. When told that its total emissions were large, China countered with the fact that its emissions per capita were less than one-fifth those of the United States, fighting demands to reduce emissions. Furthermore, it took the position as a champion of developing countries and asserted that the current problem of climate change was caused by economic activities of countries in Europe and America since the Industrial Revolution and that the primary responsibility for taking action was with those developed countries. Fighting back, it took the stance of demanding technical assistance and technology transfers to developing countries, including China.

Economic development cannot occur without an increase in energy consumption. To keep CO_2 emissions from rising, it is necessary to increase dependence on non-fossil-fuel sources, such as hydropower, wind power, and arguable nuclear power, and to increase energy conservation in every sector. Because these choices will in the long run reduce energy costs and also be positive for economic growth, China is displaying interest in this direction. The most effective approach to environmental and energy conservation measures would be to replace older technologies in production processes and buildings and factories with more advanced ones. This would be nothing less than a technological revolution driven by packaging productivity improvements together with environmental and energy conservation measures. For this to happen, China would like to have access to technology from Japan and other developed countries. Viewing China's remarkable economic growth in recent years, all countries have a keen interest in its markets, while the reality is that they are also inevitably cautious about providing their advanced technology coupled with intellectual property right.

1.3 The Path for China–Japan Environmental Cooperation

1.3.1 Economic Globalization and Environmental Issues

The economic linkages through trade between Japan and China have complex significance for the environmental dimension. As China became the factory of the world, certain products that were in the past made primarily in Japan have been replaced with products made in China. Clothing and underwear are representative of such textile products, but the majority of electronic products and toys sold in Japan today are also made in China now. Recently, imports of food from China to Japan have also increased, while there are some concerns about risks of residual agricultural chemicals on vegetables from China.

Buying products from China means asking it to assume the burden of consuming air, water, soil, and other environmental resources in order to produce products—burdens that were previously borne in Japan. In return, the environmental impacts arising in Japan decline, while the domestic impacts in China increase. This closely resembles the situation of Japan when it was in the period of rapid economic growth. At the time, while creating serious pollution problems that resulted in health victims at home, Japan produced industrial products at low, internationally competitive prices and, by exporting them overseas, was able to achieve high economic growth, thought it bathed in criticism from overseas about pollution dumping.

Another problem is with Japanese corporations' advances into China—particularly by shifting factories there for local production. During the 1980s when China shifted to policies of reform and openness, many Japanese companies seeking cheaper labor forces moved their factories there. Labor costs later rose in China, so the merits of moving there were reduced, at least on the wage dimension. Recently, before the outbreak of anti-Japan protests over disputed islands in the East China Sea in 2012, a growing number of Japanese companies were seeking a foothold in China from the strategic perspective of securing a production base in its huge and growing market.

Production overseas means counting overseas environmental resources such as air, water, and soil. In the worst case, this means that it is impossible to avoid emitting waste overseas that was previously emitted locally in the original country. This poses the risk of criticism for exporting pollution. Japanese corporations setting up operations overseas can also have positive impacts for the host country. This is because, generally speaking, the technologies of Japanese corporations are higher than those in China and developing countries.

Japanese corporations have a keen interest in the Chinese market of 1.3 billion people. Made-in-Japan products are exported to China, and, conversely, made-in-China products are exported to Japan. And it is not only final products being traded; there is also a huge trade in the import and export of raw materials, parts, and other intermediate products. Thus, no one should forget that besides the deepening of economic relations between Japan and China, the environmental problems of both countries are intimately linked through the import and export of goods and services.

Fig. 1.2 Satellite photo of East Asia at night. *Note*: The map shows where cities are located, and how intensively electricity is used there (http://geology.com/articles/satellite-photo-earth-at-night.shtml)

1.3.2 East Asian Environmental Community

The region including the eastern part of China, Korea, and Japan is one of the most vigorous centers of economic activities in the world with many big cities. Figure 1.2 is a satellite photo at night of this region: the brightness demonstrates the population density multiplied by the amount of light per person which is closely related to energy consumption.

The environments of China and Japan are inseparably connected due to their geographic proximity and increasingly interconnected economies. Similar relationships also apply to Japan and Korea. The similar could be said about the Russian Far East, Mongolia, and Southeast Asian countries. Clearly, the solutions to environmental problem require that countries do not work alone but instead work through mutual cooperation. Thus, the term "East Asian Environmental Community" has begun to appear recently. The term environmental community also appeared in the communiqué of the Tripartite Environmental Ministers Meeting among China, Japan, and Korea held in Seoul in January 1999 (Ministry of the Environment of Japan 2012).

The document announced that the three countries would cooperate in priority sectors to "raise awareness of the fact that the three countries are in the same environmental community, stimulate information exchange, strengthen cooperation in environmental research, promote cooperation in environmental industry sectors and environmental technology, search for appropriate countermeasures in order to prevent air pollution and preserve the marine environment and respond to global environmental issues such as biodiversity and climate change." Japan experienced and overcame many serious environmental problems during its years of economic development. It will be important to make use of that experience to resolve problems occurring now in China as common concerns for an environmental community in East Asia and, even further, to address global issues such as climate change.

1.3.3 China–Japan Environmental Cooperation

If we look at the situation of the world relating to environment and development, there is a big contrast between Asia, which has already launched upon a path of growth, and Africa, which still has not been able to escape from its difficulties. Turning our attention to Asia, it is safe to say that two countries—China and India—will have a particularly large effect on the direction in the twenty-first century.

Since the restoration of diplomatic relations between Japan and China in 1972, cooperation in the environmental sector has taken a special place in developing positive relations between the two countries. Nevertheless, in recent relations between the two countries, some stresses have also surfaced relating to issues of history and territory. In such a relationship between neighbors, sound wisdom is needed. China's environmental problems are changing dramatically, so environmental cooperation between it and Japan currently has the potential of building a new relationship.

Since China adopted policies of reform and openness, the Japanese government has poured much effort into economic cooperation with the nation. In particular, during the 1990s, cooperation in the environmental sector increased through the use of Japan's official development assistance (ODA). Since the start of the new millennium, however, in the context of China's growing national capacity, the core component of Japan's ODA to China has shifted away from infrastructure developments in coastal areas towards favoring areas inland in fields such as environmental conservation, boosting living standards, social development, and capacity building (Ministry of Foreign Affairs of Japan 2008a; Ministry of Foreign Affairs of Japan 2008b).

The advanced Japanese technologies in the energy and environmental sectors have attracted a heightened interest from the Chinese side. Because these technologies are in the realm of Japanese corporate rather than government know-how, these discussions are probably focused more on dealings on a commercial basis in the private sector. Even though Japan–China economic relations are expanding, it is still somewhat difficult to extinguish political tensions between the two countries.

There are various reasons for this. Among Chinese people, there is anti-Japanese sentiment coupled with burgeoning feeling of Chinese nationalism. There may also be some problems with the political governance in China: some experts suggest that China's leaders are using the dispute to divert people's attention from problems at home such as a widening gap between rich and poor, corruption, and environmental degradation.

Japan's environmental cooperation with China through ODA was very active in the 1990s, and it has already peaked. The Japanese government announced its intention to end ODA to China in 2008. The economically delayed western inland part of the country has huge financing needs for urban waterworks and sewerage systems, and expectations for Japanese ODA persist. Conversely, industrial pollution countermeasures, energy conservation, and urban waste management in the economically more powerful eastern coastal areas are now at a stage where technical cooperation on a commercial basis is most suitable. For China today, economic growth and harmony with the environment are the major challenges to address. To do so, Japanese technologies—in wastewater and waste treatment, energy conservation, and resource circulation—can play some role. China and Japan account for nearly 70 % of the economic activities of Asia, and their cooperation corresponding to their respective economic and technological capacities is essential for sustainable development of the region.

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Chapter 2
Environmental Issues in China: An Overview from Japan

Abstract This chapter presents a brief review of the history of economic development and environmental issues in China. After economic reform and opening up policies adopted in 1979, China achieved remarkable economic growth while it was associated with expanding consumption of natural resources and emissions of air and water pollutants. China and Japan are neighbor countries, having a long history of cultural exchange and trade. After the end of Second World War, however, the diplomatic relation between the two countries was disconnected, and it began to normalize only in 1972. Cooperation in the environmental sector was developed as one of the pillars of official development assistance from Japan to China, especially in the 1990s. In the 2000s, however, the environmental cooperation between them cooled down due to economic stagnation in Japan and increased political tension caused by territorial issues.

Keywords China–Japan cooperation • Environmental cooperation • ODA • Official development assistance

2.1 China–Japan Relations in Transition

2.1.1 So Far and Yet So Near

Japanese have a great interest in environmental issues in China. This is a direct extension of a natural interest in China, a foreign country, but still one perceived as being near and familiar. For a variety of reasons, in ancient times, the presence of the country known as the Middle Kingdom was strongly felt in Japan, and there has always been an interest in anything connected with Chinese culture. There are, however, underlying complexities behind the history between the two countries.

For me, personally, interest in China first blossomed at an early age, because both my parents spoke about China as something very close to us. The generation of

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Japanese of age before World War II felt its presence in real terms—even much more so than today. For a while after the war, however, China was outside our field of vision. During the Cold War between the East and West, Japan sang the praises of high economic growth, while China was under the leadership of Mao Zedong. Mao led the Great Leap Forward policy to turn China into a communist society through industrialization and agricultural collectivization. But it ended in an economic failure, followed by political turmoil and confusion of Cultural Revolution from 1966 to 1976. There were no diplomatic relations between China and Japan at that time, so we learned very little about internal conditions in China. While feeling closer to the United States and Europe—though situated much farther away geographically—through television programs and the like, China, our neighbor, seemed to be a distant country. It was only after the 1980s that this changed.

2.1.2 Restoration of Diplomatic Relations

It was only in 1972, through the efforts of then-Prime Minister Kakuei Tanaka and Chinese Prime Minister Zhou Enlai, that diplomatic relations between the two countries began to normalize. This was exactly the same time when industrial pollution problems were peaking in Japan. What really struck Japanese visiting China at the time was the smoke and wastewater issuing from old-style factories. Because Japan had already been experiencing pollution in many locations, the seriousness of the problem in China was quickly evident. Due to struggles within China relating to political and economic leadership, however, it was somewhat later that the nation began to tackle its environmental problems. In 1978, with the opportunity posed by the shift toward economic reforms under Deng Xiaoping, China began to feel the severity of its environmental problems and the need for countermeasures and came to Japan for help and cooperation.

During the 1980s and 1990s, this type of cooperation in the environmental sector was one of the pillars of official government assistance flowing from Japan to China (Ministry of Foreign Affairs of Japan 2003a). During the 1980s, China was still experiencing the aftereffects of its Cultural Revolution, and because the country's economic infrastructure was outdated, the emphasis for economic cooperation was on economic infrastructure. There was a huge disparity in the economic might of the two countries, and the arrangements were such that Japan, with its greater economic power, lent a hand to help in China's economic growth. China badly needed to modernize its factories and boost productivity while taking measures against pollution control. The cooperation in the field of environment was positioned at a center of the bilateral cooperation between Japan and China (Ministry of Foreign Affairs of Japan 2003b; Ministry of Foreign Affairs of Japan (2011); Ministry of Foreign Affairs of Japan 2003c). One monumental project was the establishment of the Japan–China Friendship Environmental Protection Center in Beijing. Japan provided 10 billion yen of grant for construction of the building and provision of basic equipment (JICA 2002).

After the early 1990s, China exhibited remarkable success in achieving rapid economic growth and made progress on its own in the improvement of environmental management regulations. By the end of the 1990s, however, while China's economic growth was proceeding smoothly, Japanese suffered the bursting of its "bubble economy" and its long-lasting aftereffects. Because of sluggish economic growth and widening fiscal deficits, the Japanese government came under pressure to review its official development assistance policies, and this included its policies regarding China (Ministry of Foreign Affairs of Japan 2003a). These factors were among those that ended up causing changes in Japan's relationship of economic cooperation with China.

2.1.3 Modern China, Modern Environmental Issues

Until the 1990s, the dominant popular image of China was a country with a vast land area and huge population, with industrialization achieved, but also as a country somewhat hobbled by out-of-date technology and poverty. Since the turn of the new century, however, it has been in the midst of a dramatic transformation. The country's economic might has grown rapidly, and it ranked second in the world in terms of GDP, having surpassed Japan in 2011. Furthermore, in 2006, China overtook Japan to become number two in automobile production. Although there has been little substantive change in its situation in which industrial air and water pollution is being caused by production technologies relatively out of date compared to those of Japan, Europe, and the United States, since the beginning of the new century, things cannot be viewed so simply.

For example, China has successfully launched a manned rocket into space, and it is quickly catching up to Western countries in computer and automobile technologies. Still, acid rain, photochemical smog, yellow dust, and PM 2.5, are being transported to the Japanese archipelago, evidently from the Asian continent, so it is important for Japan that China takes measures to address these issues. Climate change and the recycling of resources are other issues where China's actions are important. During the twenty-first century, in the context of international actions relating to environmental protection, Japan and China need to find a path of cooperation that corresponds to the respective economic and technological powers, and potential, of each country.

2.2 Understanding the Basic Issues

2.2.1 Vastness and Diversity

What do most Japanese people envision when talking about China? We could say that Japanese understanding and feelings towards it vary considerably—they differ for people who have visited the country and those who have not; or elderly people

Fig. 2.1 Map of China (*Source*: prepared by the author)

who remember the China of Mao Zedong and Zhou Enlai and younger people who know only the latest about the country; or those who have visited large cities like Beijing and Shanghai and those who have traveled further inland to Xinjiang (Xinjiang Uyghur Autonomous Region), Inner Mongolia, and other places. Moreover depending on their level of awareness, they will also have a different perception and understanding of China's environmental issues.

To best understand the country's environmental issues, first of all, it is necessary to start with an overview of the very land itself, but China is an enormous country. Taken on its own, even Japan, with its much smaller land area, is rich in biodiversity: from Hokkaido in the north to Okinawa in the south, it is virtually impossible to adequately describe its richness. This book can only possibly cover a part of the whole story about environmental issues in China. Figure 2.1 is a map of China showing the names and places which appear in this book.

2.2.2 Land

The primary factors that largely define environmental issues in China are its enormous land area and huge population. At 9.6 million km^2, it ranks fourth in the world in size, and covering about 7 % of the planet's land surface, it is roughly in the same size category as the United States, Canada, Australia, and Brazil—and about 25 times the size of Japan (380 thousand km^2). Its population of 1.34 billion people (2010) is the largest in the world, accounting for about 20 % of the global population. Total arable land amounts to 1.3 million km^2. While this is only about 14 % of China's total land area, it is equal to more than three times the total land area of Japan. Its arable land per capita is only 0.1 ha; that figure is much larger than Japan's 0.037 ha per capita (2005) but is less than half the world average. From the perspective of food production, this amount of land per capita is certainly just enough to sustain China's large population (Brown 1995).

China's massive land area supports an abundance of environmental and biological diversity, in terms of vegetation and climate, but there are also various problems it faces, depending on the region. The arable land is concentrated in densely populated regions such as the northeast plains, the North China Plain, and the midstream and downstream plains of the Yangtze River, along the Pearl River Delta and in the Sichuan Basin. Forest area in the year 2000 had declined to 1.59 million km^2 (16.55 % of national land area), but thanks to tree-planting projects, this was later restored to 1.95 million km^2 (20.36 %) in 2010.

Besides arable land and forests, much of the remaining land is classified as wasteland and grassland, but this also includes the steppes of Inner Mongolia and Xinjiang, the highlands of Tibet, and the Gobi and Taklamakan deserts. This is a country with diverse ethnic groups, so a person who, for example, travels to Xinjiang will find many Turkish Muslims or, in Yunnan Province, will encounter the traditional customs and lifestyles of the minority ethnic groups that live there. In Guilin, famous for its picturesque scenery, one can float down the River Li and on both sides of the river see the habitations and lifestyles of the minority Zhuang people.

The land and nature of China vary greatly from north to south and from east to west. In the north is the arid land with its scarcity of rain, expansive steppes and grasslands, and the Gobi and Taklamakan deserts. Meanwhile, Guangdong Province and others in the south are in the subtropical zone. In the west there are the Tibetan and Pamir plateaus with altitudes over 5,000 m, and Xinjiang has the towering Tianshan Mountains. The Yangtze River basin in the south has a wet climate, and it is a land of rice paddies with their networks of watercourses; the Yellow River basin in the north is an arid region with little rain, where field crops like wheat, sorghum, and corn are more commonly grown. There are sayings such as "boats in the south, horses in the north" and "rice in the south, sorghum in the north," each describing the difference in major transportation means and foods. The climate varies dramatically by region, and because food ingredients also differ, there are big differences in the types of food as well—even though many people think of Chinese food as one broad genre.

2.2.3 Regional Government Structure

China today, that is, the People's Republic of China, is comprised of 23 provinces, five autonomous regions, four direct-controlled municipalities, and two special administrative regions.

- Twenty-three provinces: Henan, Hebei, Shanxi, Shandong, Anhui, Hubei, Jiangxi, Jiangsu, Zhejiang, Hainan, Hunan, Guangdong, Fujian, Jilin, Heilongjiang, Liaoning, Gansu, Qinghai, Shaanxi, Yunnan, Guizhou, Sichuan, and Taiwan
- Five autonomous regions: Guangxi, Xinjiang, Inner Mongolia, Ningxia, and Tibet
- Four direct-controlled municipalities: Beijing, Shanghai, Tianjin, and Chongqing
- Two special administrative regions: Hong Kong and Macao

Here, the status of Taiwan involves political issues, but China considers it one of its provinces. In China's hierarchy, under the provinces and autonomous districts are cities and counties. The relationships among cities and counties in China are confusing in that the category of Chinese cities includes direct-controlled municipalities (cites), regional-level cities, and county-level cities. The direct-controlled municipalities are the four cities shown in the above list, and these are treated as having the same administrative powers as provinces. Regional-level cities can generally be considered as relatively large cities, and below them are counties and county-level cities. A regional-level city usually administers a few counties and county-level cities. A direct-controlled city is further divided into districts. Below counties are towns and villages. There are more than 40,000 of these towns and villages nationwide.

In summary, there are 661 cities including the four direct-controlled cities, 283 regional-level cities, and 374 county-level cities. The term "castle city" is used to call cities in China. The use of the term for "castle" is a vestige of former times when a town was encircled by castle walls. Pingyao in Shanxi Province is famous as a town where the castle walls and streets from the Ming and Qing Dynasties (AD1368–1644, and 1644–1911, respectively) have survived to this day.

A person traveling to China will see factories scattered here and there in farm villages; these are the township and village enterprises. Towns and villages are predominantly located in rural areas with large agricultural populations. Before China's economic reforms, there were communes to which farmers belonged, and they were largely self-sufficient. Workers in the communes were engaged not only in agricultural work but also basic industrial production. It was the township and village enterprises that established and ran these operations, and many of them are identified as major polluters in local areas.

2.2.4 Inland and Coastal Areas: Big Disparities

East of China is the sea. The country has an 18,000-km-long coastline blessed with good harbors. Economic development is most advanced in the coastal areas along the Bohai Sea, East China Sea, and South China Sea. From north to south the largest cities are Dalian, Beijing, Tianjin, Qingdao, Shanghai, Guangzhou, Hong Kong, and so on. The Yellow River, Huai River, and Yangtze River are the three great rivers of China, but the Yangtze is particularly deep and serves as a major route for transport, allowing large ships to travel upriver about 2,300 km from Shanghai at the estuary, via Nanjing and Wuhan, to Chongqing further upstream. The T-shaped economic region is formed by the coastal region and the Yangtze River basin central to the Chinese economy, which is tied together by water transport.

Large cities such as Dalian, Qingdao, Shanghai, and Hong Kong have ports and have achieved rapid economic development thanks to their connection to the rest of the world by the seas. Conversely, the inland region—generally referred to as the West—is relatively less developed economically due in part to the lack of access to marine transport. The Beijing capital is situated rather in the northeastern section of the nation, but has developed as the nation's political center. Modern day Xi'an (Shaanxi Province) was once the Tang capital of Chang'an, which flourished thanks to the trade route connecting with the Eurasian continent. Today, however, the city's location inland is a disadvantage for its own economic development. In the globalized world economy, the coastal cities with large port facilities have the greater advantage, because marine routes are the primary mode for the transport of goods.

2.2.5 The Rise of Heavy Industry

China's environmental issues are closely related to its unique political and economic systems. China was established as a socialist state in 1949, after the end of the Second World War. At the time the country was formed, and its model was the Union of Soviet Socialist Republics (USSR). Based on the structure of the USSR, China introduced a centrally planned economy and placed priority on nurturing and strengthening heavy industries and on the struggle to escape from being a poor agricultural nation. Under the post-World War II paradigm of the Cold War, an urgent motive for developing heavy industry was to strengthen the country's national defenses. Imagining a war scenario, China spread heavy industries around the country in various locations; this was a structure that permitted each region to be independent and self-sufficient (Economic and Social Research Institute, Economic Planning Agency of Japan 1997).

The geographical distribution of industry in China is also related to the reserves of underground resources, such as coal and iron. Inland cities such as Anshan and Fushun (Liaoning Province), Chongqing (now a direct-controlled city in Sichuan Province), Taiyuan (Shanxi Province), Lanzhou (Gansu Province), and Wuhan

(Hubei Province) were given heavy industries such as steelmaking and made into regional centers of economic activity.

Since the 1980s, economic reforms boosted China's role as the factory of the world in textiles, electronic products, machineries, and other products, and many of those industries became established in coastal provinces such as Zhejiang, Jiangsu, and Guangdong. The stimulus for these industries was the creation of special economic zones intended to attract foreign investment, and as one example one can recall the pace of development in Shenzhen, which in 1980 became designated as a special economic zone adjacent to Hong Kong.

The productive entity behind heavy industry was the state-owned enterprises. These were not only entities for production, but they also fulfilled the role of providing lifelong security for their workers, including housing, education, health care, and pensions. For example, the Anshan Steel Plant (Anshan City, Liaoning Province), which essentially took over the facilities of the Showa Steel Factory established by the Japanese before the war, provided everything for its workers—including education for workers' children, from primary, middle, and high school to university, nurseries, hospitals, cafeterias, and so on—and its total population grew to as large as 200,000 people (as of 1995).

In cities that had large state-run enterprises, reportedly as many as half of the residents were employees of the company or their families. To some extent, this resembles Japan's company towns such as Toyota City and former Yahata City in Japan, but the range of employees in China's case was extremely broad. As economic reforms expanded in China, however, state-run enterprises with this older kind of structure were the cause of widespread unemployment in many cases. Under the planned economy system, state-owned enterprises carried out the procurement of materials, production, and allocation of resources based on orders from the central government and had no self-determination in their own management. For them, the most important thing was to achieve the production quotas given to them from above; production efficiency was a secondary matter. Transactions of materials among state-owned enterprises could not be conducted in a market based on price; payment was done by something that resembled bartering. Financial centers and banks were not well developed. The concepts of debt and bonds were not clearly formulated, and even in the event of a financial loss, it was impossible to go bankrupt. In the 1980s and early 1990s, when Japanese corporations began business with local state-run enterprises in China, a problem they encountered was that the financial settlement system did not function in a way one would normally expect in a capitalist country.

According to the guiding principles of the Communist Party, farmers were given a high rank in the working class, but the economic environment farmers found themselves in was very difficult. They were affiliated with communes, and their livelihood was one of self-sufficiency completely covered by the commune. The government would purchase their agricultural products, but prices were kept low. In principle, farmers were not permitted to select which crops to plant, to sell the harvest on the market, or to obtain cash revenues. The emphasis of national policies was on heavy industries such as steelmaking, and the agricultural and light industry

sectors were subordinate to heavy industry. Heavy industry was fostered as a government priority, and under a system with rigid economic policies of the planned economy, closed to the outside world, investment was inefficient; production efficiency was also low because of sluggish technological development. These conditions resulted in slow development of the overall economy and also led to serious pollution problems.

2.2.6 Reforms

China in the 1970s went through a period of political conflict and confusion after the Cultural Revolution, and the economy was battered, but Deng Xiaoping of the realist faction triumphed; his economic reform policies began at the end of 1978. The aim of those reforms was to open up the country to foreign trade, to modernize the backward industrial sector, and to revitalize the agricultural sector by introducing pricing mechanisms into the agricultural products market. The emphasis of industrial modernization was placed on the light industry, rather than heavy industry, to make use of China's abundant supply of labor. This choice was related to the fact that many heavy industries were located far inland—which was disadvantageous for foreign trade—and many were bloated state-owned enterprises, so there were concerns that it would be difficult to shift those enterprises quickly to a market-based economy.

The agricultural sector underwent a transformation from the collective farming system of communes to a household contract system of farming. Consequently, the price of farm products rose, and the motivation of farmers to produce improved dramatically. Special economic zones were established in order to promote foreign trade. At first, four zones were designated along the coast, including Shenzhen (Guangdong Province) and Xiamen (Fujian Province). Labor-intensive industries that required China's cheap labor were attracted to these zones, and incentives such as corporate tax reduction or exemptions were offered to foreign corporations that came to do business. Having the advantage of being close to Hong Kong, Shenzhen attracted many foreign corporations and achieved phenomenal growth as a base for product components to be brought in and assembled under contract.

The successes of special economic zones then led to the establishment of various special zones by the national and local governments. Economic and technological development zones were established in Shanghai, Tianjin, Guangzhou, Dalian, and other coastal cities. Many cities were proactive in attracting foreign investment, and foreign trade expanded significantly. As a result of the economic reforms, agricultural productivity improved dramatically in the mid-1980s. Improved agricultural productivity produced surplus capacity; labor and capital in rural areas was directed toward establishing manufacturing industries. During the era of communes, factories in rural areas did not require advanced technology. These township and village enterprises had been engaged in a variety of areas, including textiles, sundries, bricks,

cement, farm implements, and food products. With the wave of reforms, these enterprises now play a growing role as a source of rural income, accounting for about a quarter of GDP and over 40 % of total industrial production in China (as of 2005).

Among the township and village enterprises are some that transformed into excellent companies by international standards, but in general, with their dated technology, they became a source of serious pollution and other problems in rural areas. In 2007, for example, there were even news reports about the discovery of more than 300 children who had been abducted from Henan Province and forced to labor in captivity at a brick factory in Shanxi Province.

2.2.7 Economic Disparities

The theory that "some areas must get rich before others" is representative of the basic principles of Deng Xiaoping. The basic idea was that places able to become prosperous first should be allowed to do so and then as a result prosperity would spread to other areas. If, for example, the special zones in the coastal areas became prosperous first, then later, in theory, the prosperity would spread inland.

The economic reforms had tremendous results in terms of economic growth, but they also created a large paradox in Chinese society. Economic disparities expanded between the rural and urban areas and between the coastal and inland areas. Greed became rampant, and graft and corruption spread in the bureaucracy. Inflation and unemployment shot up, and a visible gap emerged between those who became rich first and those who did not.

There was also growing discontent with the Communist Party. It was against this backdrop that the Tiananmen Square incident erupted in 1989; economic reforms were halted as a result (Hay 2010). As a consequence of the incident at Tiananmen Square, China fell under the stern glare of the international community. Investment in China dried up. In 1992, though, China shifted again toward policies to strengthen foreign economic relations, and economic growth spurted forward again. Thereafter, economic growth in China has been steady. Nevertheless, the disparities have grown wider between urban and rural and between coastal and inland areas; the discontent of farmers, who account for about 60 % of the population (as of 2000), has deepened. To address the farmers' discontent, the government eased policies restricting resettlement and migration for work, but this has led to increased urban populations. Thus, to develop the inland areas, the government's Tenth Five-Year Plan (2001–2005) announced a major component for "Western Development."

In 1998, Zhu Rongji became the premier and introduced three major reforms: state-owned enterprises, finance, and government. Through these, China's old tendencies were dramatically reformed, giving way to a Chinese-style market economy. In these ways, the Chinese economy has continued to surge ahead, but in the background, challenges remain, such as the disparities between rural and urban areas, the issue of unemployment, and worsening environmental problems. Environmental issues are in no way anything new. Though many of them have been

around for a long time, they have simply not been given much attention. With the increases in standards of living and the spread of television and newspaper coverage, public concern about the environment has grown, and this has led to the surfacing of new problems. In recent years, the spread of the Internet and mobile phone has also played an important role.

2.3 Phenomenal Economic Growth

2.3.1 High Growth Rate

The acronym BRIC has appeared in recent years, in reference to Brazil, Russia, India, and China. The economic development of these four countries was delayed compared to developed countries in Europe and America, but in recent years, with their large populations and land area, and abundance of natural resources as their assets, they have been achieving remarkable economic growth. While they will play an important role in driving the world's economic development in the twenty-first century, it is also these countries that will also have a major influence on the state of the global environment in terms of resource consumption and environmental burdens. China in particular has a strong relationship with Japan in terms of geography, history, economy, and politics, so Japan cannot simply ignore the environmental issues unfolding there.

Besides the size of the Chinese economy, its rate of growth is also something to watch as demonstrated in Table 2.1. At the beginning of this new century, the average annual rate of growth during the Tenth Five-Year Plan (2001–2005) was high, at 8.8 %. As a result, GDP per capita in 2004 surpassed 10,000 yuan (one yuan equals about 14–15 yen or 0.52–0.55 US dollars). Total imports and exports in 2006 amounted to 1.4 trillion US dollars, more than 2.9 times the figures at the end of the Ninth Five-Year Plan (1996–2000), ranking its economy the third largest in the world. Government fiscal revenues increased from 1.34 trillion yuan at the end of the Ninth Five-Year Plan to 3.0 trillion yuan. National infrastructure measures increased significantly between the end of the Ninth and Tenth Five-Year Plans: power generation capacity nationwide went from 319 million to more than 500 million kW, the total length of highways from 16,300 to 41,000 km, and operational railways from 68,700 to 75,000 km.

Economic development advanced further during the Eleventh Five-Year Plan (2006 through 2010); China's nominal GDP increased more than double in this 5-year period, and China became the second largest economy in the world surpassing Japan in 2011. The Beijing Olympics in 2008 and the Shanghai Exhibition in 2010 were drivers of China's economic growth. In the run-up to both events, airports, road, and other infrastructure development proceeded at a rapid pace in both cities. Other major projects underway included the construction of a high-speed railway connecting Beijing and Shanghai and the South–North Water Transfer

Table 2.1 Indicators of economic development of China

Item		Unit	1978	1990	2000	2005	2010
Population	Total	Million persons	963	1,143	1,267	1,308	1,341
	Urban share	%	17.92	26.41	36.22	42.99	49.95
	Rural share	%	82.08	73.59	63.78	57.01	50.05
GDP	Total	Billion yuan	365	1,867	9,921	18,494	40,120
	Primary industry	%	28.2	27.1	15.1	12.1	10.1
	Secondary industry	%	47.9	41.3	45.9	47.4	46.8
	Tertiary industry	%	23.9	31.6	39.0	40.5	43.1
Income	GDP per capita	Yuan	379	1,633	7,828	14,144	29,920
	Disposable income per capita (urban)	Yuan	343	1,510	6,280	10,493	19,109
	Net income per capita (rural)	Yuan	134	686	2,253	3,255	5,919
Food and industrial production	Grains	Million tons	305	446	462	484	546
	Coal	Million tons	618	1,080	1,384	2,205	3,235
	Oil	Million tons	104	138	163	181	203
	Electric power	Billion kWh	257	621	1,356	2,500	4,207
	Crude steel	Million tons	31.8	66.4	128.5	353.2	637.2
	Cement	Million tons	65.2	209.7	597.0	1,068.9	1,881.9
	Automobiles	Million vehicles	0.15	0.51	2.1	5.3	18.3
Transportation	Passenger (passenger km)	1978 = 100	100	304	582	727	1,287
	Freight (ton km)	1978 = 100	100	390	546	748	1,302
Construction	Room space per capita (urban)	m^2	–	13.7	20.3	26.1	31.6
	Room space per capita (rural)	m^2	–	17.8	24.8	29.7	34.1
	Access to tap water (urban)	%	–	48.0	63.9	91.1	96.7
	Highways	1,000 km	0	0.5	16.3	41	74.1
Environment	COD (chemical oxygen demand)	Million tons	–	–	14.45	14.14	12.38
	SO_2 (sulfur dioxide)	Million tons	–	–	19.95	25.49	21.85
	Environmental pollution control investment	Billion yuan	–	–	101.5	238.8	665.4
		Ratio to GDP (%)	–	–	1.13	1.40	1.66

Source: China Statistical Yearbook 2006, 2011(China Statistics Press)

Project to bring water from the Yangtze River to the north including Beijing to mitigate the water shortages.

It is worth noting that in the Eleventh Five-Year Plan, for the first time, "resource conservation and environmental protection" are listed as basic national priorities. Concern is also rising in China regarding energy and environmental issues such as air pollution, river pollution, and soil contamination. Thus, the

official plans recognize the constraints imposed by resources and the environment, but even so, they present a rosy overall picture of China's economic prospects, predicting that its economy can maintain an annual growth rate of between 8.0 % and 8.5 %.

2.3.2 Resource Security, Energy Security

China has become the world's largest consumer of iron and steel and also the destination for more than one-third of the world's iron ore exports. In terms of crude steel production, in 1996, China passed the 100 million-ton mark, surpassing Japan and the United States to rank first place, and in 2010 this figure rose to 637 million tons. Despite this increase, production could not keep up with rising demand, requiring an increase in imports. As a result, Japan's steel-making industry is unexpectedly benefited from the boom in Chinese demand.

The demand for other basic materials such as cement, plastics, and paper and pulp is also increasing. With the construction boom, annual cement consumption exceeded one billion tons in 2005, and electrical power demand is also rising steadily. Scrap metal, waste plastic, waste paper, and other recyclable resources and used products are being exported from Japan to China in large quantities, causing Japan's own recycling industry to complain of a shortage of raw materials for its own needs. As with coal, petroleum, and natural gas, as well, the trends are all pointing upward; annual coal production has passed the two billion-ton mark in 2005 and further increased to 3.2 billion tons in 2010. Water consumption is also rising rapidly. As this country, with its population of more than 1.3 billion people moving towards the production and consumption levels of developed countries in America and Europe, as well as Japan, the consumption of energy and resources is increasing, and the impacts on the global environment are huge.

The top cause for concern is the increase of fossil fuel consumption and the associated increase in carbon dioxide (CO_2) emissions. To address climate change, a response is needed by all of humanity; in this, China holds an important key. There are concerns in China that the lack of resources will become the largest constraint on the country's economic growth going forward. It is easily understandable why the Chinese government has given resource recycling and sound material cycles in the economy an important place in its policies for economic growth. The Chinese government, looking at the future growth in its own demand for oil, iron ore, and other resources, is actively engaged in diplomacy in Africa, the Middle East, and Central Asia, with a view to securing those resources. It is also the recognition of potential resource shortages that is a factor behind the issues relating to oil fields and other resource developments in the East China Sea—adjacent to Japanese territorial waters.

The further motorization of China can only mean greater future pressures on oil supply and demand. And just as the Bush Administration of the United States asserted, it will be difficult for the world to tackle climate change without China's

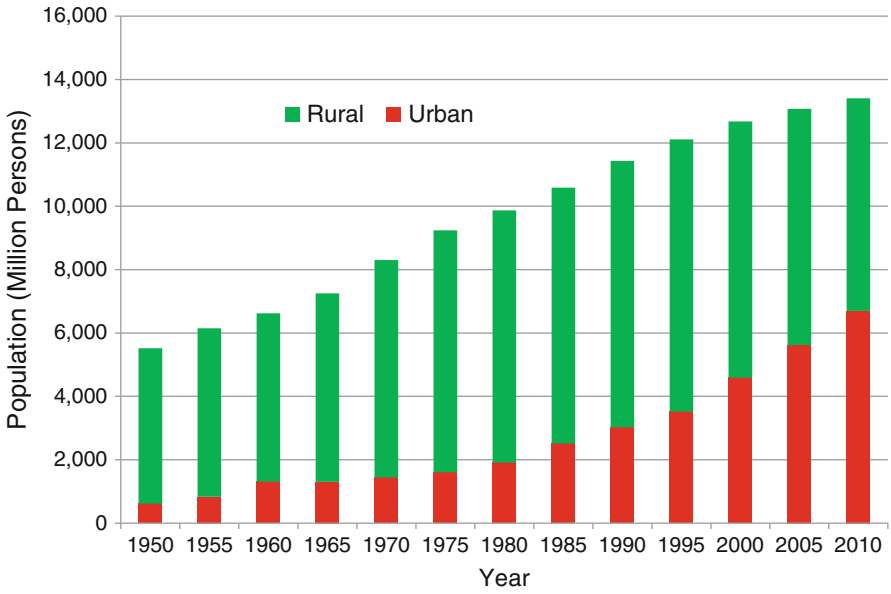

Fig. 2.2 Urban and rural population of China, 1950–2010. The total population is divided into the urban and rural populations (*Source*: China Statistical Yearbook 2011)

participation. As for food, the recently feared global shortages have not occurred, but if China's living standards and meat consumption rise, demand for feed grains will also rise, with inevitable impacts on the world market. Meanwhile, the country faces a serious shortage of energy, particularly electricity, leading to concerns about possible power stoppages nationwide during summer months, due to supply shortages. Thus, along with China's rapid economic growth comes a voracious appetite for resources and energy. Whether or not China itself recognizes it, the international competition for resources is becoming increasingly fierce due to China's economic prominence. When considering environmental issues in China, this is an important aspect to remember.

2.3.3 Urbanization and the Construction Boom

With economic growth, the country is also urbanizing at a fever pitch. Figure 2.2 shows the change in population of China, where the total population is divided into urban and rural populations.

The flow of migration from rural to urban areas is as high as ten million people per year, and large cities like Beijing and Shanghai are in the midst of an unprecedented construction boom. Shanghai's Pudong district is lined with modern skyscrapers, and in Beijing's suburbs stand rows of tall apartment buildings. In the days

when all enterprises were state owned, all housing was provided by the employer. Even after retirement, people could continue to live where they were at low-rent costs. As China shifted toward the socialist market economy, a growing number of people purchased from the government the units in their state-supplied apartment buildings and also purchased units in apartments and condominiums built by the private sector. The "sick building" syndrome (sickness often associated with poor indoor air quality in buildings) has also been occurring frequently in newly constructed apartments.

It should be noted that private ownership of land is not currently permitted in China. For a company to obtain land for development, it must purchase a time-limited right to use the land. This was permitted since 1990 in state-owned lands in urban areas, and it had a major impact on economic activities. The time limits were 70 years for housing land, 50 years for industrial land, and 40 years for land used for commerce, tourism, and recreation. In addition, the continuation of user rights after the end of the term is now recognized. Ultimately, the land is still state owned, but, in effect, it is close to being privately owned.

With the population concentrating in cities comes the pressure to deal with environmental problems associated with urban lifestyles. In the large cities, the basic infrastructure is in place to collect sewage and household effluent; the ratio of sewage being treated in cities rapidly increased to 72.9 % in 2010, while the treatment of household wastewater in rural areas is a big challenge. Meanwhile, household garbage is often simply dumped into a landfill after being collected. The improvement of urban sewerage systems and wastewater treatment facilities is a priority for public investments, but because government financial capacity is limited, there is active debate about introducing foreign capital or privatization in water sector.

It may feel like a daunting task to complete the infrastructure of sewerage systems in China—a country with 25 times the land area and ten times the population of Japan. In this context, Japan's governmental assistance in the environmental field placed a priority on urban environmental infrastructure improvements in western China or not.

Meanwhile, the scarcity of water is becoming increasingly severe in the watersheds of the Haihe, Yellow, and Huaihe rivers (which includes Beijing and Tianjin) in northern China. When it comes to a lack of oil, China can rely in part on imports from overseas, but the import of water resource is not as easy. The South–North Water Transfer Project already began to divert water from the Yangtze River to Beijing, Tianjin, and the rest of Hebei Province, but only time will tell if this approach can solve the problems.

2.3.4 A Well-Off Society

China has entered a phase in which the people themselves refer to theirs as a "well-off" society. This could be described as a state in which most people have enough to eat and are even beginning to feel some affluence in their daily lives. Rising level of

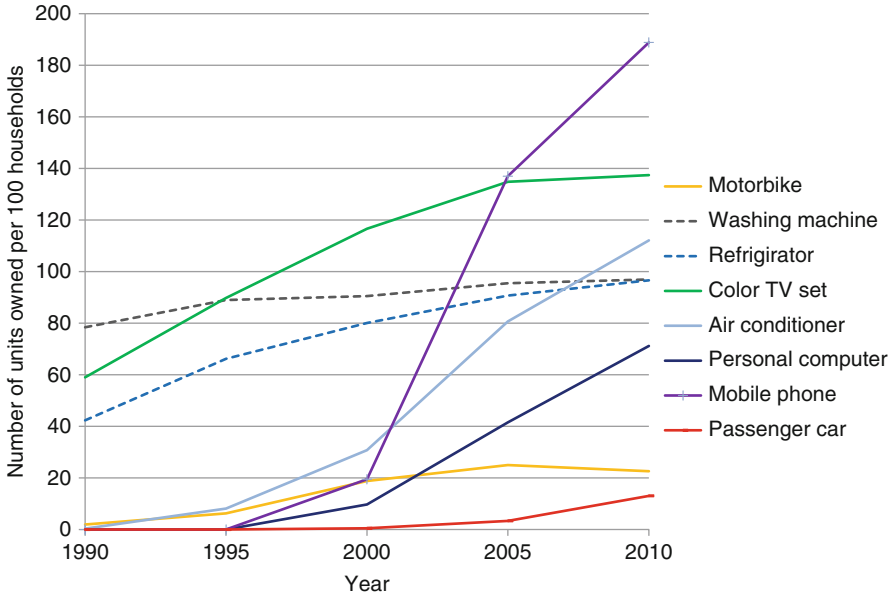

Fig. 2.3 Diffusion of home electric appliances and cars in Chinese urban households (*Source*: China Statistical Yearbook 2011 (China Statistics Press))

living standard can be demonstrated by the increased durable goods owned by urban households as shown in Fig. 2.3. Private car ownership is increasing sharply: the number of cars owned per 100 urban households was only 0.5 in 2000, and then it increased to 3.4 in 2005 and 13.1 in 2010. This phenomena somewhat resembles the situation in Japan during the 1960s. With these circumstances comes a greater interest in health and the environment and a boom in healthy food products.

Even in the way pollution problems flare up here and there, the government's style of information disclosure and tardy reactions also resembles Japan during the 1960s. A pollution incident that occurred in 2005 on the Songhua River—a major river in China's northeastern region near the border of Russia—provides an example of a company's delayed response to a crisis. An explosion occurred at a petrochemical plant in Jilin Province at the end of 2005, and about 100 tons of nitrobenzene and other toxic chemicals were released into the Songhua River. This river is more than 1,900 km long. As great length of water was polluted, this became an international issue affecting areas from the upper reaches right down to the lower reaches of the river.

The accident was caused by an affiliate of the oil giant China National Petroleum Corporation (CNPC), which after the accident insisted that the river was not polluted; nevertheless, the city of Harbin—which normally draws water from the river—decided to suspend the intake of river water. The government made an announcement of the accident more than 10 days after it occurred. Russia was also

late in receiving notification of the accident, and the ensuing confusion threw the Russian city of Khabarovsk into a panic over concerns about the safety of its own drinking water.

China was advancing its policies of reform and openness, and, by all appearances, the country appeared to have improved its information openness with the international community, but even so the disclosure of information was slow in this case. The head of what was then the State Environmental Protection Administration (which became the Ministry of the Environment in 2008) was replaced in order to take responsibility for the delayed response, although actual details of the incident still remained guarded.

Many problems have also emerged regarding the safety of food and medical products exported from China. This became an issue in countries like Japan and the United States, and also in Korea, which has a high flow of people traveling to and from China. Because the safety of products made in China became a major international issue, an American health food products company began to affix a "China-Free" logo on its own products; this action soon spread to other companies, particularly in the food products industry. The intention was to give the impression of safety by indicating that nothing made in China was being used. In response to this kind of international action, the Chinese government strengthened its food safety regulations, exposed the companies that had caused problems, created a list of products banned for export, and made a great effort to restore confidence in Chinese products.

It is not easy to govern such a large country as China. Finding a balance between economic growth and the environment is a major challenge, but how can that balance be found? While proclaiming the importance of the environment, the reality is that the economy still gets top priority. This proclivity grows stronger as the economic growth race of cities accelerates further: poorer cities' fierce desire to be rich becomes stronger and rich cities want to be richer. As for the safety of food and medical products, while some legislation has been passed, it will have no effect on those corporations and people that have no intention to observe the law. This is similar to the way things were even in developed countries in the past. By reaching the stage of being a well-off society, people feel a sense of security that there will be enough food to eat, but concern is growing about the safety of that food. Today—as China attempts to move on to the next level—having become a "well-off" society represents a turning point for the country's environmental policies.

2.3.5 The Japanese Experience

Japan experienced serious pollution problems and the destruction of nature during its period of rapid economic growth in the 1960s. It also experienced enormous social transformation associated with economic growth. Petrochemical complexes and other large industrial bases were established around the country, resulting in pollution concentrated at certain locations and causing pollution-related afflictions such as Minamata disease and Yokkaichi asthma (Imura and Schreurs 2005).

Industrial pollution associated with industrial production is the result of production processes. Wherever we may be, to the extent that the same technologies are used, the same types of problems will arise. If, on the other hand, more advanced technologies are used to address these problems, they can be resolved. Regarding air and water pollution from steelmaking, chemical, paper, or power generation facilities, if you know the type of factory at a given location and the kind of technologies being used, not only can you generally determine the scale and attributes of the problems that will arise but also the details, costs, and other specifications of the necessary countermeasures. Roughly the same thing could be stated regarding pollution problems—vehicle air pollution, municipal wastewater, municipal waste, and other issues—arising from life in cities. Thus, to understand China's issues regarding industrial and urban pollution, and to consider solutions, it might be informative to examine the experience of Japan, America, and Europe.

On the other hand, when it comes to issues relating to the natural environment—soil erosion, forest protection, desertification, etc.—many of these are influenced by China's own unique circumstances, so these are areas where the Japanese experience may be less relevant. Issues pertaining to the management of the long and mighty rivers such as Yellow River and Yangtze River will also be quite different from those of Japan's rivers. These issues are controlled by geography, soils, meteorology, climate, and other factors unique to China.

2.4 Issues Facing China

2.4.1 Problem Sectors: Changing Over Time

Until now, the main area of concern when discussing environmental issues in China was industrial pollution arising from the time lag between the expanding production demand and the delay of technology. Today, however, the nature of the issues has changed dramatically.

During the 10 years from 1995 to 2005, China's production of steel and other raw materials increased by a factor of four or five. Meanwhile, pollution data showed no major change or even a slight improvement. The large increase in steel production was also due to the investment in new facilities, and one can infer that considerable effort was put into pollution prevention, though the main achievement was probably just to prevent a further worsening of pollution. China is still far from achieving dramatic improvements in this area.

What will happen if economic growth continues at the current pace while production and consumption double? Naturally, there are doubts about such an optimistic scenario. The rise of China will mean competition in global markets with the United States, Europe, and Japan. This can only lead to some political friction. In the area of environmental issues, China must modernize its technologies in a way that will significantly reduce pollution. Some leading enterprises that have partnered

with foreign capital have progressed in the introduction of advanced technologies from Japan, Europe, and the United States. Nevertheless, looking at the country as a whole, one can see that there are many small rural township and village enterprises operated by farmers using out-of date technologies. To deal with pollution across the nation, China needs financial resources, human resources, and time.

Another big issue to deal with is climate change. If the economy continues to grow at the rate of 8–8.5 %, and it depends on coal for more than 70 % of the primary energy supply, CO_2 emissions can only increase. Oil demand is also increasing rapidly with increased use of the automobile, and Chinese corporations are very active in oilfield development overseas. If these trends continue, there could eventually be a rush of nuclear power plant construction in coastal areas.

2.4.2 China's Weak Spots

China is developing rapidly, but many weaknesses are also evident. The first is that governing 1.3 billion people is not an easy task. Simply saying, China is too big: some single provinces in China have the same area and population as an entire country. Put them all together, and it is not easy to distribute the economy's fruits equitably to all people. Regarding the economy and markets, as well, each region has strong independent streaks.

The debate about democratization includes two issues—increased public participation and equitable distribution of wealth. Along with these, there is governmental corruption and the corruption of local governments, problems dominant in the Communist Party—which are not entirely unrelated to environmental issues. Why is this? Because there are connections with unregulated polluters, the falsification of environmental data, the improper use of incoming foreign assistance, and other intricate matters. Also, imbalances in wealth tend to favor the coastal areas, giving rise to inequalities between eastern and western regions and between urban and rural areas. If it tries to transfer income from affluent to poor areas, the central government will require strong authority. If this means increasing the leadership power of the Communist Party, then that would contradict the trend toward democratization. Conversely, if the power of the central government is weakened, the result could be regional grabs for more power, resulting in greater regional disparities in terms of income, welfare, living conditions, environmental control, and others.

Another aspect is the issue of farmers and agriculture. China has a large land area, but there are also many mountains and deserts. Arable land accounts for only about one-seventh of the total land area, while almost 50 % of the population still consists of farmers. Arable land amounts to 0.9 ha per farm household, about the same as in Japan. Thanks to fertilizers and mechanization, yields per hectare have increased, and at this point there is no sign of the food crisis about which the famous American environmental academic Lester Brown (Brown 1995) rang the alarm bells. But along the road toward a market economy, sustaining agriculture—which has lower productivity than manufacturing—involves major challenges.

In many places, there are problems with soil degradation due to the heavy use of chemical fertilizers and agrochemicals, crop residues, and falling groundwater levels. The influx of poor farmers to cities is another challenge for governments. Rural areas are home to an enormous number of small businesses (township and village enterprises) that become a source of industrial pollution but provide profit-making opportunities to farmers. The increase in coal production is also being sustained by town and village enterprises operating with poor safety measures. Behind the increase in production is also an increase in mine accidents. In the Huaihe River basin, which suffers severe pollution problems, in one fell swoop, the government took the step of closing thousands of polluting town and village enterprises. Authorities believe that because it is farmers who are running the town and village enterprises, they can simply return to their villages if factories are closed, so they expect no major social unrest as a result of their crackdown.

2.4.3 Global Markets, China's Responsibilities

Many private companies have been created through the government's policies of moving toward a market economy, but their circumstances vary greatly. Some among them cannot escape the former psychology of being state-run enterprises. It has been pointed out that China's market economy is still very young and that when it comes to performance on contracts and corporate social responsibility, many firms have a paucity of the corporate ethics normally required to sustain a market economy.

Environmental issues are a major qualitative issue for the economy and society of China. One would do well to recall that this inextricable linkage of environment and socioeconomic change is similar to what Japan experienced after the Second World War. Japan too experienced a massive migration from the countryside to the cities, housing issues in large cities, inadequacies of urban environmental infrastructure (sewage treatment, waste treatment, etc.), destruction of the natural environment by public works projects, the adoption of lifestyles of mass consumption and waste, and the increase in automobile use.

With economic globalization, the entire world is undergoing a large transformation in awareness and values, affecting the ethics of the market and corporate social responsibility (CSR). This transformation is also having an enormous impact on responses to environmental issues. The Chinese economy is growing, and exports of made-in-China products are growing steadily. The number of corporations entering the Chinese market from Japan, Europe, America, and elsewhere is also increasing. Few Chinese corporations have established factories overseas so far, but they are likely to become more common in the future. The world will not tolerate China presenting itself as a developing country forever. When it comes to protecting the environment, the responsibilities and the roles expected of China and Chinese companies are sure to increase in the future.

2.4.4 Pollution Control Efforts: Priority Areas

Environmental issues in Japan during the 1970s were usually water and air pollution. As with the cases of Minamata disease and Yokkaichi asthma, these were issues that directly affected human health and livelihoods. The Chinese lived under restrictions on freedom of speech in the days of the socialist regime. Environmental pollution cases were rarely made public and discussed by the people. The situation began to change with the shift toward reform and openness policies. An expansion of industrial production will inevitably result in an increase in pollution. Greater openness to the outside world creates more opportunities for the facts about pollution to be known by foreign media. The Chinese government understood this situation, publicly recognized the risks of environmental problems, and launched countermeasures. But major factors behind environmental problems are the delayed modernization of former state-run enterprises and town and village enterprises, together with the lack of financing, technology, and human capacity, so there has been a tendency to be slow in taking action.

China's pollution countermeasures started with top-down initiatives by the government. These included the enactment of legislation providing the basis for pollution control, establishment of standards, monitoring of those performance according to those standards, and enforcement and guidance for polluters that fail to meet them. Institutional structures responsible for environmental protection have also been established in the central and local governments, but law enforcement systems still leave something to be desired.

China's priority areas for pollution control are encapsulated by the numbers "332211." The numbers 33 refer to the priority areas in terms of freshwater pollution—three rivers (Huaihe, Liaohe, and Haihe) and three lakes (Taihu, Dianhu, and Chaohu). The numbers 22 refer to two national projects—the Three Gorges Dam, and the South–North Water Transfer Project, and two districts established for the regulation of acid rain and sulfur dioxide (Acid Rain Control Districts and Sulfur Dioxide Control Districts). The numbers 11 refer to one city and one sea—the capital city of Beijing for its severe air pollution and the Bohai Sea (in the inner reaches of the Yellow Sea) for its serious problems with water quality. These are the areas in China with the worst pollution. It is also here where the Chinese government is focusing its efforts on measures to deal with pollution. Accordingly, each of these will be referred to frequently throughout this book.

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Chapter 3
Resource Consumption: Economy with Sound Material Cycles Needed

Abstract This chapter discusses the risks of expanding demand of energy and materials that are required to sustain rapid economic growth of China. China relies more than 70 % of its primary energy sources upon coal. China's coal consumption has increased very rapidly in accordance with economic growth, and it exceeded three billion tons in 2010. As a result, China's emissions of carbon dioxide surpassed the United States, and it is now the largest emitter in the world. Coal consumption also accompanied air pollution and acidification of soils in vast areas. Economic growth also accelerated the demand of materials including mineral resources, petroleum and its products, and paper and pulp. Transformation of traditional production systems to more rational and efficient ones through the effective use of energy and materials is a big challenge for China.

Keywords 3Rs • Energy and environment • Resource recycling • Sound material cycles

3.1 Problems Born of Resource Consumption

3.1.1 Something New: Developed-Country Problems

The characteristics of environmental problems in China are evolving with the times. Until the 1990s, many problems were caused by out-of-date technologies and the poverty typical of a developing country. Since the new millennium began, a new theme has been the problems caused by the pursuit of material wealth—those more commonly associated with developed countries and economic growth. China's consumption of energy, minerals, water, and other resources is steadily increasing. Driving this increase are the stimulus effects of productive activities in this country now serving as the factory for the world and also the rise of consumption-oriented lifestyles. Demand is rising steadily for cement and metals destined for economic

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infrastructure—roads, ports, and the like, which form the basis for economic activities—as well as the construction of buildings and housing associated with urban expansion.

A person can feel the reality that people have become more prosperous by looking at the products on display in urban department stores and seeing the busyness in restaurants. Until the 1990s, department stores, restaurants, and most other businesses were state-run enterprises, so the standards of service offered by employees were low by international standards, but this has vastly improved in recent years. The ownership of electrical and electronic goods has increased. For urban residents, the use of air conditioners, for example, increased from 8.1 units per hundred households in 1995 to 30.8 in 2000 and 112.1 in 2010. Mobile phone ownership has increased from 19.5 in 2000 to 189 in 2010 (as already shown in Fig. 2.3 in Chap. 2). The ownership of personal computers increased from 9.7 in 2000 to 71.2 in 2010, and an Internet connection has virtually become a must-have for urban dwellers. For rural residents, however, numbers are much smaller reflecting the gap in income and living conditions between urban and rural areas.

Beijing summers are very hot. Anyone can easily see that the number of air conditioners mounted externally on apartment balconies has increased. As a result, electrical power consumption during the summer is increasing rapidly. The maximum power demand during the summer in Beijing was 13 million kW (2006), of which 4.9 million kW (38 %) was evidently consumed by air conditioners. In cities like Beijing and Shanghai, a wave of supermarkets is opening, funded by foreign capital. The products being sold there are not very different from what is being sold in supermarkets in Europe, American, and Japan. The plastic bags that staff once used to put purchased goods into were thin and not very strong, but they have now become much better in quality. The quality of paper and books has also improved; many books are now printed on thick, coated paper in beautiful color.

Previously, few Chinese sought luxury in food, but now food ingredients have become more lavish. Meat consumption is increasing, so livestock consumption of feed grains like corn is also increasing. Meanwhile, the amount of arable land is decreasing year by year as it gets converted to other uses such as urban expansion and factory sites. Food demand to feed China, with one-fifth the world's population, is now a global issue. By achieving greater prosperity, China has also increased its resource consumption, and the associated environmental issues are looming larger. Despite this, the economic disparities between urban and rural areas, and between coastal and inland areas, do not appear to be shrinking. Even within the same country one can find problems typical of both developing and developed countries, although the actual circumstances differ greatly depending on the region.

3.1.2 Transportation, Distribution, and Resource Consumption

Material consumption is increasing along with rising incomes, and the amount of waste output is also increasing. The amount of "stuff" in Japanese households

multiplied quickly during the period of rapid economic growth. A steady stream of new household appliances appeared, and the amount of waste disposed increased as people bought new items to replace the old. As supermarkets and convenience stores appeared on the scene in the 1970s, the country was inundated with containers and packaging—plastic bags, containers, cans, bottles, wrapping paper, and so on.

Material consumption by people until the early 1990s was still modest in China. The look of department stores and shops was not flashy nor was the design of products on their shelves. But by the end of that decade, big changes began to occur. In cities like Beijing and Shanghai, new buildings were always going up, and the world's top brands were on display in the department stores. The McDonald's hamburger restaurant chain, which caused a big stir when it first appeared there in the early 1990s, can now be found everywhere.

If a country is to have a products-based economy that spans a large geographical area, good distribution systems are needed. China had weaknesses in its transportation networks for covering such a large territory, so the government began to put efforts into developing a high-speed transportation network. The rapidly growing expressway road network is a remarkable example of this. The total length of the expressway network was 41,000 km in 2005 and 74,100 km in 2010. At only 500 km in 1990, it grew at the pace of more than 5,000 km/year on average after the year 2000. In this, China differs greatly from Japan which must spend much time and money to purchase land and obtain public consent and agreement. Construction is much easier and speedy in China where much of the land is publicly owned and the government has the power to decide and enforce construction plans.

A plan is now in place for the next 20–30 years to complete an expressway network, known as Plan 7918, stretching 85,000 km in total, through the construction of seven routes radiating from Beijing, nine routes running north and south, and eighteen routes running east and west as shown in Fig. 3.1.

With the development of a road network, business can expand with the entire national market in its sights. In Inner Mongolia, a dairy company which I had the opportunity to visit gave me a good example of this reality. Inner Mongolia is well suited to raising cattle, but the company had a problem: with the existing transportation system, it could not easily reach the national market hubs. In the past several years, however, it has been able to develop a large-scale business expansion plan targeting all of China. This is thanks to the development of a transportation and logistics system making that possible.

Expressways included, one after another, plans that have been developed for the construction of high-speed passenger rail networks to connect cities, and construction has begun. New rail lines for speeds of over 300 km/h were completed and started operation in June 2011. A month after, two high-speed trains collided in Zhejiang Province, and forty people were killed. The two derailed trains were hastily buried without much investigation, and the government issued directives to restrict media coverage. Thereafter, there is some skepticism about the safety of high-speed railways in China.

Each regional market in China was relatively independent due to the big size of country, but through the development of transport networks and logistics

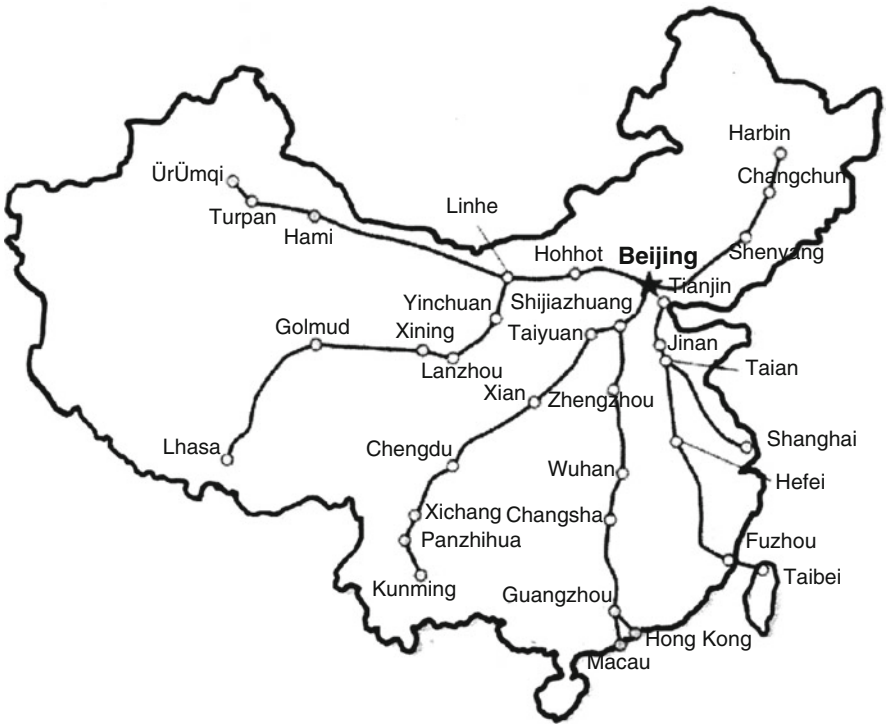

Fig. 3.1 China's future highway network: seven routes radiating from Beijing

systems, changes are underway. As the economic sphere expands, however, energy consumption will also increase with the expanded movement of goods. Even if the economic disparities do not shrink between urban and rural areas, and between coastal and inland areas, China will grow into being one huge market. With that, the consumption of goods will increase, and the demand for resources will continue to grow. One can also predict a flood of used household appliances, mobile phones, computers, and other wastes. The need for used items will also be great in China, so one would also hope that a strong reuse and recycle market for used goods—desirable for resource conservation—will also develop.

3.1.3 China's Resource Consumption: Seeds of Concern

Lately, whenever international oil prices jump higher, China's thirst for oil becomes a popular topic. Economic growth boosts Chinese imports of crude oil, and many in the world feel that this is a factor in the jump in the international price of oil. Crude oil imports in 2003 by the United States, Japan, and China were 516 million tons, 205 million tons, and 91 million tons, respectively. China's imports were as small as

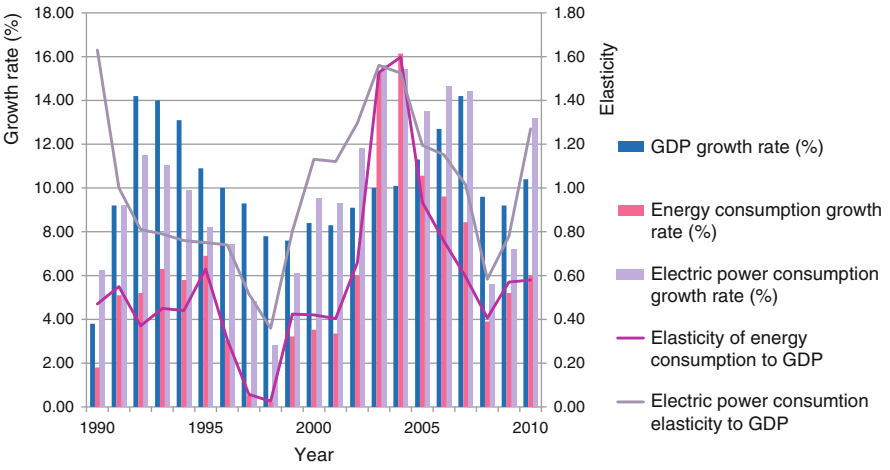

Fig 3.2 Relationship between the economic growth and energy consumption in China (*Source*: China Statistical Yearbook 2011)

about one-fifth those of the United States and about one-half those of Japan. Thereafter, however, Chinese oil import grew constantly and amounted to 265 million tons in 2011. As a result, 56.5 % of oil consumption in China relies upon imports. Figure 3.2 shows the relationship between the economic growth and energy consumption in China.

Because Chinese crude oil imports are expected to increase steadily going forward, however, they will without any doubt end up in the eye of the storm. China's resource consumption cannot avoid having a huge impact on the global economy and global environment—due to the country's rapid economic growth, together with its huge population. In the United States, in particular, as these topics involve political, economic, and military issues, there is active debate about how the country should deal with China, and an emerging undertone is that China poses a threat from the perspective of resources and the environment. The basis for this perspective is the thinking that China's rapid economic growth will lead to serious environmental problems and that this is therefore not a domestic issue for China alone but should be viewed as a global risk.

The Worldwatch Institute released a report in 2006 stating that the world's resources could be depleted by resource consumption in China and India (The Worldwatch Institute 2006). Also, the Earth Policy Institute, headed by Lester Brown, has produced forecasts that if China follows resource consumption patterns similar to present-day developed countries, it would be utterly impossible to satisfy the demand for resources (Brown 2006; Brown 1996).

Because China's population is 3.9 times that of the United States, in one sense this conclusion is self-evident. If Chinese were to consume resources at the same rate per capita as Americans, an absolute shortage of the world's resources would be virtually inevitable. India also looms large, as it is predicted to eventually surpass

China's population. But this kind of debate has a bit of American-style self-righteousness to it. Americans may think that their current pattern of resource consumption is the standard for developed countries and have little enthusiasm for suppressing that consumption. But Chinese are likely to rebuff the tone of warnings about the emergence of China and India. In places like Europe and Japan, efforts are now underway to search for ways to achieve economic growth while suppressing resource consumption. Is it possible to create new models to replace the American style of resource consumption and economic growth? And is it possible for China and India to adopt such a model? These are huge questions that will have major implications for the future of the global environment.

3.1.4 Competing for Resources: China and Japan

China's growing demand for resources has both positive and negative implications for Japan. Minerals are one such example. China's imports of iron ore were at 325 million tons in 2006, about six times the amount in 1998 (52 million tons), propelling China to be the world's largest importer of iron ore. This figure increased further to as high as 743 million tons in 2012. Japan depends on Australia for more than 60 % of its iron ore, for which prices started skyrocketing in 2003, and Australia has expressed its intention of increasing prices for Japan further. Meanwhile, Japan's shipping industry was able to enjoy good times, having received orders to transport iron ore to China. These ripple effects also reached Japan's shipbuilding industry.

There are also some concerns about competition between Japan and China for copper ore. Japan imports more than about 60 % of its copper ore from Central and South American countries such as Chile and Peru, but China has recently been making its presence felt as a copper buyer. Central and South America are among the few regions in the world with copper ore in the ground, so they are an important source of supply for Japan. But an increase in Chinese demand will lead to an increase in prices, so Japan cannot be complacent. The Besshi Copper Mine (Ehime Prefecture) and Ashio Copper Mine (Tochigi Prefecture) are well known in Japan as places where mining pollution from copper smelters occurred during the country's Meiji period (1868–1912). In copper-producing countries like Chile and Peru today, pollution from mining is becoming a huge problem, and measures to address these problems are among Japan's environmental ODA projects. If copper exports to China increase, there will also be implications for pollution in the supplier countries.

3.1.5 Technology: A Key to Energy Efficiency

Economic growth, energy, and the environment are inseparably intertwined. This triumvirate could be called the "three Es." Energy consumption has increased

steadily together with economic growth since the Industrial Revolution. If fossil fuels such as coal, oil, and natural gas are used as energy sources, the emissions of the greenhouse gas (GHG) carbon dioxide (CO_2) will inevitably increase, and the release of air pollutants such as sulfur oxides (SOx) and nitrogen oxides (NOx) will also increase.

Since energy is also required for activities such as water treatment and the recycling of resources, the higher the level of treatment level, the greater the requirement for new equipment and chemicals, and the greater the need for energy to produce and operate them. Furthermore, a growing economy means more energy consumption, not only in the industrial sector but also for transport of passengers and cargo by vehicle and train, for heating and air-conditioning equipment, electrical devices, and appliances in offices and households.

When analyzing economic growth and environmental issues, it is instructive to analyze energy consumption. Generally speaking, the greater the energy consumption—in other words today, the greater the fossil fuel consumption—the greater the impact on the environment. Measured in terms of financial or material inputs, the lower the energy consumption for production—in other words, the greater the energy efficiency—the better it is for the environment. And in these equations technology is the factor that determines the outcomes. Rapid economic growth in China began during the 1980s, and continues to this day. In Japan it began about 30 years earlier, in the mid-1950s, and continued until the first oil shock in 1973. The sectors that sustained Japan's rapid economic growth were heavy industries such as steelmaking, shipbuilding, and chemicals. The Japanese economy in later years shifted more into high technology, services, and information-based industries. Today, China is trying to promote its high-tech and information industries at the same time as it modernizes the older heavy industries. Together with changes in industrial structure, there are two approaches to address environmental problems. One is the development and introduction of pollution prevention technologies for polluting factories. The other is the transformation of the country's industrial structure.

Pollution prevention technologies include "end-of-pipe" technologies—the final treatment to remove pollutants from smokestacks and factory effluent—and "clean production" technologies that change the very manufacturing processes so that pollution is not generated in the first place, and these are referred to as "cleaner technologies." As an example of the power of technology, the generation efficiency of a coal-fired electrical power plant in China averages 33 % nationally, while in northern China, coal-fired thermal power plants are located right in cities, and the heat from the facility is also used for heating during the winter, so the net efficiency may be slightly higher. In Japan, the average is 40 %, but in the latest facilities, it is more than 43 %. Furthermore, the latest cogeneration equipment in Japan uses waste heat from boilers in city buildings for room heating and hot water supply, so the net energy efficiency could be greater than 80 %.

To produce one ton of cement, energy consumption in China is nearly 1.5 times higher than for the new so-called NSP kiln (or new suspension preheater kiln) method used in Japan. Turning to the overall economy, if we look at primary energy consumption (tons of oil equivalent) per million dollars of gross domestic product

(GDP, in 2000 US dollars), China rates 699, the United States 190, and Japan 98 according to 2009 data (The Energy Data and Modelling Center 2012). In other words, China's energy efficiency is almost seven times less than that of Japan. These figures do not take into account exchange rates and the purchasing power of currencies, however. In China, where prices are cheaper, much more can be purchased per dollar equivalent. What is needed for comparison is an index for converting purchasing-power parity. Reports of organizations like the World Bank suggest that it is at about three times between Japan and China considering exchange rates, consumer prices, and other economic indicators (World Bank 2008). In other words, the same dollar could purchase three times more worth of value in China than in Japan. If we consider differences in purchasing power, very roughly speaking, China's energy efficiency per amount of monetary value produced is about 50 % that of Japan. This is a very approximate evaluation, but it suggests that if Japanese technologies and systems were introduced to China, its economy could double in size without increasing the amount of energy consumed.

3.1.6 Accelerating Oil Consumption

China has no choice but to improve its energy efficiency. During the 20 years from 1990 to 2010, China's economy grew by a factor of 9.4 while energy consumption increased by a factor of about 3.3. These numbers suggest that the country made considerable progress in energy use efficiency improvement. Since the year 2000, however, the pace of this progress has slowed as shown in Fig. 3.2. As of 2005, China's energy consumption was 1.5 billion tons of oil equivalent, accounting for almost 14 % of global consumption and ranking second after the United States. Thereafter, in 2010, China's energy consumption surpassed that of the United States.

In 2010, China's energy sources were as follows: coal (68 %), oil (19 %), natural gas (4.4 %), and others including hydropower, nuclear, and wind power (8.6 %). Besides these, straws, wood tips, and other forms of biomass are used in large quantities in rural households. Because China has coal in abundance, it can afford to be a net exporter of coal. It is self-sufficient in natural gas but has been a net importer of oil since 1993. China's net imports of oil have reached 100 million tons per year in 2004 and exceeded 200 million tons in 2009. The pace of increase of oil imports has been extremely fast, and the major factor here is the spread of the automobile.

Personal car ownership in 1990 was only 0.8 million vehicles nationwide, but by 2010 had increased by a factor of 73, to 58.4 million vehicles. The rate of increase is accelerating every year, and in 2006 new vehicle sales amounted to 7.5 million vehicles, more than the vehicle sales in Japan that year. The production further increased to 18.3 million vehicles or 23.5 % of the world total in 2010. Increase in car ownership is drastic in Beijing: 58,000 of cars were added every month in 2010, and the total number of passenger cars reached 4.4 million vehicles, causing traffic jams and air pollution.

Tokyo has a well-developed subway and railway network, so car owners tend to leave their cars parked most of the time; the frequency of car use is thus relatively low. In Beijing and other cities in China, rail and other public transport are being developed rapidly, but car usage is still high partly because the public transport systems have not been well organized as a network and service quality is low. There seems to be more cars on the road than one would imagine based on the rate of car ownership, and these are the source of traffic congestion and air pollution. China's energy consumption is already second in the world, but because of its large population, per capita energy consumption is only 1.54 tons (oil equivalent), less than Japan's 3.70 tons and far less than the United States' 7.05 tons (The Energy Data and Modelling Center 2012). Reading between the lines, this figure is likely to grow higher in China with the country's present economic growth.

Burning coal happens to emit the most CO_2 among fossil fuels, in terms of CO_2 generated per unit of energy. Because China's coal dependency is high, its amount of CO_2 emissions is also high. China's CO_2 emissions until 2006 were second in the world behind the United States, but it surpassed the USA in 2007 (The Energy Data and Modelling Center 2012).

3.2 Energy Supply Structure

3.2.1 Coal Resources: Abundant

China is generously endowed with coal resources. Confirmed recoverable reserves exceed 110 billion tons. Coal accounts for three-quarters of primary energy supply, the top use for power generation, but due to strong steel demand, coal demand for steelmaking is also growing rapidly. Coal mine production is increasing rapidly, from 1.39 billion tons in 2000 to 2.97 billion tons in 2005 and 3.24 billion tons in 2010.

Coal mines are found in various regions, including Liaoning Province, Shanxi Province, and Hebei Province in northern China. A famous open-pit coal mine—6 km wide, 20 km long, and 280 m deep—is located in Liaoning Province's Fushun City. Around the pit is a railway that runs in a spiral direction, to carry the coal extracted from the bottom of the pit. Anyone standing at the pit's edge and surveying the scene would be surprised at its enormous scale. This coal mine once boasted a large reserve of coal, but in recent years, production has dropped. The area around Taiyuan in Shanxi Province is also endowed with quality coal in an underground coal seam. As mining progresses, however, the distances from the tunnel opening to the seam have gradually grown longer; and in some cases it takes as much as 2 h for the train or a person walking to reach the location of active mining.

There are many coal mines in China, and many of them are medium and small sized. In places where coal production cannot keep up with demand to match the rapid economic growth, safety management is inadequate and many mining

accidents occur. During the 1990s, more than 10,000 people died each year in coal mining accidents. In 2004, the number had dropped to 6,000 deaths, but even so, between November 2004 and August 2005 there was a series of six major accidents in Henan Province, Shaanxi Province, and Heilongjiang Province, in which more than 100 people died each time. Many of the mines are run by small-scale township and village enterprises, and most of the accidents happen here. This is why in 2004, to deal with coal mining accidents, the government of China announced a policy of closing 44,000 coal mines that had inadequate safety measures.

The transport of mined coal also presents challenges. Much of the coal-producing areas are located inland from the sea, whereas most of the coal consumption and demand is on the coastlines. About 60 % of the mined coal is transported by rail, and coal accounts for about 40 % of all rail freight. Where the distances are relatively short, trucks are also used. With my own eyes I have seen long convoys of hundreds of trucks loaded with coal and parked along the highway between Datong (Shanxi Province) and Beijing. Evidently, they are waiting for the time to pass, due to restrictions on truck use of the highways during the day. The coal in the trucks looked like enormous jet-black boulders.

3.2.2 Oil Production: Further Increases Look Difficult

Oil consumption in China is second in the world only to that of the United States, at about 9.75 million barrels per day or about half the US consumption of 18.8 million barrels per day (2011). Although highly unlikely, if China's consumption per capita ever rose to match that of the United States, China would require about 90 million barrels per day; that would actually exceed current global daily oil consumption. Countries in the Organization of Petroleum Exporting Countries (OPEC) have a daily oil production which is around 30 million barrels, so depending on trends in China, it will be impossible to keep up with demand without a rapid increase in production. And if supply cannot meet demand, there are concerns that crude oil prices will rise.

In 2005, China's confirmed recoverable oil reserves amounted to 16 billion barrels, or 1.3 % of the world's reserves. But China is having difficulty in increasing its oil production. During the 1990s, most of China's oil production came from three major oil fields in the eastern part of the country—Daqing, Shengli, and Liaohe—but these are being depleted, and production is generally flat or declining.

China is attempting to revitalize the reduced production in the three largest oil fields and develop inland oil fields in western China as well as offshore oil fields such as those in the East China Sea. According to a news report, the production of the three oil fields increased again to 89 million tons in 2007, but production cannot keep up with the increasing demand. As a result, imports expanded drastically from 8.5 million tons in 1995 to 136 million tons in 2005 and 265 million tons in 2011. China feels a strong sense of urgency about securing oil supplies and is scrambling to find resources. This is becoming a flash point for international friction. Japan has

issues with China pertaining to seabed resource development in the East China Sea around the Senkaku Islands. A state-owned enterprise named China National Offshore Oil Corporation attempted to purchase American oil company Unocal Corporation, but the deal faced opposition from the United States Congress from the perspective of national security. Eventually it fell through (2005).

In the scramble for resources, one can also see an increase in China's influence in African countries. Chinese capital has been active in oil-producing Nigeria since the 1990s, and in 2005 Chinese interests signed an agreement with Nigeria's state oil company for 30,000 barrels of crude oil per day. In order to secure foreign oil resources, since the 1990s China has been encouraging state-owned enterprises such as China National Petroleum Corporation (CNPC), China National Petrochemical Corporation (SINOPEC), and China National Offshore Oil Corporation (CNOOC) to make investments and pursue their own developments overseas. These companies, under the aegis of the government and with enormous funding, are taking on gargantuan projects to secure foreign energy resources as well as large projects such as the construction of large pipelines. Oil interests abroad secured the increasing total imports in these ways in the 2000s.

China is also very interested in strengthening relations with Russia, Kazakhstan, Uzbekistan, and Kyrgyzstan, in order to secure oil and natural gas which lies in abundance in Central Asia. A project is currently underway to transport oil produced in the region around the Caspian Sea in Russia by pipeline through Kazakhstan. As for natural gas, China is hoping to attract natural gas produced in places like Siberia and Sakhalin in Russia, and this is another issue that very much affects Japan's interests.

3.2.3 West-East Gas Pipeline Project

Natural gas is a relatively clean fuel compared to coal and oil. CO_2 emissions per unit of thermal energy generated differ with each one; if coal is given a value of 1.0, oil would be 0.76, and natural gas would be 0.55. Simply by converting boilers in thermal power plants to natural gas, the need to install flue gas desulfurization equipment is eliminated while effectively reducing the emissions of CO_2. Also, because natural gas can be delivered by pipeline, delivery costs are lower. Confirmed recoverable reserves of natural gas in China were 2.35 trillion m^3 (end of 2005). This is equivalent to 2.2 billion tons oil equivalent, not exactly a large amount. Nevertheless, future developments are promising, and a supply of natural gas is definitely needed for household use in cities.

Currently, natural gas fields have been confirmed in the Ordos region, bordering on Shaanxi Province, Gansu Province, and Ningxia Hui Autonomous Region, and these areas are producing 80 % of China's natural gas.

In this context, the West–East Gas Pipeline Project has been implemented to carry natural gas from the western part to the eastern one of the country; the enormous amounts of natural gas in the ground in the Tarim Basin travel by pipelines

totaling 4,000 km in length to Shanghai, Jiangsu, Zhejiang, Anhui, Henan, and elsewhere in the eastern area. The pipeline was fully opened and commercial operation began in 2004. Plans were to carry 12 billion cubic meters in 2007 and ultimately to supply 20 billion cubic meters per year. The West–East Gas Pipeline Project is only one of four megaprojects centering on developments in western China during the Tenth Five-Year Plan (2001–2005), with the other three being the South–North Water Transfer Project, the Qinghai–Tibet Railway Project, and the West–East Electricity Transmission Project.

The West–East Electricity Transmission Project involves generating electricity from the abundant coal resources in the west and transmitting the electricity to the east. Total investment for the West–East Gas Pipeline Project is 150 billion yuan, of which 43.5 billion yuan is for pipeline construction, 27.3 billion yuan for natural gas development and production, and 80.0 billion yuan for the construction cost of the pipeline network in the cities to be supplied. The funds invested for the pipelines will have economic ripple effects for related industries, and the project is being implemented with the aim of economic stimulation in the western region of the country, which is less economically developed.

If we look more closely at China's natural gas calculations, we see that natural gas from Sichuan is being supplied to Hubei and Hunan; natural gas from Changqing is being supplied to Beijing, Tianjin, Hebei, and so on; and natural gas from Qinghai is being supplied to Lanzhou and Xining. Finally, natural gas from Tarim is being supplied by pipeline to the Yangtze Delta and eastern areas as well as the eastern coastal area. It is worth noting that Guangdong Province and other areas on the southern coast are using imported liquefied natural gas. In terms of cost and efficiency, this may be a rational approach.

The fact that natural gas produced in the west is being supplied to large cities in the east has had a major impact on air pollution prevention in the cities. In Beijing, gas for household use previously came from coal gas produced from coal, and cokes furnace gas produced in steel factories in the city. Because of this, gas plants and steel factories were a major source of air pollution. Later, steelmaking was moved into the suburbs, and by closing the coke-oven gas plants, air pollution in Beijing was reduced considerably, particularly SOx concentrations.

As for vehicles, about 15,000 buses in Beijing are being converted to run on natural gas. Vehicles are also being converted to natural gas in the city of Chongqing. To facilitate these efforts what is needed is the construction of natural gas supply stations. It is also necessary to make improvements in the vehicles themselves, but at initial stages, I have seen buses there, carrying what looks like a large balloon on the roof containing natural gas.

3.2.4 Nuclear Power Plant Construction

Nuclear power is one effective way to deal with global warming, in the sense that it does not use fossil fuels during the power generation phase. Meanwhile, there are

concerns about accidents and the disposal of nuclear waste. Since the Three Mile Island incident in the United States in 1979, and the Chernobyl nuclear accident in the former Soviet Union in 1986, there have been strong demands for the abolition of nuclear power, particularly in Europe. Meanwhile, the disastrous nuclear accident of Fukushima in Japan in 2011 has had interrelated, profound, and complex impacts on Japan's energy, environment, and economy policies. If we continue using fossil fuels, we get global warming, but nuclear power brings the risk of accidents. As one saying goes, this is like having "tigers at the front gate, wolves at the back." There is no easy way out.

Currently, nuclear power plants are located along the coastline of Fujian Province and Guangdong Province. There are concerns that, in the event of an accident, Japan could be seriously affected, due to the predominant direction of winds. With the prospect of energy shortages and from the perspective of global warming countermeasures, if nuclear power plant construction proceeds in China, Japan will inevitably have major concerns to deal with. Safety issues relating to nuclear power are not limited to technical issues. It is also essential to have mutual trust and good communication between the governments that are responsible for regulation and the power companies. In Japan, there have been cases of power companies falsifying and concealing data. In this regard, it is difficult to say with confidence that there are no concerns regarding political and economic systems in China today.

In 2011, nuclear power capacity in China totaled 12.5 million kW from 15 plants. Nuclear power's share of total electrical power generation is still low in China, at about 2.2 %. By comparison, the figure for Japan was 26.3 % in 2005. During the 1970s, the dominant argument in China was that nuclear power was not necessary because the country had abundant coal resources. Since the 1990s, however, the country has been more interested in nuclear development in order to meet the constantly rising demand for power.

The Qinshan Nuclear Power Plant in Fujian Province was the first commercial nuclear power plant constructed in China, and it used a pressurized water reactor (PWR). Construction work began in 1985, and commercial operation began in 1994. Since the construction of the plant, China has been establishing the technology capacity to gradually increase the construction of nuclear plants while introducing foreign capital and technology from other countries such as France, Canada, and Japan. Meanwhile, Russia has been offering cooperation relating to the Tianwan Nuclear Power Plant in Jiangsu Province (Reactor 1 began operation in 2004 and Reactor 2 in 2005) in the form of financing and technical training.

In the context of severe power shortages, the government is considering increasing the reliance on nuclear energy to 8 %, by increasing nuclear power generation to 80 million kW by 2020. In order to achieve this target, the country is building at least 26 new nuclear power plants. This would be considerably faster than the pace at which the country constructed the first nuclear plant of Qinshan. The new construction plans include the Sanmen plant in Zhejiang Province, and the Yeongdong plant in Guangdong Province, as well as the Yangjiang plant in Guangdong Province, Donggang plant in Dalian and Wafangdian City, and more reactors in Sichuan Province and elsewhere.

As the new construction of nuclear power plants has been stagnant in many countries, manufacturers from Europe, the United States, Japan, and Korea are targeting the Chinese market, hoping for opportunities to win contracts. However, as has done with the construction of high-speed rail and other projects, the Chinese government is aiming to make nuclear power a domestic industry. Corporate strategies relating to advancing into the Chinese market put them at critical crossroads depending on how they see the future China.

The securing of uranium resources is another important issue for China. Confirmed recoverable resources of uranium in China as of the year 2000 amounted to about 73,000 tons. Besides the exploration area of mines being small, China also does not have adequate fuel-processing capabilities, so economic viability is apparently low. The current situation is that China will find it difficult to obtain adequate uranium from new mines in any quantity to satisfy the future projections of nuclear plant capacity. Thus, China will have no option but to depend on imports for the foreseeable future. Nuclear power development trends in each country, including China, have an impact on the international supply and demand for uranium. Until recently, uranium supply and demand were relatively well balanced, but since 2005, it has become more difficult to read the market.

Since the Three Mile Island incident and the Chernobyl accident, there have been constraints on the construction of new nuclear power plants in the United States, as well as European and other countries, but attitudes have again shifted to favor a reexamination of the role of nuclear power in the context of the need to tackle climate change. The report from the Working Group 3 of the Intergovernmental Panel on Climate Change (IPCC) released in May 2007 placed a relatively greater emphasis on the role of nuclear power than in past reports (Metz et al. 2007). In the United States, as well, for the first time in years, reports are emerging about the construction of new nuclear power plants. In India there are also debates about nuclear plant construction. All this leads to concerns about tighter supply and demand of uranium going forward. In this context, uranium export negotiations between Australia and China have attracted considerable attention. Australia boasts the world's largest reserves of uranium, but due to government policies demanding nuclear safety, the country was not actively promoting uranium resource development, and uranium exports to China were prohibited. In 2006, however, an agreement was reached between the two countries permitting the export of uranium to China. The ending of the ban on these exports is expected to drive uranium mine developments in Australia.

The Great East Japan Earthquake which involved earthquake, tsunami, and nuclear power accident created big concerns about energy security and nuclear safety issues. China has a lot to learn from Japan's experience about this.

3.2.5 Energy Supply and Demand: Future Predictions

Many rosy predictions are being made about the future of China's economy. The Chinese government's targets are for the economy to quadruple by 2020 compared

to 2000. This would mean a growth rate of more than 7.2 % per year. Nevertheless can high growth rates, the norm for China since the 1980s, continue for such a long period of time? The basis for thinking that sustained economic growth is possible in China is the country's large land area and population. Currently, it is only the people of the coastal cities, or about 20 % of the total population, who are receiving the fruits of economic growth. Conversely, this means that there is a huge amount of room for further development. On the other hand, there are constraints on economic growth for China: resources, energy, and the environment.

The population of China is larger than the populations of the European Union, Japan, and the United States combined. Is it possible for such a large population to consume resources and energy on the same scale as developed countries? There is no question that China's resource consumption will result in an increase in resource prices overall. Since the year 2000, price trends for metals and other commodities have been clear. From the perspective of climate change, there is no question that there will be stronger headwinds blowing against China's consumption of fossil fuels. If that is the case, under resource, energy, and environmental constraints, one could not expect that China's economic growth will be able to sustain a steady level forever, and while China may encounter many serious obstacles, it will probably proceed by making repeated adjustments in terms of the economy, society, and technologies.

It is quite difficult to determine how this all will take shape. The followings are a very rough sketch of the future energy and economic trends in China.

The role of technological progress is increasingly important as a factor supporting China's economic growth. The relatively low current level of technology in China means that great potential exists to introduce new technologies, and this is a plus for economic growth. In terms of industrial structure, primary industries (agriculture and raw materials) will decline, and tertiary industries (services) will grow, while secondary industries (manufacturing) will roughly maintain the status quo. Production of commodities and materials such as steel and cement and ethylene will increase. As incomes rise, automobile use also increases. Car ownership in 2003 was 24 million vehicles, but there is a great possibility that this will rise to 120 million in 2020 and 240 million in 2030.

As for macroeconomic trends and energy policy, past trends and Chinese government measures will, in principle, be maintained. In short, energy use efficiency will rise, the rate of energy efficiency can improve at 2–3 % per year for the next 30 years, and renewable energy technologies such as solar energy panels will be further developed. It is expected that China will be self-sufficient in coal, that oil production will peak in the year 2020 and then decline thereafter, and that natural gas use will increase. The use of nuclear power may rapidly increase driven by electricity shortages. Meanwhile, there will be issues arising concerning the question of who will cover the high cost of nuclear power generation if electrical power markets are liberalized, and how to deal with the processing of spent nuclear fuel and nuclear waste arising from nuclear power generation.

According to an estimate of IEA (international Energy Agency), energy demand in 2035 will amount to about 3.9 billion tons oil equivalent, or almost double the

amount of 2.1 billion oil equivalent in 2009 (The Energy Data and Modelling Center 2012; IEA 2011). This figure is larger than the combined consumption of the United States and Japan in the year 2000 or 2.83 billion tons. The GDP elasticity for energy consumption (value calculated by dividing the energy consumption growth rate by the GDP growth rate) may be lowered to 0.6. The overall energy consumption is large, but because the population is large, energy consumption per capita even in the year 2035 would be less than the average level of Organization for Economic Cooperation and Development (OECD) countries today. The energy composition is expected to have no change from being coal centered, but coal's share is expected to drop from the current roughly 70 % down to 50 %. China has the potential to be self-sufficient in coal because it has its own resources. It currently exports coal to other countries, but in the long term, it is expected that China will lose the surplus capacity to export overseas. Another major issue will be securing the transport capacity to carry the coal from northern China, which produces 90 % of the mineral, to the coastal areas where demand is concentrated.

Oil demand was 380 million tons in 2009 but is predicted to increase rapidly to 810 million tons in 2035. The overseas dependency will be as high as 76 % compared to 50 % in 2009. If this happens, various other problems will emerge, such as whether or not China can secure such a huge amount of oil and whether it is possible to secure safe means of transport, and furthermore there is the issue of impacts on foreign currency reserves. It is possible that China could experience the same situation as Japan, when a period of rapid economic growth was stopped cold by the oil shock in 1973. Demand for natural gas is rising rapidly, particularly for household use and electrical power generation, so there is a high likelihood that domestic supply will be unable to keep up with demand, making China a net importer.

The face of the future will depend on various factors such as economic growth rates and energy prices, but it is extremely unlikely that energy consumption will be lower than today. As for nuclear power, besides an enormous amount of funding required for investments in facilities, it also takes time to grow. If CO_2 emissions continue to rise, and effective countermeasures are neglected, there are concerns that air pollution will become more severe.

3.2.6 Oil Alternatives: Coal Liquefaction and Biomass

The biggest worry for China is probably oil security. At present, a large increase in oil production cannot be expected. Thus, China is putting its efforts into securing resources in places to source its oil other than the Near East and Middle East, including Africa and Central Asia.

As an alternative to oil, the government is paying attention to the liquefaction of coal. Because coal resources are present in abundance in China, it may be possible to ensure economic viability if liquefaction can be done domestically. However, a coal liquefaction project being implemented in the Ordos region of Inner Mongolia is not yet going very well. Original plans were to complete the first phase in 2007

and, using 9.7 million tons of coal per year, produce 3.2 million tons of various petroleum products (heavy oil, gasoline, LPG, benzene, and so on). Besides requiring gargantuan investments for coal liquefaction, it appears that the operation cannot be run economically because of the need for large amounts of energy for production. Furthermore, coal liquefaction requires a large amount of water. Reportedly 15 tons of water is required for liquefaction of each ton of coal. Meanwhile, most of the coal resources are found in northern China, a region that suffers from a lack of water. Coal liquefaction may inevitably lead to a tug-of-war with agriculture for water resources.

Another possibility as an alternative to oil is the manufacture of ethanol from corn and other grains. Currently, China is the third largest producer of fuel ethanol in the world after the United States and Brazil. The purpose of this production is to reduce dependency on the import of oil. In 1999, four ethanol plants in Jilin Province, Heilongjiang Province, and elsewhere were designated as priority factories. Government subsidies were also provided, and as of 2005, production capacity at the four plants amounted to 1.02 million tons. International corn prices are trending upwards, however, because biofuel manufacturing from corn in the United States expanded as well. Because of this, in 2007, the Chinese government stopped issuing permits for the construction of new ethanol factories using corn as raw material. The idea is to aim for ethanol production from non-grain raw materials such as cassava and cellulose, going forward, but the technology has not yet been perfected.

As a conclusion, each of the oil alternatives comes with a variety of problems, whether it be coal liquefaction or biomass. Both of these are predicted to have impacts on water supplies and food production, and not only that, their energy conversion efficiency is poor.

3.3 Energy Conservation: Possible Dream?

3.3.1 Energy Conservation, Pollution Control Measures

During 2001–2010, annual average GDP growth in China was 10.5 %, and energy consumption grew by 8.45 % per year and electricity consumption by 12.1 %. If we divide the growth rates for energy consumption or electricity consumption by the GDP growth rate, we find the elasticity to be 0.80 for energy consumption and 1.15 for electricity consumption (National Bureau of Statistics 2012).

China during the 1990s achieved a certain level of energy conservation, but after the year 2000, the pattern of growth accompanied by high energy consumption returned. This is likely due to an increase in the production of basic materials such as steel and cement for building infrastructure and for manufacturing industries supported by exports. Furthermore, the rapid increase in electrical power consumption reflects the growth of cities as well as the affluence of lifestyles based on high consumption. Thus, the GDP elasticity of energy consumption—which during the

1990s stayed below 1.0 and moved within a range between 0.16 and 0.63—increased significantly and largely exceeded 1.0 in the early 2000s, at 1.53 in 2003, and 1.59 in 2004. As for electricity, elasticity is constantly high especially in the provinces which are relatively poor, but people's lifestyles are rapidly changing to more affluent ones.

Because of this, the Chinese government made energy conservation an important national strategy. The Eleventh Five-Year Plan (2006–2010) lists as objectives the establishment of a harmonious and conservation-oriented economy and society. Within this, energy conservation policy targets have been given a prominent role. More concretely, the targets for the period are to reduce energy consumption by about 20 % per unit of GDP and total emissions of major pollutants by 10 %. It is worth noting that this is the first time the country has used energy consumption per unit of GDP as a macroeconomic control indicator besides the traditional economic indicators such as economic growth, prices, employment, and balance of trade. Through this decision, the Chinese government has shown that its stance is aiming for not simply the quantity of high economic growth but rather quality of economic growth in terms of resource conservation and energy conservation.

To achieve these targets, the government has policies to put an effort into upgrading facilities with an emphasis on energy conservation as well as improving technologies, as soon as possible eliminating production processes, equipment, and products that consume large amounts of energy, water resources, and raw materials, and giving more emphasis on environmentally friendly economic growth. Furthermore, the government says it will publish data annually about energy consumption per unit of production of regions and major industries. As one powerful measure to achieve the targets, the Chinese government is making efforts to create a system of resource and energy taxes. Because the overall level of resource taxes in China is now low, the policies lead towards a gradual increase of oil resource taxes going forward.

3.3.2 Clean Development Mechanism Projects

China has a large potential to mitigate GHG emissions by developments of renewable energy, such as wind power, solar power, and biomass, and reductions of GHG emissions other than CO_2, such as chlorofluorocarbons (CFCs). In this context what attracts attention is Clean Development Mechanism (CDM) which was incorporated into the Kyoto Protocol. The CDM is a system by which projects are implemented leading to GHG emission reductions in developing countries through the financial and technological assistance of developed countries. All or part of the reductions generated from those projects are acquired by developed countries in the form of emissions credits, which are then used to achieve the emission reduction targets of those developed countries (Institute for Global Environmental Strategies 2011).

The Kyoto Protocol also has provisions for Joint Implementation (JI). Because JI is carried out between developed countries, it does not apply to China. Nevertheless,

both possess reduction targets (or emissions credits) for projects that will lead to emissions reductions. Emissions credits of an amount equivalent to all or part of the reductions arising in the host country through the project will be acquired from the host country by the country that provides funding and can be added to the emissions credits of the country that provides funds.

There have been many cases in which Japanese corporations purchased GHG emissions credits, or certified emission reduction credits (CERs), through CDM projects in China. In order to acquire CERs, the registration and approval by CDM Executive Board (CDM EB), the supervisor of CDM, is required. A certain Japanese electrical power company entered into a purchase contract for CO_2 emissions credits from a hydropower CDM project in Sichuan Province. This is a project to reduce CO_2 emissions that would otherwise come from thermal power production, through the construction and operation of a hydropower plant. In another example, a group including a Japanese construction company and trading company entered into a project contract to recover and destroy CFCs that were previously being discharged into the atmosphere through the production process of the CFC factory in Zhejiang Province.

Since the approval by CDM EB started in 2004, the number of registered CDM projects has risen: over 3,000 at the end of 2011. Most of the projects registered were in Asia; it is significant that 45 % of the total was in China, and most of these projects were developed by Japanese corporations (Institute for Global Environmental Strategies 2011).

The CDM can also offer projects that are profitable for Chinese corporations, so interest in China is high as well. There are various possibilities for projects that match the interests of companies in Japan and other developed countries that wish to obtain emissions credits. However, China also happens to be a major emitter of greenhouse gases of an amount that is nearly on par with the United States. It must not be forgotten, however, that there are unfolding overwhelming numbers of issues such as energy conservation that China needs to address as its *own obligation*, without relying on the framework of the CDM.

3.3.3 The State of Recycling

In Japan, the interest in recycling has risen and the Japanese word junkan (for circulation) has even become a byword for environmental protection. The term "the 3Rs" (for reduce, reuse, and recycle) is also in common use. Recently, in China as well, a term meaning "circular economy" has also come into common use, though the meaning of this term is slightly different between China and Japan.

In Japan, in the year 2000, the Basic Law on Establishing a Sound Material-Cycle Society was enacted, and it defined a "sound material-cycle society" as one in which the burden on the environment is minimized to the extent possible by ensuring the 3Rs and proper waste disposal and by limiting the consumption of natural resources. Its starting point is waste management, and the history behind the

enactment of the law was the absolute shortage of landfill sites to dispose of waste, so local municipalities began promoting legislation under waste management regulations in order to reduce the amount of waste and promote recycling. The recycling of household appliances, automobiles, construction waste, food waste, and other materials shows up as major components of resource circulation, but behind all this was the desire to do something about ever-growing mountains of waste. Meanwhile, until now with China's economic levels, waste was treated as a precious resource, and resource recycling was conducted quite proactively (Ministry of Economy et al. 2013).

In recent years, waste materials collected separately in Japan such as waste plastic, used PET bottles, scrap iron, and used household appliances are being exported to China as resources. Because a lot of human labor must be involved in the recycling of these materials, this is not viable in Japan due to high labor costs, while an adequate profit can be made if the work is done in China. It is ironic that precious resources are flowing overseas as a result of the establishment of legislation originally intended to promote recycling within Japan. Each type of waste material could be treated as a treasure of resources such as rare metals, if only the perspective was changed. In China, waste resources are called "the second mine" or "urban mine," and in the context of low-cost labor, the resource-recycling industry has high potential. The work of extracting salvageable or useful resources from waste at the present time is something difficult to do by machine. In China, the sheer force of large numbers of workers is used to extract valuable materials from mountains of garbage with a mix of a variety of types of things and materials. Next, relatively primitive means such as simply using heat are used to extract metals. In this process, there is the risk of the generation of toxic materials. The current reality is that the recycling industry there is built upon simple methods that rely on cheap labor without taking safety into account.

3.3.4 Circular Economy: High Product Quality, High Efficiency, and Low Pollution

China's circulation economy is innovative in its principles. Rather than thinking about how to dispose of waste, the target or objective is rational and efficient overall production systems through the effective use of resources. This thinking is deeply rooted in the pressures of having to procure vast amount of resources amidst a shortage of resources.

China's concept of circulation is to look at things from four perspectives: small cycles, medium cycles, large cycles, and waste management and recycling industries. Rather than concepts of recycling, these are closer to the concept of "zero emissions" (aiming for zero emissions of waste from society as a whole).

- Small cycles: Initiatives at the corporate level, aimed at minimizing the generation of pollutants by achieving cleaner production and reducing the amount of material and energy used in products and services.

- Medium cycles: Initiatives at the regional level, promoting the development of functional industries of groups of companies, industrial parks, and economic development zones. These initiatives aim for the realization of zero emissions at the regional level, by using the byproducts and waste products of upstream production processes as the raw materials for downstream production processes and constructing eco-industrial parks consisting of eco-industrial chains of metabolic and symbiotic relationships among businesses.
- Large cycles: Initiatives at the societal level, ultimately aiming for the realization of a society with sound material cycles, by promoting green consumption, establishing separated waste collection systems, and through circulation among primary, secondary, and tertiary industries.

In order to advance these kinds of policies, the first thing is to enact a law that set forth the rights and obligations of corporations and citizens toward the creation of an economy with sound material cycles. Next, there must be detailed legislation or rules to deal with specific resource items such as metal scraps, waste plastics, and waste paper.

China is singing the praises of economic growth, but some regions are steadily declining, unable to break free of the heavy industry-based model built up in times past. Economies with sound material cycles display a new development model in old industrial cities in northeastern China, which have until now survived on industries that are heavy consumers of resources. In order to promote an economy with sound material cycles, it is necessary to offer some kind of incentives to local governments, which are responsible for local industrial policy. An economy with sound material cycles means the construction and introduction of new high-quality, high-efficiency, and low-pollution production facilities to replace conventional production systems that generated wastes and pollution. This is therefore an attractive topic for local governments. The next real issue is the technologies required in order to realize these principles. Energy efficiency and environmental protection are areas in which Japanese corporations have strength and also in which China looks to Japan. However, discussion here relates to fundamental production technologies and production systems, so for Japanese corporations, this may be a sensitive topic to discuss.

3.3.5 Garbage Volume and Waste Treatment: Both Growing

As the consumer lifestyles of the Chinese people have become increasingly affluent, the volume of urban waste has increased, and its characteristics have also changed. During the 1990s, plastic bags and containers were strewn about the countryside and in cities, earning the label “white pollution.”

Municipal waste has a different meaning depending on the country and is difficult to define. In Japan, waste is divided into municipal waste and industrial waste, with municipal waste including household waste (garbage generated in the typical

household) and commercial waste (garbage generated in offices, retail stores, hospitals, and so on). Furthermore, in areas that do not have sewerage systems, municipal waste also includes human sewage. Using this definition, Chinese statistical data for the year 2005 show that urban household waste treatment nationwide amounted to 155.8 million tons and the sewerage 38.0 million tons, totaling 193.8 million tons. This amount corresponds to the volume of municipal waste treatment in Japan but is larger than current figures for the United States. In 1996, household waste amounted to 108.3 million tons and sewage 29.3 million tons, totaling 137.6 million tons. This means that the amounts increased by 40 % over the course of 10 years. This increase is due to the fact that urban populations increased and consumer lifestyles became more affluent. If this pace of increase continues, in 2030, the amount will reach about 500 million tons.

In the case of Beijing, municipal waste (excluding sewage) amounted to about 4.5 million tons and has remained relatively constant since 1995. Per capita for the resident population, the amount is about 0.8 kg, lower than the Japanese average of about 1.1 kg. Although it is difficult to make direct comparisons because of the different ways of interpreting the data, one gets the impression that the gap is shrinking between Japan and China in terms of the generation of waste. The amount of human waste is decreasing as sewerage systems are improved. Detoxification treatment is being conducted on 52 % of household garbage nationwide and 96 % in Beijing. The methods of treatment include sanitary landfill (85.2 %), composting (5 %), and incineration (9.8 %) (as of 2005).

For landfills, the main method of garbage management, in the past the most common method was for open dumping in the suburbs, but in recent years, sanitary landfill with waste being properly covered by soil has become more common. Until recently, sanitary landfill standards were not clearly articulated, and a variety of hazardous substances, construction waste, medical waste, and other types of waste were being dumped. Because of this, more than 5,000 landfills nationwide have reportedly been polluted by hazardous waste and chemical substances. Concern about this problem is currently low in China, but in the future, the cost of cleaning up the sites will be high.

As public concern regarding landfill safety increases in the future, the cost of landfilling will probably increase, and it will become more difficult to secure future sites. The incineration of waste is another topic of concern from the environmental perspective. The incineration currently being conducted in regional cities in China today is done simply by burning garbage in old-style furnaces. Combustion temperatures are low, the furnaces are not being operated continuously, and the smokestacks are low in height—in effect, environmental mitigation is nonexistent. It is very likely that a considerable amount of dioxins are being generated. Modern incineration plants on the level of the technology that was being used in Japan in the 1990s have been constructed in Shanghai, Ningbo, and several other cities, but they are still few in number. No waste incineration plants in China today incorporate the latest dioxin countermeasures used in Japan since the year 2000.

This fact that few garbage incineration plants have been constructed in China is related to the special characteristics of the composition of garbage. Garbage reflects

the lifestyles of the people in society. In the past, organic content constituted a large part of garbage in China, but because the ratio of combustibles such as paper and plastics was relatively low, combustion was not the appropriate treatment. As a result of lifestyles becoming more affluent, the proportion of combustibles became greater, and the calorific content of garbage increased, leading to the beginning of incineration for dealing with waste.

Japan has had many difficult experiences with the construction of garbage incineration plants. Considered to be unwanted by communities for being nuisance facilities, the only solution was to deal with the waste in the jurisdiction where it was generated. In Tokyo today, based on the principle of waste management in one's own jurisdiction, incineration plants are sited in each of the metropolis's 23 wards. Through stringent environmental measures, the public came to accept them, eventually making this arrangement possible. Thanks to improvements in incinerators, the generation of dioxins has been reduced to only a few percent of what it once was in the past. In Beijing as well, reaction to plans for incineration plant construction presented recently by authorities suggests that citizens have strong concerns about dioxins. One would hope that Chinese authorities will refer to lessons learned in the case of Japanese cities such as Tokyo. .

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Chapter 4
Water: The Key to China's Destiny

Abstract Among the most critical environmental issues in China are the shortage of water in the north and water pollution in rivers, lakes, and seas throughout the country. Demand of water resources is rapidly rising due to increasing urban population, industrial production growth, and the expansion of irrigation-based agriculture, and all these factors are also causing water pollution. Most of China's water resources are concentrated in the Yangtze River basin and other regions in the south, while the Yellow River basin and other parts of the north including Beijing suffer from absolute shortage of water. Therefore, the South–North Water Diversion Project was undertaken to transport water from the south to the north, but it is not certain whether the project can be an ultimate solution of the water shortage in the north.

Keywords South–North Water Diversion Project • Three Gorges Dam • Water pollution • Water shortage • Yangtze River • Yellow River

4.1 Time Bombs: Water Shortages and Water Pollution

4.1.1 Growing Problems: Water Shortages and Water Pollution

Among the most pressing or critical environmental issues in China are the shortage of water, and water pollution. Annual precipitation in China amounts to 6.1 trillion tons, of which usable water resources of surface water (rivers) and groundwater amount to 2.8 trillion tons (2005) (National Bureau of Statistics of China 2012). This amounts to 2,170 tons per capita, or less than one-third the global average and two-thirds the Japanese average (3,366 tons). China's figures are not exactly low, but most of the country's water resources are concentrated in the Yangtze River basin and other regions in the south of the country, while the Yellow River basin and other parts of northern China suffer from absolute shortages of water.

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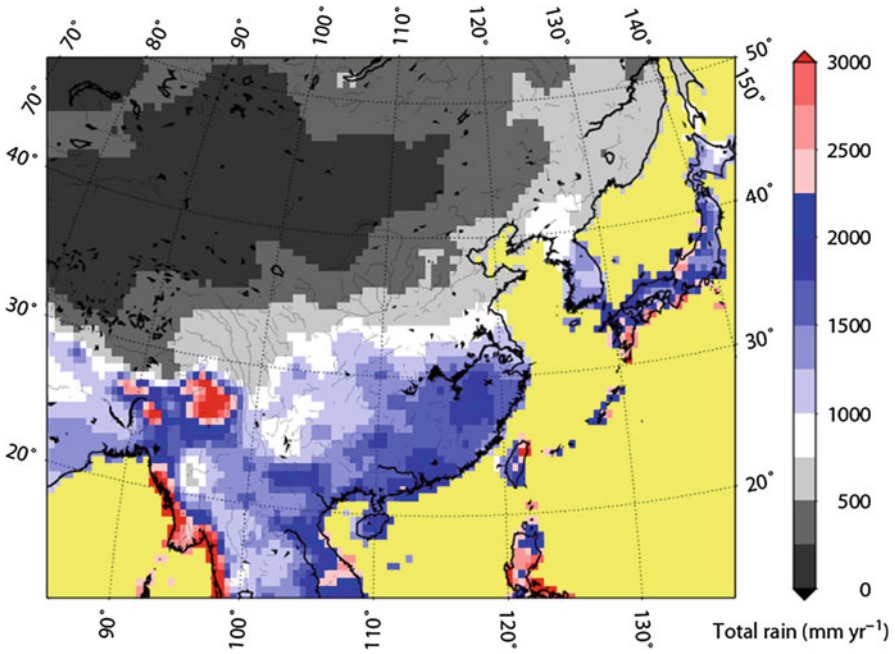

Fig. 4.1 Yearly precipitation in Asian monsoon region, averaged over 23 years from 1980 to 2002 (*Source*: Provided by Akiyo Yatagai)

Although precipitation in Shanghai, Chongqing, and other cities in the Yangtze River basin exceeds 1,000 mm annually, Beijing in the Haihe River basin only receives about 400 mm and Taiyuan and Yinchuan in the Yellow River basin less than 400 mm. Japan's national average is 1,700 mm, and even in Kagawa Prefecture known for its low rainfall, the amount is 1,100 mm. China's rainfall is low by comparison. Figure 4.1 illustrates the annual precipitation in Asian monsoon region including China (Yatagai et al. 2012).

The Yellow and Yangtze are both great rivers, but there is a large difference in the amount of water running through them. Consider their total amounts of water resources in the average year: the Yangtze has about 950.0 billion tons, and the Yellow River about 54.0 billion tons. Table 4.1 compares water resources and water quality of seven major rivers in China.

China is divided into seven major river watersheds: Yangtze, Yellow, Pearl, Songhua, Huaihe, Haihe, and the Liao. Of these, the river basins of the Huaihe, Yellow, Haihe, Liao, and Songhua in northern China are home to 44 % of China's total population, and 65 % of the arable land is concentrated here. Despite this, this region has only 13 % of the nation's water resources and only about one-third the national average of those resources per capita.

Since the 1970s, during the months of May through September when agricultural water demand is high, there have been many times when the lower portions of the

Table 4.1 Water resources and water quality of seven major rivers in China (2005)

River	Area of river basin (1,000 km^2)	Length (km)	Water resources (2005)		Water quality (2005)	
			Total water resources (billion tons)	Water withdrawal for human use (billion tons)	Number of measurement points	Ratio of the measurement points worse than grade V standard (%)
Songhua	557	2,308	152.5	37.8	42	19.0
Liao	229	1,390	45.4	19.1	37	40.5
Haihe	264	1,090	26.7	37.9	65	53.8
Yellow	752	5,464	75.6	38.1	44	25.0
Huaihe	269	1,000	140.0	54.4	86	31.4
Yangtze	1,809	6,300	988.7	184.2	104	10.6
Pearl	454	2,214	439.1	87.4	33	6.1

Source: China Statistical Yearbook 2011 (China Statistics Press), China Environmental Yearbook 2006 (China Environmental Yearbook Press)

Note: Total water resources can vary greatly depending on precipitation each year

river dried up because of the lack of river water flowing that far. Since the year 2000, further increases in water use have to some extent been suppressed, but the overall trend is for more water demand for agriculture, industry, and urban areas.

Besides the shortage of water, the pollution of water is also serious. According to the annual China Environment Yearbook, factory and domestic wastewater discharge volumes were declining during the 1990s, but since the year 2000 have begun to increase again. Between the year 2001 and 2010, factory effluent increased from 20.3 billion tons to 23.8 billion tons, and household wastewater discharge grew from 23.0 billion tons to 38.0 billion tons. Chemical oxygen demand (COD), an index of the pollution load in water, dropped from 6.1 million tons to 4.3 million tons from factories, but domestic wastewater stayed almost constant at about 8.0 million tons. Incidentally, during the 1970s, the COD load in Japan's then-polluted Seto Inland Sea was about 400 thousand tons/year (or one thousand tons/day). One cannot simply compare these numbers with the vast expanse of China, but they may provide a rough indication of their magnitude.

Municipal water service has spread to 91 % coverage in cities, but the actual details are not as good as the numbers suggest. In 22 of 47 major cities, water quality in the water supplies fails to meet drinking water standards and poses a health risk (2005). Boiling will kill bacteria and volatile pollutants can be removed, but heavy metals cannot be removed. Furthermore, more than 440 of 661 larger cities have water supply shortages, and in 110 cities, these shortages are severe. Even if citizens happen to have running water, in many cities, they have to deal with time restrictions on the supply of water.

Pollution of water supplies is widespread, and 320 million people in China reportedly do not have safe drinking water. Various reasons for this include factory discharge, mining discharge, fertilizers and agricultural chemicals, urban domestic wastewater, heavy metals in soils, and other issues. Only a low percentage of urban

sewage is treated, and discharge from piggeries, fish breeding ponds, and other nonpoint sources is left virtually untreated. Many rural areas have no running water service, and 70 million people are using poor quality and untreated groundwater drawn from wells. There are reports of groundwater tainted by toxic arsenic and fluorine in many places, but more accurate studies are needed.

On top of this, groundwater levels are dropping in many places around the country due to the lack of sufficient surface water and the excessive use of groundwater. Related to this, ground subsidence of more than two meters has occurred in Shanghai, Suzhou, Wuxi, Tianjin, Taiyuan, Xi'an, and other cities.

4.1.2 Water Shortages: A Constraint on Future Economic Development

Water is an essential natural resource for human existence and economic activities. Water resource reserves are imbalanced in temporal and spatial distribution, and this fact has a variety of impacts on human activities. Japan is associated with the Asian Monsoon region, and with the exception of cities such as Takamatsu and Fukuoka, Japan does not usually experience serious water shortages. Around the world, however, an overwhelming number of arid regions receive less than a few hundred millimeters of precipitation per year, and water consumption is steadily rising due to the expansion of irrigation-based agriculture with the aim of boosting agricultural production and due to the growth of urban populations. In the inland areas of the Eurasian continent, including northern China, predictions call for increasingly severe shortages of water resources—with the increase in demand for water resources due to human pressures combined with drying and desertification trends caused by global climate change (Solomon et al. 2007). China must overcome the constraints posed by the lack of water if it hopes to continue with its remarkable economic growth in the future.

In China today, more than 70 % of demand for water is in the agricultural sector. In the past, this sector relied upon natural rainfall, but in order to increase food production, large-scale irrigation was introduced through the construction of canals. Although the irrigated land area in 1950 amounted to no more than 170,000 km^2, this figure rose to 450,000 km^2 in 1980. The rate of increase has slowed since then, but in 2005 it amounted to 550,000 km^2. Despite this, irrigation efficiency in China ranges from 30 % to 40 %, about half the level in developed countries. The water being drawn into irrigated areas is not necessarily being used efficiently, and much of it is lost through evaporation. The amount of evaporation is particularly high in the arid regions in the middle reaches of the Yellow River. In this way, the abundant water resources of the upper reaches of the river are steadily reduced as the water flows down the river.

Due to the expansion of industrial production, and the growth of urban populations, water demand for industry and for urban use is also rapidly increasing.

Authorities have been adopting policies giving priority for allocation of the finite water resources to industry and cities in order to promote industrial and urban development. Then, what results? The agricultural sector is now feeling the strain. Although an increase in food production is necessary in order to sustain a growing human population, the trend is for a reduction in arable cultivated land. It is necessary to reduce the volume of water used per unit of area or unit of harvest and at the same time to increase productivity. To achieve this, the top priority is to adopt water-conservation methods in agriculture that consume the smallest possible amount of water. The challenges here will be the modernization of the agricultural sector and finding a balance between the developing industrial sector and the use of out-of-date farming methods.

Water shortages and the worsening of water quality reduce the quality of urban drinking water (tap water). In order to increase the amenities, scenery, comfort, and livability of cities in arid northern China, it is important to have green areas and water surfaces, but these all require water. Water is also essential for tree planting as a measure to combat desertification. Plus, in order for China to sustain a sound economic growth, the challenge is to use and allocate the limited water resources in an efficient way. If one happens to live in a country like Japan with abundant water, people have a tendency to forget that the resource known as water is not something that humans can monopolize for themselves alone. If humans use too much water, the water also required by plants, animals, and ecosystems will be depleted. In this context, besides the terms "agricultural water," "industrial water," and "domestic water," the term "ecosystem water" is also used in China. This latter term refers to the water that is absolutely necessary for the survival of trees, grasses, birds, fish and insects, and the conservation of ecosystems. It also includes water for trees lining city streets, water that flows through canals, and so on. In the case of the Yellow River, an enormous amount of water is needed to wash away the accumulated sediment in dams, and this also is included in the concept of ecological water.

4.1.3 Water Quality Standards

The water quality standards of lakes and rivers in China are evaluated in a total of 21 categories, including COD, biological oxygen demand (BOD), ammonia, phosphorus, total nitrogen, metals, petroleum, and phenols. The water in rivers and lakes is classified into the following five grades depending on water quality:

- Grade I: Natural-flowing water. Applies to national nature reserves.
- Grade II: Water sources for domestic and drinking water supply in first-class protected areas (municipal tap water for cities). Applies to protected zones for valuable fish, shrimp and fish spawning grounds, etc.
- Grade III: Water sources for domestic and drinking water supply in second-class protected areas. Applies to protected zones for regular fish and to swimming areas for the public.

- Grade IV: Applies mainly to zones that supply water to industry, and recreational zones where humans do not come into direct contact with water.
- Grade V: Applies mainly to zones that supply agricultural water and zones required for general scenic purposes.

Grades I and II are high in water quality. Grades III, IV, and V each have a different level of quality, but one could say that water quality is considered acceptable, posing no serious problems for humans. The issue is that much water in China falls into a grade referred to as "fails to meet Grade V," assessed to be worse than Grade V, which already has the worst quality in this five-grade system. This refers to untreated sewage and other water that appears very dirty, even to the untrained eye. As for rivers, water quality is measured at more than 400 observation points nationwide and is assessed according to which section of the river flow falls into a given grade of water quality. The results are published by the State Environmental Protection Agency every year (Ministry of Environment of the People's Republic of China 2012).

4.1.4 Industrial Wastewater and Environmental Monitoring

In 2005, the total amount of wastewater in China amounted to 52.4 billion tons, of which 24.3 billion tons were industrial wastewater. Industrial wastewater contained about 1,000 tons of mercury, lead, cadmium, chromium, and other heavy metals as well as arsenic, 570 tons of cyanide compounds, and 23,000 tons of oils. Besides this, a national survey of coastal cities found that industrial wastewater discharged into coastal waters amounted to 1.52 billion tons. It has been reported (2005) that the COD removed from industrial effluent totaled 10.88 million tons, that the operating costs of removal facilities amounted to 27.7 billion yuan, and that 91.2 % of facilities met effluent standards.

Figures such as these are released annually in publications such as the China Environment Yearbook and the Report on the State of the Environment in China (Ministry of Environment of the People's Republic of China 2012). There is generally some debate regarding the reliability of statistical data in China. In some cases, the numbers do not match direct observation. People cannot avoid sensing a gap between numbers suggesting that more than 90 % of facilities are meeting effluent standards and the actual serious pollution arising at many locations. All the while that such serious pollution is visible, many corporations assert that they are operating in compliance with national standards. One could only conclude that not only are the standards set too low but also that monitoring and enforcement is not being adequately implemented.

Water quality is being measured at observation points along 411 river sections in the seven major river basins. Measurements have found that the worst pollution is along three rivers: the Haihe, the Liao, and the Huaihe. The worst polluted is the Haihe, with 53.8 % of river sections failing to meet Grade V standards. Next are the

Liao at 40.5 % and the Huaihe at 31.4 %. The Haihe River basin includes the North China Plain, which contains two major cities in its north: Beijing and Tianjin. Although it is sweepingly referred to as the Haihe River basin, it does not contain one single large river comparable to the Yellow River or the Yangtze but rather is a collection of many smaller rivers. This area receives little rain. It is suffering from chronic water shortages, on top of its normal lack of water, because of the growth of the two major cities, Beijing and Tianjin, and Hebei Province's growing use of water for domestic, industrial, and agricultural irrigation uses. Tianjin is China's leading industrial city, and because factories are numerous throughout Hebei Province, the use of water by industry is enormous. Water shortages have become a serious problem that will inevitably cause trouble for Beijing, the nation's capital.

Lake pollution is another serious problem, with one-third of all lakes nationwide failing to meet Grade V water quality. Pollution is particularly bad in three lakes: Taihu Lake (Jiangsu Province), Chaohu Lake (Anhui Province), and Dianchi Lake (Yunnan Province). Water quality fails to meet Grade V in Chaohu Lake and Dianchi Lake. Water quality rates Grade III in Taihu Lake, and the city of Wuxi, which draws water from the lake, is plagued by foul-smelling tap water. The Haihe, Liao, and Huaihe trio of rivers and the Taihu, Chaohu, and Dianchi trio of lakes are priorities for water pollution control in China. There are also two key areas of air pollution policies (sulfur dioxide control area and acid rain control area). One city (Beijing) is the priority for urban environmental policies. And one sea (Bohai) is the priority for marine pollution control. Combined, these are referred to as the "332211 Projects," as mentioned in Chap. 2.

4.2 Beijing's Reason to Worry

4.2.1 The Drinking Water Situation

Turn the faucet and out should come clean water. Not only that, one hopes it tastes delicious. But most people cannot expect such luxuries in China. Municipal water service covers more than 90 % of the population in Chinese cities, but the water coming out of the tap is not suitable for drinking. The very reason for this is poor water quality in the rivers and lakes from which the water comes. Even after filtration or other types of water treatment, a smell or color often remains, and the taste is not good.

Taihu Lake suffers from large outbreaks of blue-green algae caused by eutrophication. In the city of Wuxi, which uses the lake as its source of water, tap water reportedly has an unusual odor and is not suitable for drinking, not to mention for cooking. In the city of Taiyuan, located near the Fen River, a tributary of the Yellow River, the water coming from the tap has a faint red color. The Fen River has virtually dried up, so its water is drawn from the main course of the Yellow River, and its red color cannot be removed even through filtration. Furthermore, because of the

lack of adequate facilities, water quality can be negatively affected by the aging secondary water supply equipment, as it is being carried in pipes after coming out of the water treatment plant. For these reasons, it is accepted as a matter of course that people in China will buy and drink water in plastic bottles. In the past, many people would carry boiled water in a container, but this custom has been disappearing. One can purchase mineral water from France at supermarkets in cities. Mineral water production is also increasing in China. Cheaper water is also available, but it is nothing but regular tap water that has been filtered, and its taste is less than pleasing. For the 2008 Summer Olympics, Beijing prepared a system to supply drinking water to the tap in the core Olympic district of the city, so that the water coming directly from the tap would be drinkable.

Thus, municipal water coming from river and lake surface water sources is often unfit to drink, although water quality is good closer to the upstream source or if it comes from groundwater. Beer, juice, wine, vinegar, and other drinks are produced in places that are endowed with good water, so it would not be correct to say that springwater and high-quality water cannot be found. In the city center of Jinan in Shandong Province is a spring from which pure and abundant springwater gushes forth from underground. Many people come here to fill their plastic water tanks. Yellow River water carries large amounts of sediment. Upstream, near Lanzhou, its color is reddish brown, while in the middle section near Zhengzhou, it is the color of yellow soil. The Weihe River is one of major tributaries of the Yellow River. The author has visited near the source of one of its tributaries, the Jinghe River. There, springwater flows from the banks on both sides of the river, and its quality is completely pure. The muddy stream of the Yellow River is caused by runoff of a large amount of topsoil by the rain, though the groundwater is clean.

4.2.2 Beijing Water Shortages

Although Beijing is located in the Haihe River basin, where water resources were scarce to begin with, the amount of water use is steadily growing due to rapid economic development and population growth. A construction boom, an increase in car washing, and also the increase of green space in the city are also rapidly increasing the amount of water needed. In addition, domestic sewage and industrial effluent has worsened the water quality in reservoirs that supply water to the city. Moreover, since 2000, low rainfall has continued to afflict the region year after year. Experiments to stimulate artificial rainfall are being conducted to deal with the problem.

The population of Beijing at the end of 2006 was 15.81 million people. Of this number, 11.97 million are officially registered as residents; migrants (farmers who also work in factories) who stay more than half a year amount to 3.83 million. In the past, there were strict restrictions on people who came to the city to earn a living but were not registered as residents, but these regulations have been relaxed recently. The construction boom in hotels and office buildings also continues. In particular,

with the 2008 Beijing Olympics the population increased further, adding concerns about an even more serious shortage of water.

Beijing's annual water resources, as calculated from the amount of rainfall, is about 300 tons per capita, about one-seventh the national average, and about one twenty-fifth the global average. Few national capitals in other countries of the world face such a shortage of water. Greenery and water is an important part of the urban landscape. Beijing has no big rivers flowing through it, but moats and canals are scattered throughout the city. The Golden Water River and other water bodies in front of Tiananmen Square are such examples. These canals, which were once polluted, are gradually being cleaned up and made more beautiful by filling them with treated water and dredging their bottoms. Places like these in Beijing are also places of recreation and relaxation for citizens, including the Summer Palace in the northwestern part of the city. This 290-ha park was created at the end of the nineteenth century by Empress Dowager Cixi. Within the park is a large artificial lake named Kunming Lake. Meanwhile, next to the Forbidden Palace of the Qing Dynasty in the heart of Beijing is Zhongnanhai, where Chinese government officials live. The Chinese characters for Zhongnanhai are "central south sea." As the name implies, there is a large artificial lake here. At the time of Empress Dowager Cixi it was possible to travel by boat along a canal from Zhongnanhai to Kunming Lake. Today, however, the water in Kunming Lake is shallow enough for a person to stand. Recently, the lake water quality has deteriorated and the water level has dropped. The falling water level is reportedly due to an increase in the pumping of groundwater within the city.

4.2.3 Beijing's Water-Conservation Measures

Beijing has implemented various measures to turn itself into a city that conserves water. The main pillars of these measures include (1) water-conservation measures in every sector; (2) improvement of water quality of the Guanting Reservoir, which supplies the city; and (3) divert water to Beijing by the South–North Water Diversion Project. The city is also requiring factories that consume a lot of water to adopt water-saving technologies and stopped the agricultural use of water from the Miyun Reservoir, which is an important water source. The city is also putting effort into improving the aging secondary water supply facilities and piping. The price of water was also raised from two yuan to six yuan per ton (2007).

Through efforts such as these, the city achieved water savings of more than 170 million tons/year. In order to monitor the waste of water, the Beijing Water Affairs Bureau established the Beijing Water Administration and Law-Enforcement Office with 80 enforcement officers (2007). Every day, the officers conduct surprise inspections of construction sites, restaurants, and other sites, where water is visibly being wasted. In addition, water is frequently stolen from public faucets intended to water trees in parks, and the officers sometimes expose those incidents.

Meanwhile, severe restrictions have been placed on water use in villages upstream, even if they happen to be close to a reservoir, because the reservoir serves Beijing. As for improving water quality in the Guanting Reservoir, as stated below, there is a need for pollution countermeasures over the entire catchment area of the reservoir. Construction began at the end of 2003 on the middle course of the South–North Water Diversion Project being implemented to bring water from the Yangtze up to northern China, including Beijing and Tianjin. One section was completed in 2008, just in time for the Beijing Olympics. After the entire completion in 2010, it is planned to supply between two billion and three billion tons of water to Beijing annually.

4.2.4 Beijing's Two Reservoirs

Beijing has two sources for its water supply: the Guanting Reservoir and the Miyun Reservoir. The Guanting Reservoir in Hebei Province's Zhangjiakou has for a long time been an important source of surface water for Beijing, supplying a billion tons of water annually. Pollution became a serious problem further upstream, however, rendering the reservoir unfit as a source of drinking water since 1998. As a result, Beijing now relies primarily on groundwater and the Miyun Reservoir for its drinking water. Because the Miyun Reservoir also lacks sufficient water, groundwater is being used excessively.

The pollution in the Guanting Reservoir is from nonpoint sources—distributed over a large area. It comes from domestic wastewater associated with a growing population in the surrounding area, from fertilizers and pesticides from agricultural land, and discharge from piggeries and other livestock operations. In this respect the pollution resembles a situation similar to many lakes in Japan, including Lake Biwa and Lake Suwa. The challenge of solving Beijing's problems can be deduced from examples in the Japanese experience. First, it is clear that Beijing cannot solve the problem alone. Any effort to combat pollution will require the cooperation of Hebei and Shanxi provinces.

The following projects are being undertaken under the leadership of the central government: (1) the promotion and expansion of water-efficient irrigation in agriculture, (2) the construction of sewage treatment plants and the improvement or closure of dozens of polluting paper mills and leather factories, (3) the return of farmland upstream of the Guanting Reservoir back to forest or grassland in order to prevent rain-driven soil erosion, and (4) the promotion of environmentally sound agriculture in harmony with the ecosystem and the use of this agriculture as a touristic resource. Through these efforts the government aims to achieve Grade III or if possible Grade II water quality standards in the Guanting Reservoir.

The government's target is to maintain water volume in the Guanting Reservoir at 300 million tons during normal years and 60 million tons even in drought years. It was for this reason that in September 2003, 30 million tons of water was diverted by canal from the Cetian Reservoir in Shanxi Province to the Guanting Reservoir. This was the first time Beijing ever diverted water from another province or

municipality. The Cetian Reservoir is located 50 km southeast of Datong in Shanxi Province, and with a storage capacity of 580 million tons, it is the province's second largest dam and is located 196 km from the Guanting Reservoir. Because of the lack of adequate water volume in the Guanting Reservoir, there is also a drop of water volume in the rivers downstream.

At a glance, one can see a river without water when one visits the Yongding River southwest of Beijing, by the Lugou Bridge (also known as the Marco Polo Bridge), which also was a cause of outbreaks during the Japan–China war. It was visited in the thirteenth century by Marco Polo, who praised it as the most beautiful bridge in the world. Anyone who goes to the site today, however, can see that the river has completely dried up. The river bottom is exposed and only the remains of boats are left.

The Miyun Reservoir was once a place of relaxation and recreation for citizens to visit, but since it became an important water source for Beijing, access to the water has been sealed off. During the 1950s, it was declared to hold three billion tons of water. Subsequent development, particularly for agricultural irrigation, resulted in more than 200 large and small dams being built in the river basin, and by the 1990s the stored water had plummeted to 1.2 billion tons. That amount has dropped even further, to the extent that today the reservoir holds only 600 million tons in normal years and can barely maintain 300 million tons in drought years. The official target is to maintain a Grade II rating for water quality.

4.2.5 Wastewater Treatment Facilities: Improving Water Quality

Chinese cities are delayed in terms of development of sewerage systems. In Japan, efforts to improve sewerage systems infrastructure began after the Tokyo Olympics in 1964, and the projects really gained momentum during the 1970s. Even with those efforts, municipal sewerage systems still serve only 68 % of the total population (2004). The reason for this figure is that the efficiency of sewerage systems is poor in small and medium cities and rural areas where population density is low.

It staggers the imagination to think about the cost and amount of time that would be required to improve the sewerage system infrastructure for China with its huge population and land area. On the other hand, because the demand is enormous, this also means enormous business opportunities. Because there are limits to what can be accomplished with government finances alone, there may be some potential for a business model that includes private sector participation. Until the beginning of the 1990s, in Beijing, industrial discharge and household discharge continued to increase, although sewage treatment facilities did not improve.

In the early 1990s, contaminated wastewater discharge from Beijing's built-up areas alone amounted to 2.4 million tons/day. Until the Gaobeidian Sewage Treatment Plant was constructed in the eastern suburbs of the city, there were only two small treatment plants, and they could only do temporary treatment. More than 90 % of the

contaminated water from chemical, textile, and other factories, as well as households and office buildings, was discharged untreated directly into the Tonghui River, which flows through the built-up area of the city. Furthermore, the existing sewage treatment facilities were simply designed for the settling of the sewage, and the supernatant water after treatment was simply discharged. As a result, water quality in rivers and groundwater deteriorated, and the rivers released a fetid odor.

Because of this, at the request of the Chinese government, the Gaobeidian Sewage Treatment Plant was constructed in the city with official development assistance (ODA) loans from Japan. With a treatment capacity of 500,000 tons/day, it was able to process one-fifth of all the sewage generated from Beijing each day (at the time of construction). This pioneering Japan–China environmental ODA project was completed in 1993. Later, as the second phase of the project, sewage treatment facilities were also constructed, with a treatment capacity of an extra 500,000 tons/day. This project was financed by a loan from Sweden. Treatment facilities with a total capacity of one million tons are something without comparison. A reprocessing project has also been implemented. The reprocessed water (gray water) is used in a variety of areas in factories, parks, for sanitation, and so on. Thanks to this project, Beijing is able to conserve 100 million tons of water resources annually.

China's first advanced treatment facilities were also installed at the Gaobeidian Sewage Treatment Plant, and it has become a pilot model for sewage treatment facilities in China, including the use of sludge that remains after treatment as a dry fertilizer. Thanks to this project, the water quality in the Tonghui River has improved considerably, and the microorganisms that had disappeared from the water river have returned again. Furthermore, this project is also helping to improve the aquatic environment in areas downstream including Hebei Province and Tianjin City.

4.3 The Reality of Water Pollution: Current Strategies

4.3.1 Water Pollution in Taihu Lake

Taihu Lake is the fourth largest freshwater lake in China, with an area of about 2,200 km^2, about three times that of Lake Biwa in Japan. It is located 20 km south of the Yangtze River, in the lower reaches of the Yangtze River delta, and was once in the floodplain of that river. Throughout the area of paddy fields near the estuary of the Yangtze River can be found many freshwater lakes used for raising crabs, touted as a Shanghai delicacy. Regardless of the taste of the crabs, this environment is something that might cause concern if one considers the fertilizers and pesticides running in from the surrounding paddy fields.

Near the shores of Taihu Lake is Wuxi, a city of six million people today. A legend says that during the spring and autumn periods of ancient times, the beautiful Xi Shi lived near here. The famous Japanese haiku poet Matsuo Basho (1644–1694) of the Edo Period wrote of her "Kisakata in the rain, as if Xi Shi were asleep, wet

mimosa blossoms." This he wrote upon visiting lakeside Kisakata in Japan and evokes the image of a beautiful woman by the lakeshore amid picturesque scenery. But today the lake is covered by blue-green algae. Taihu Lake already had problems with pollution, but it was in May and June 2007 that a real crisis occurred, that is, when the tap water in Wuxi started to give off foul odors. According to local television reports, the odors were foul enough to make children cry.

The Wuxi Municipal Waterworks Bureau acknowledged the foul odors but asserted that the water did not contain anything toxic and that it met Chinese water quality standards. It used chemicals to eliminate the algae but without success. Despite various attempts to solve the problem, the odors emanating from tap water have not gone away, so the city of Wuxi has decided to cut the water rates in half until further notice. The odor is caused by an outbreak of cyanobacteria on the lake surface. The large outbreak apparently occurred from the discharge of domestic effluent pouring excessive nutrients into the lake and then exacerbated by warm air temperatures.

Wuxi's Environmental Protection Bureau said that besides high air temperatures, low rainfall in the first half of 2007 resulted in lowering the water level in Taihu Lake to the lowest in 25 years, from January through April that year. This resulted in more eutrophication in Taihu Lake than in usual years. The bottom sludge layer, which until a few decades earlier was about 50 cm deep, had grown to more than one meter of sediment. Phosphorus and other pollutants in the sludge encourage the growth of cyanobacteria. Regarding the water quality in Taihu Lake, the average amount of total nitrogen content is 2.86 mg/L of water, and total phosphorus content is 0.077 mg/L. Incidentally, in Japan the threshold between eutrophic and oligotrophic conditions as an indication of eutrophication is between 0.15 and 0.20 mg/L for total nitrogen content and about 0.02 mg/L for total phosphorus.

In Taihu Lake, the pollution is particularly serious in the northwestern part of the lake near Wuxi. The ecosystem destruction is advancing here, to the extent that the 160 species of fish observed here in the 1960s have declined to about only 60 or 70 species and migratory fish have virtually died out. Taking this situation seriously, the government (Taihu Lake Bureau of the Ministry of Water Resources) increased the flow of water from the Yangtze River into the lake from 100 to 150 tons/s. The aim is to maintain the water level in the lake at 3 m and improve the water quality. In addition, it closed 23 water gates to prevent contaminated water from flowing into the lake.

In the confusion that ensued when the tap water could no longer be used, a shortage of mineral water arose, and some businesses raised the prices of bottled water. The pricing department of the municipal government issued an emergency alert and was poised to expose the unscrupulous companies. Companies found guilty were subject to a fine of up to 300,000 yuan.

The problems of lake pollution and eutrophication are reminiscent of Lake Biwa in Japan. A variety of measures were taken, such as restricting the use of detergents and controlling the use of fertilizers and agricultural chemicals, but improvements in water quality were slow to happen. Based on the above information, it is safe to say that the situation in Taihu Lake is considerably worse than in Lake Biwa.

Located near both Taihu Lake and Wuxi is Suzhou, known as "the City of Water." Effluent from textile factories here is polluting the canals. During the 1960s people washed rice and vegetables here, but during the 1980s and 1990s the water quality deteriorated seriously. More recently, however, the water quality has improved somewhat, to the extent that one can now see small fish swimming here.

4.3.2 Dianchi Lake and Chaohu Lake

Chaohu Lake is China's fifth largest freshwater lake, located 350 km inland from Shanghai. It is connected to the Yangtze River and located in central Anhui Province close to the city of Hefei. Its surface area is about 820 km^2, the catchment area is 19,350 km^2, and the catchment area's population is 6.11 million people. This is a shallow lake having about four times the area of the well-known Lake Kasumigaura in Japan, and with a similar look to it. Here as well, the pollution load has increased year after year due to population growth, increased industrial production, and increasing nonpoint sources, leading to various problems such as blue-green algae due to the growth of phytoplankton.

Dianhu Lake is a scenic lake located in the highlands southwest of Kunming in Yunnan Province. It is one of the six largest freshwater lakes in China, but pollution is increasing due to tourism developments and population growth.

4.3.3 Pollution Countermeasures: Three Rivers, Three Lakes

"Three Rivers" (Huaihe, Lianhe, and Haihe) and "Three Lakes" (Taihu, Dianhu, and Chaohu) are priority projects of the Chinese government when it comes to addressing water pollution. The target watershed area covers 810,000 km^2, spanning 14 provinces and direct-controlled municipalities nationwide, and is home to a population of 360 million people. The watersheds are also home to more than 5,000 major polluting companies.

In its ninth and tenth Five-Year Plans, the government established priority water pollution control areas and is implementing total pollutant control programs here. This approach resembles the total pollutant control programs being applied in Japan's enclosed water bodies and lakes (Tokyo Bay, Ise Bay, Seto Inland Sea, Lake Biwa, Lake Kasumigaura, and other lakes), except that China's ongoing introduction of controls through pollution permits for pollutants is more precise of an approach for controlling each pollution source.

In the pollution permits system in China, factories and other operations that discharge polluting substances are required to obtain a pollution permit and may not operate without one. Furthermore, the government is giving priority to projects such as improvement of sewage treatment plants. Even though the Chinese government is making a serious effort in these initiatives, the fact that pollution has progressed

so far suggests that the regulations are still too lax. It is necessary to strengthen regulations and to introduce monitoring of factory discharge as well as pollution removal technologies. Nevertheless, if we examine the Japanese experience with Lake Biwa and other water bodies, we see that even if progress is made with better sewerage systems in the affected areas, problems do not easily go away. That is just a sign of how difficult it is to carry out pollution countermeasures for nonpoint sources of lakes and other enclosed water bodies.

4.3.4 South–North Water Diversion Project

The South–North Water Diversion Project was designed to resolve water shortages in northern China by diverting water from the Yangtze River in the south, in order to achieve the efficient allocation of water resources. The project includes three routes: eastern, central, and western. The main purpose of the eastern route is to supply water to the Haihe River basin in the north, including Beijing, Tianjin, and Hebei Province, although some water will also be supplied to Yantai, Weihai, and other places in the eastern part of Shandong Province. The total amount of water supplied from the Yangtze River will be 14.8 billion tons. The basic idea is to draw water from the lower reaches of the Yangtze River, let it flow along the Beijing–Hangzhou Grand Canal which already existed as a canal, and then raise it up in steps by pump to the Yellow River, Huaihe River, and Haihe Plains in the north. The total length of the route is 1,150 km.

By the eastern route, the water destined for the Haihe River basin will pass through a tunnel under the riverbed of the Yellow River. Under this plan, canals will link a number of lakes. When completed, water will pass through Nansi Lake (literally "Southern Four Lakes," the collective term for four lakes—Weishan, Zhaoyang, Nanyang, and Dushan) bordering on Jiangsu Province in the southern part of Shandong Province. Nansi Lake is part of the Huaihe River drainage system and has a surface area of 1,266 km^2, while the entire catchment area covers 31,700 km^2. It is long and narrow, stretching 125 km north to south, with a maximum width of 30 km east to west, and it is shallow with an average depth of 1.5 m. Nansi Lake is seriously polluted by domestic wastewater flowing in from surrounding areas, so any water that moves northward will probably be polluted. Meanwhile, near the lakes are wetlands that are high in natural environmental value, but there are concerns that bank reinforcement and other projects will wipe them out. There are also concerns that fishermen may lose their livelihood. Based on these factors, strong voices of opposition were raised against the plan, resulting in much debate. In the end, the decision was made to go ahead with this plan. The only way to prevent contaminated water from flowing northwards will be to prevent pollution of Nansi Lake. Thus, the government established the Pollution Prevention Project for the Eastern Route of the South–North Water Diversion Project, but as one can see in the case of other lakes, the reality is that it is not easy to clean up pollution of lakes.

It is no surprise that the destination of the central route also happens to be Beijing, and in this case water will be directed northward, crossing the Yellow River. Construction on this project began at the end of 2003. The section was completed before the 2008 Beijing Olympics and carried water to Beijing. All sections were slated for completion in 2010, and this route is expected to supply between two billion and three billion tons of water per year to Beijing. Thus, water from the Yangtze River will flow into an area of 5,876 km^2 that receives municipal water in Beijing and Tianjin. This will cover 90 % of the level area in Beijing, but there are concerns as to whether this water will be able to keep up with the growing population and urban development.

In contrast to those two, the western route is designed to divert water from the upper reaches of the Yangtze River directly to the Yellow River. Its purpose is to resolve the shortage of water in parts of northern China and the northwestern region, which includes the river basin in the upper and middle reaches of the Yellow River. Consideration of the western project first began when the Yellow River Conservancy Commission dispatched a study team in 1952. A basic proposal for its construction was later released in 1989, and after consideration of the project's feasibility and rationale, a report was issued in 1996.

The basic plan for the western route is to draw a maximum of about 20 billion tons of water per year from three rivers in the Yangtze River basin: the Tongtian River, the Yalong River and the Dadu River. More specifically, this is to include 10 billion tons from the Tongtian River, about 5.0 billion tons from the Yalong, and about 5.0 billion tons from the Dadu River. The areas to receive this water are Qinghai Province, Gansu Province, Ningxia Hui Autonomous Region, Shaanxi Province, Inner Mongolia Autonomous Region, and Shanxi Province. The Yangtze and Yellow rivers are separated by the Bayan Har Mountains, and the riverbed of the Yellow River is between 80 and 450 m higher than the riverbed of the Yangtze. It is necessary to either build a higher dam and allow the water to flow by gravity or to raise and move the water by pumping. In addition, it is also necessary to dig a long tunnel through the Bayan Har Mountains. Because this will be a gargantuan construction project, the plans for the western route have not yet been finalized (Fig. 4.2).

4.3.5 Sedimentation in the Three Gorges Dam

The Chinese leadership includes many engineers with a background in hydroelectric power. Former Premier Li Peng was educated at the Moscow Power Engineering Institute and General Secretary of the Communist Party of China Hu Jintao at the Department of Hydraulic Engineering of Tsinghua University. An ancient proverb says, "He who rules the Yellow River rules the world," but in fact, even today flood control is among the biggest challenges facing the country. The construction of dams on the Yangtze and Yellow rivers is in line with important national objectives of flood control, irrigation for agricultural, and electrical power supply.

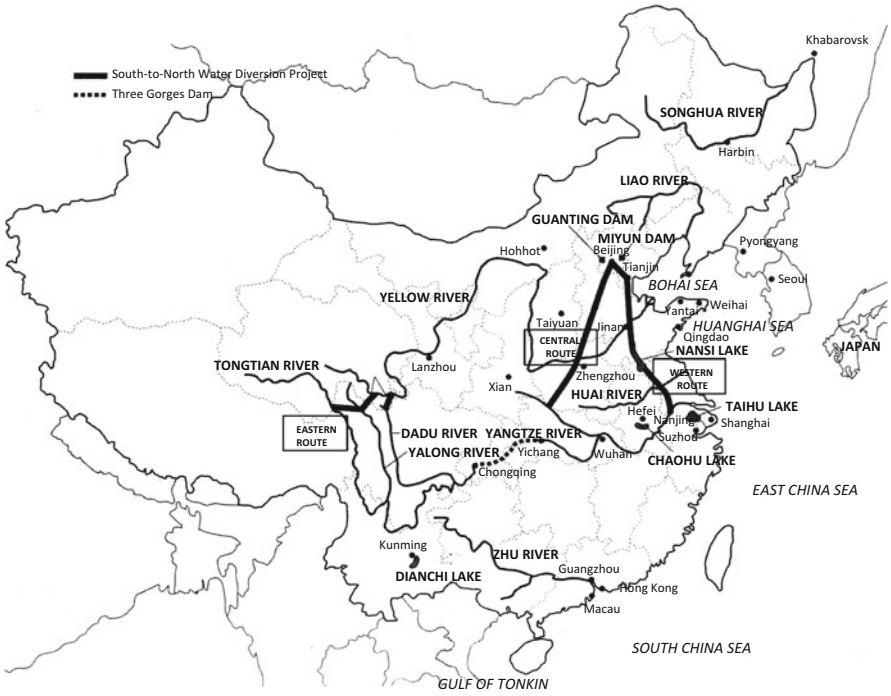

Fig. 4.2 Rivers, lakes and South–North Water Diversion Project

The first phase of construction of the Three Gorges Dam in the upper reaches of the Yangtze River began in 1993. In 1997, the dam across the main course of the Yangtze was completed, and the second phase of construction began. In 2003, a partial filling of the reservoir began. With this also began the third phase, and in May 2006, construction of the main dam was completed. Entire project including power generation stations was completed in 2009. At completion, the Three Gorges Dam hydropower plant, at 18.2 million kW, is the world's largest hydroelectric dam. If the same amount of electricity were to be supplied by oil-fired power plants, it would require 17.5 million tons of oil and would emit 54.5 million tons of carbon dioxide per year. The initial plan projected that it would provide almost 10 % of China's annual electricity consumption, but actual figure in 2010 is smaller than 2 %. This figure is due to the rapid increase of electricity consumption in China which was not correctly projected when the project started.

The reservoir of the dam extends about 660 km from just below the city of Yichang in Hubei Province to just downstream of Chongqing. Because the water levels will rise in this section, various famous historic sites on both banks of the Yangtze were inundated, and 1.4 million people forced to relocate. On the other hand, flooding is controlled downstream from the dam. Furthermore, because of higher water levels, large ships can navigate almost as far as Chongqing using the reservoir. This is a plus for water transport.

There was a major debate in China regarding the Three Gorges Dam project. When the National People's Congress (NPC), the equivalent of parliament, approved the project in 1992, one-third of those in attendance either opposed or abstained from voting. The NPC in principle functions through consensus, so it was extremely unusual to have so many opposing votes and abstentions. Residents who were forced to relocate due to the dam construction are referred to as "Three Gorges migrants." They were given no freedom to choose their destination and had no choice but to move to places unfamiliar to them, as instructed by the government.

The Three Gorges Dam created a huge reservoir stretching 660 km long, as mentioned above. Upstream is the city of Chongqing, with a population of more than thirty million, so a large amount of industrial effluent and domestic wastewater flows into the reservoir. The government has installed water quality monitoring stations at eight locations. Of these eight, Grade I or II water quality standards have been met in six locations, and two locations have met Grade III standards. The quality of water flowing into the reservoir includes Grade III, and the water leaving it is Grade I, so at this point there is no problem. However, eutrophication has been detected in some tributaries and in some local waters and near embankments.

Another concern is the issue of sediment deposition. Concerns have been expressed that the Three Gorges Dam will be filled with sediment flowing into the reservoir. Sedimentation is an enormous problem, already experienced with the Sanmenxia Dam (completed in 1960) as well as the Xiaolangdi Dam (completed in 2001), constructed on the Yellow River. The water of the Yellow River is very muddy and has a high level of suspended solids, so there are concerns that the dam will be rendered useless due to the buildup of sediment more quickly than originally expected. The level of suspended solids in the Yangtze River is less than in the Yellow River, but even so, with a dam catchment area of 1.08 million km^2, it is estimated that the annual influx of sediment amounts to more than 500 million tons. The authorities assert that the 450 billion tons of water flowing into the reservoir per year—or 20 times the 22 billion tons of water in the reservoir—are enough to wash the sediment down the river, but this opinion has also been challenged.

4.3.6 Sewerage Systems: More Progress Needed

Major causes of pollution in lakes and rivers include industrial effluent and domestic wastewater from households, but after the year 2000, the proportion of domestic wastewater has increased. To treat domestic wastewater it is essential to improve sewerage systems. In China today, about one-third of urban populations are served by sewerage systems, and the national figure is about 10 %. Domestic wastewater is not treated at all in rural areas. It is not easy to make a simple comparison between sewerage systems in China and those in Japan and other developed countries. This is because there are large differences in the level of technology for treatment of the contaminated water collected by the sewer system as well as the operating conditions of the facilities.

In China, the majority of the contaminated water collected by the sewerage pipes only undergoes primary treatment such as settling by sedimentation and then is released into rivers. The Tenth Five-Year Plan states the target of raising the ratio of sewerage water being treated to 60 % by 2005, but the actual result achieved was only 52 %. Neither was the target achieved of reducing total COD by 12 % of the 661 cities classified as castle cities; only 310 were conducting sewage treatment. In the nearly 20,000 municipalities classified as towns, there were absolutely no treatment facilities. Sewage treatment described here refers to secondary treatment intended to reduce the COD (or BOD) levels and other pollutants, but there are many cases in which treatment facilities are not functioning effectively. According to one report, of ten treatment plants constructed in Shaanxi Province, only two were operating properly (Task Force on Financial Mechanisms for Environmental Protection in China 2003). Reasons for this included the lack of an adequate budget for operations and maintenance, even after a new facility was constructed, and inadequate technology on site.

Another issue was that because the treatment facilities belonged to the government, workers might have lax attitudes sometimes characterized by public servants. As one approach to deal with these problems, private finance initiatives (PFI) and other approaches are being considered that will make use of foreign investment and private sector capacity (Task Force on Financial Mechanisms for Environmental Protection in China 2003). One particular approach is to contract operations and management of the facilities out to private sector corporations. In order to procure the enormous financing required for construction, another approach that appears likely to be realized is the build, operate, and transfer (BOT) method, in which private sector companies build a facility, operate it for a set period of time, and after making a profit, transfer the facility to the government.

In Japan as well, at one time there was a tendency for the priority to be placed on construction of economic infrastructure such as roads, power plants, and other projects that involved easier recovery of financing through tolls and fees, whereas environmental infrastructure such as sewer systems tended to be postponed. In a country such as China, with many new urban development projects, one would expect effective return on investment to be made possible by using an integrated approach to constructing and operating utility projects such as electricity, heat, gas, and municipal water and sewer systems.

Japan also spent an enormous amount of financing and time to improve sewerage systems. What will it cost and how long will it take to improve these systems in China, a country with such a huge land area? Even if progress is made in sewerage system improvements in cities, rural areas still remain a problem. Because the construction of sewerage systems for small- and medium-sized cities and rural areas with low population density is less efficient than in cities, much is being expected of decentralized treatment such as combined septic tank systems. Besides domestic effluent, there are also problems with fertilizers and agricultural chemicals spread on farmland. To deal with the problem of eutrophication in water bodies, it is necessary to not only reduce BOD and COD levels but also to take measures to remove nitrogen and phosphorus. For China, these measures are a huge issue that will require an enormous amount of financing, technology, and time.

4.3.7 Marine Pollution

The pollutants emitted from cities, farms, and various nonpoint sources over the vast area of China are eventually mitigated in part by nature or absorbed by the soil and eventually flow via rivers to the sea in the east. About 6 % of industrial effluent nationwide is discharged directly into the sea, but in the coastal city of Shanghai, this figure is 32 %. Eighty-four percent of effluent being discharged into the sea fails to meet government water quality standards.

China's coastal area can be described in terms of four seas: the Bohai Sea, Yellow Sea, East China Sea, and the South China Sea. The Yellow Sea is situated between the Korean Peninsula and Shandong Peninsula. The Bohai Sea is in the inner reaches of the Yellow Sea and forms a gulf upon the shores of which are the cities Dalian and Tianjin. Seawater is rated in four grades from good to poor, with Grade I being the best quality and Grade IV the worst; in addition "Inferior to Grade IV" is worse than the worst grade on the scale.

The results of measurements in 2005 indicate that the East China Sea is the worst, with 41 % of sites measured ranked as Inferior to Grade IV (Ministry of Environment of the People's Republic of China 2012). Next worst is the Bohai Sea, with 13 % of measurement sites ranked Inferior to Grade IV. Marine pollution of the East China Sea and Bohai Sea has the most serious impacts on the coastal areas of the city of Shanghai, Zhejiang Province, Jiangsu Province, and the city of Tianjin. Significant increases in nitrogen, phosphorus, and oil in the water is making red tides occur more frequently, giving cause for concerns about the impacts on fisheries.

The total discharge into the ocean in 2010 amounted to 12.2 billion tons, and this included 1.7 million tons of COD and 168 thousand tons of ammonia (Ministry of Environment of the People's Republic of China 2012). Major pollutants included nutrients such as phosphorus and nitrogen, fecal coliform bacteria, petroleum oils, heavy metals, and arsenic. The polluted area of the sea amounted to 139,000 km^2. Red tide outbreaks are occurring more frequently. From 2001 through 2005, outbreaks in the four coastal seas occurred four hundred and fifty three times, with the cumulative area being 93,000 km^2. "Toxic red tides" caused by toxic algae also occurred more frequently, resulting in direct economic losses such as damage to the fisheries. Incidentally, red tides occurred just more than two hundred times over the entire 10 years of the 1990s.

Damage is also occurring in ecosystems such as coastal mud flats and wetlands along bays and estuaries due to marine pollution; of 18 monitoring sites at six locations—Jinzhou Bay (Liaoning Province), the Yangtze River estuary, the Yellow River estuary, Laizhou Bay (Shandong Province), Hangzhou Bay, and the Pearl River estuary—ecosystems have deteriorated to "unhealthy" levels, meaning that they do not possess the capacity to recover in a short period of time. China's marine pollution is also said to be associated with large outbreaks of what is known as Nomura's jellyfish, which is a problem in Japanese waters. There are also concerns about effects on human health caused by the contamination of seafood.

As mentioned in Chap. 2, the last "1" in the "332211" Projects for pollution control in China is the pollution countermeasures in the Bohai Sea. Because this area is also close to the capital city of Beijing, the central government, in cooperation with four other parties—Shandong Province, Liaoning Province, Hebei Province, and the direct-controlled municipality of Tianjin—has established the "Bohai Blue Sea Action Plan" and is carrying out priority measures. The focus of the projects is measures to deal with nonpoint-source pollution through the construction of urban sewage treatment plants and solid waste treatment plants, environmentally friendly agriculture, environmentally friendly aquaculture, and other measures.

4.3.8 Health Effects of Drinking Water: Arsenic and Fluorine Pollution

A variety of elements are contained in groundwater. While good-tasting water contains important minerals, some ingredients may also be hazardous to health. Fluorine and arsenic are examples of elements for which the health impacts are an issue in China.

Three million persons in China reportedly have chronic arsenic poisoning. Symptoms of chronic arsenic poisoning have been confirmed in an average of 5 or 6 years from arsenic-contaminated well water measured at 0.5 parts per million (ppm) and in a few months from drinking well water contaminated with high concentrations of arsenic (3–5 ppm). Characteristic symptoms include keratosis-like protrusions on the palms and bottoms of the feet. In China, many cases of arsenic poisoning have been reported in agricultural areas near Hohhot (Inner Mongolia Autonomous Region) and in the alluvial plain (Heihe River basin and the Hetao Plain) between the Yellow River and the Yin Mountains to the north. Extensive arsenic contamination is also present further to the south, in Shanxi Province.

Long-term intake of drinking water containing more than a certain amount of fluorine (1.5 ppm) has been confirmed to cause dental fluorosis, in which the teeth become colored dark brown, and higher concentrations can lead to bone growth disorders, thyroid disorders, and developmental disorders. In China, which uses groundwater for drinking, 260 million people may be exposed to concentrations of fluorine high enough to potentially cause health problems, and there are reports that more than 40 million can be observed to have chronic disabilities caused by fluorine. Poor quality coal contains fluorine. The burning of this coal can lead to direct inhalation of fluorine in the air. It can also be ingested through the intake of food if fluorine has become attached to grain stored indoors. In Guizhou Province, coal containing both fluorine and arsenic is being used, and there have been reports of arsenic contamination through the air.

There have also been reports in Jilin Province and elsewhere of Minamata disease caused by mercury exposure. So far, it seems that the Chinese government has not been serious to investigate these environmental health issues, and foreign research teams have limited access to data.

4.4 Water Control Initiatives

4.4.1 Yellow River Drying, Yangtze River Flooding

The area of the Yellow River basin is about 800,000 m^2, and the river's length is about 5,500 km. The basin includes eight provinces and one autonomous region (Shanxi, Henan, Shandong, Shaanxi, Ningxia, Gansu, Sichuan, Qinghai, and Inner Mongolia Autonomous Region) and spans about 1,900 km from east to west. The mouth of the river forms a delta with an area of about 5,400 km^2. Here, 31 km^2 of new land is created every year from sediment deposition, and the coastline advances a further 390 m into the sea. The livelihoods and diverse productive activities of the people who live in this vast area, twice the land area of Japan, depend on one sole river—the Yellow River (Imura et al. 2010).

By comparison, the total length of the Yangtze is 6,300 km, about the same as the Yellow River, but the area of its river basin is 1.8 million km^2, more than twice that of the Yellow River. Furthermore, the flow volume of the Yangtze is more than ten times that of the Yellow River. Compared to the Yangtze River basin, the Yellow River basin has an overwhelming shortage of water. In the 1990s, this became a problem when the lower reaches of the river dried up because of the lack of water to flow that far. The first time it was recorded that the lower reaches of the Yellow River dried up was when it was observed at the Lijin Monitoring Station in Shandong Province in April 1972, and it lasted for 19 days. Over the next 26 years, from 1972 through 1997, there were only 6 years in which the river did *not* dry up. Notably, the river dried up every single year from 1991 through 1997, and the average occurrence lasted more than 100 days. The volume of water flow is also declining. The annual river flow during the 1950s was 48.3 billion tons at Huayuankou, near Zhengzhou, and 48.1 billion tons at Lijin. It had dropped dramatically in 1997 to 14.3 billion tons and 1.85 billion tons, respectively.

On the other hand, an enormous flood occurred on the Yangtze in 1998. There are various causes for the Yellow River drying up. Demand-side factors include the enormous increase in water demand as a result of industrialization and urbanization, driven by rapid economic growth. Another supply-side factor is the declining amount of precipitation in the entire river basin, reportedly due to climate change; in the future it is necessary to conduct detailed research into the relationship between global warming and desertification. While flow interruptions are one problem, the damage that results in the event of a flood is enormous.

Flooding on the Yellow River can occur at any location along its main course or tributaries, but particularly in the area downstream, from Zhengzhou to Kaifeng, as a result of many years of sedimentation, in some places the riverbed has risen as high as ten meters above the surrounding area. Furthermore, because of the conversion of land to farming, the reduction in tree and grass cover along the middle reaches of the river results in large amounts of soil (yellow soil) being washed away, creating the problem of water and soil runoff. Major reasons for the massive flooding of the Yangtze River include the loss of buffer zones that could absorb water

when it overflowed the banks, because of the loss of water retention capability due to deforestation in the upper reaches of the river, and the loss of wetlands and other flood control areas due to development in the lower reaches of the river. It is thought that the construction of the Three Gorges Dam will prevent such massive flooding in the future.

4.4.2 Shifts in the Government's Water Management Policies

Facing the flow interruptions of the Yellow River and the flooding of the Yangtze, the Chinese government established legislation on the utilization of water resources and on water utilization infrastructure such as dams and irrigation systems, and in doing so, it clarified its stance on the promotion of the rational and effective development, as well as integrated management, of water resources.

The Water Law of the People's Republic of China was passed in 1988. Under this piece of legislation various policies and measures have been implemented, relating to the use, protection, and management of water resources, as well as measures to address flood damage. The legislation was amended in 2002, with the main purpose being a shift away from the previous approach to governing water resources with an emphasis on dam construction for flood control, hydropower, and irrigation. Instead, policy shifted toward integrated watershed and water resource management policies, with an emphasis on systematic management and control of water demand, as well as ecological construction projects such as soil erosion prevention.

Besides stating clearly that water resources belong to the state, the amended law also sets forth a wide range of objectives and affairs:

- Meeting the needs of socioeconomic development and allowing sustainable use of water resources, through the rational development, utilization, conservation of water resources, and the promotion of comprehensive flood control
- Implementation of water withdrawal permit systems and fee-based water use systems
- Establishment of a National Water Resources Strategic Plan and detailed plans to be created for each region in each river basin
- Strengthening of the system of water resources management administration at the county level and higher
- Protection of drinking water

The management of water resources combined with river management can be described as the basis for national land administration in China. Within the central government, it is the Ministry of Water Resources that is responsible for these matters. Furthermore, for each river an organization has been established—such as the Yellow River Conservancy Commission and the Yangtze River Water Resources Commission—which also administers affairs in cooperation with the related local governments at the provincial level and below. Thus, where there was previously a tendency for each province to operate in a decentralized way, the direction now is to

strengthen the authority of water resource commissions for each river basin and for the national government to strengthen its leadership in the area of water utilization and water-related governance. More specifically, initiatives being advanced include the establishment of detailed water-conservation targets for each type of water use, promotion of water-conserving agriculture, promotion of the treatment and reuse of contaminated water, consideration of methods to control demand by increasing the price of water, and tree-planting projects to prevent soil erosion.

4.4.3 How Best to Manage Water Resources?

The challenges of flood control and water resource management for China's great rivers contrast dramatically with the case for Japan's rivers. In the case of Japan, because of the high amount of precipitation, most of the water withdrawals (more than 85 %) are from river water, while the remaining water withdrawals come from groundwater. Japanese rivers are short because of the steep topography, and river basins are relatively small in area, so these rivers experience large local and seasonal fluctuations in precipitation, such as at the time of typhoons and the annual rainy season in early summer. In contrast, China's rivers have vast catchment areas and enormous river flow volumes. Because it is necessary to fulfill water demands inside the vast area associated with each river basin, the appropriate allocation of those water resources is a big task.

When considering issues such as floods and droughts in China, it is necessary to use a much larger temporal and spatial perspective than what one would use in a country like Japan, and it is necessary to see these issues as very long-term challenges—in terms of understanding the phenomena and their impacts—and then implementing countermeasures or actions. Water resource issues include four major themes: (1) flood prevention, (2) ways to address the scarcity of water resources, (3) environmental protection such as soil erosion prevention and water pollution prevention, and (4) the shift toward integrated water resource management policies.

For the management of water resources, it is necessary to address water resource allocation issues all the way from upstream to downstream, but it is not an easy task to understand and manage in any comprehensive way the demand for water over the entire area of a vast river basin. It is also necessary to address the different interests among all the provinces concerned. The relationships between upstream and downstream areas also reflect different levels of affluence and poverty between different regions. Generally speaking, whereas the upstream areas are relatively poorer agricultural regions, the downstream areas and surrounding area include many cities that are relatively more affluent than rural villages, and industrial production is great. Efforts to increase the amount of food production in arid areas upstream and midstream areas that receive little rainfall increase the amount of water used for agriculture and also accelerate soil dehydration and erosion due to land clearing for cultivation.

The path of industrialization under the country's economic reform policies has increased the income disparities between industry and agriculture and between urban and rural areas. The issue of the allocation of water resources is also related to the issue of addressing economic disparities between regions, and this is an important issue that will have a major influence on the destiny of China as a country.

4.4.4 The Shift to Water Withdrawal Allowances and Water Rights Transfers

A water withdrawal allowance system is being strictly enforced in the Yellow River basin, which suffers from an absolute shortage of water, as mentioned above. This system is somewhat similar to the water rights in Japan, but its background and details differ significantly. In the case of China, the Water Law states clearly that water resources are the property of the state. There is no recognition of private or monopolistic water usage rights that might allow the exclusive withdrawal or utilization of water from lakes and rivers.

In the case of a river such as the Yellow River that straddles multiple provinces, the government determines the allowance for the amount of water that can be used by each province, based on a national water resources allocation policy. Within each province, the quotas are further allocated to cities and counties, and these again are allocated to irrigation districts and individual factories. These irrigation districts and factories receive a water withdrawal allowance which clearly states the amount of water they are allowed to withdraw from the Yellow River. Without such an allowance, they cannot draw the water. Because the amount of usable water resources fluctuates depending on whether a given year has high water flows or a drought, the permitted amount of water withdrawals is to be adjusted for each level—whether it be a province, city, or factory, etc.—depending on the amount of water available that year. This approach is a typical example of centrally planned allocation.

In the case of the Yellow River, the allocations determined for each province in 1989 are still in effect today, with no amendments. Because the situation is one in which there is an absolute shortage of water, each province, once having acquired an allocated volume, attempts to protect it as an acquired right, making any later adjustments extremely difficult. One method to overcome this barrier that is now attracting attention is the use of tradable permits, referred to as "water rights transfers." The amendment of the Water Law in 2002 recognized this approach, in principle. The trading of permits could be possible at each level: between provinces, between cities and counties, between irrigation districts, and between factories. The most feasible for implementation are transactions among irrigation districts, power generation plants, and factories.

In the middle reaches of the Yellow River, a transaction was actually concluded between a power plant and an irrigation district in the city of Ordos (Inner Mongolia Autonomous Region). Because this region is rich in coal reserves, the power plant

desired to expand its facilities but did not possess the water withdrawal permit required for cooling water. As a solution, the power plant covered the funds necessary for canal repair of the irrigation district in the same city and in return was given the permission to use the amount of water that was conserved in the irrigation district. This arrangement has merits for both parties—the power plant and the irrigation district. This type of transaction has only begun on a trial basis, but in the future it has the potential to expand. In principle, transactions are also possible beyond jurisdictional boundaries, such as between cities, counties, and provinces. Through transactions between provinces that lack the water needed for industrialization and urbanization, and provinces upstream that focus on agriculture, it may also be possible to find a balance between industrial development and modernization of agriculture. This approach is also attracting attention as a means of reallocating incomes between regions that have disparities in their level of development.

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Chapter 5
Air Pollution: Concern Rising About Health Effects

Abstract Air pollution in Chinese cities and acidification of soils in broad areas caused by airborne pollutants are big challenges in China. About 90 % of sulfur dioxide comes from the combustion of coal with high sulfur content. Increasing number of cars is another cause of air pollution in large cities such as Beijing and Shanghai in terms of ozone and PM 2.5. Air pollutants originating from China are transported to Japanese archipelago by jet stream, and they may cause photochemical smog, high concentration of PM 2.5, and acid deposition in wide area of the country. In the 1990s, Japan used its official development assistance to China for transferring its experience and technology to combat air pollution, but the initiatives shrank in the 2000s due to changing economic and political relation of the countries.

Keywords Acid rain • Air pollution • Photochemical smog • PM 2.5 • Transfrontier air pollution

5.1 Worsening Air Pollution

5.1.1 Air Pollution Standards

At present, air quality standards in China are classified into three grades—I, II, and III—based on atmospheric concentrations of ten types of air pollutants, including sulfur dioxide (SO_2) and total suspended particulates (TSP) (Ministry of Environment of the People's Republic of China 2012):

- Grade I (excellent): Levels at which no hazard is posed to natural ecosystems or to human health even under long-term exposure. Applied to protected areas such as nature reserves and protected scenic areas
- Grade II (good): Levels at which there are no harmful effects on human health or on flora and fauna (with the exception of the highly sensitive) under long-term or

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short-term exposure. Applied to residential areas, commercial districts, cultural districts, general industrial districts, rural areas, etc.
- Grade III (slightly polluted): Levels at which there will be no acute or chronic effects on humans and at which general flora and fauna can grow normally in cities. Applied to certain industrial areas
- Below Grade III (moderately or severely polluted): Fails to meet Grade III

In February 2012, new air quality standards were promulgated and they will be put into effect in January 2016, and the current standards will be abolished at that time (Ministry of Environment of the People's Republic of China 2011). The new standards are defined for six basic items (SO_2, NO_2, CO, O_3, PM 10, and PM 2.5) and four other items (TSP, NOx, Pb (lead), and BaP (benzo a pyrene)). The new standards include new items such as PM 2.5 and BaP which are more relevant to evaluate the actual air pollution conditions in Chinese cities. PM 2.5 particulates (particles smaller in diameter than 2.5 μm) are particularly important because they deeply penetrate lung and are hazardous for human health.

Atmospheric concentrations of pollutants vary over time with the conditions of the pollution sources and meteorological conditions, so the significance of the values depends on the frequency of measurement of concentrations as well as the method of calculating average values. The values also differ depending on the method of measurement and analysis. Because of this, it is not possible to make a straight comparison of standards between countries. A quick review, however, suggests that China's Grade II is about the same level as or slightly more relaxed than environmental quality standards in Japan, the United States, and European countries.

Japan's SO_2 standards are a daily (24 h) average of hourly values of 0.04 parts per million (ppm) or lower and hourly 0.1 ppm or lower. By comparison, although the measurement unit is different between China and Japan, China's Grade II standards are equivalent to a daily average of 0.0525 ppm or lower and hourly 0.175 ppm or lower. Japan's nitrogen dioxide (NO_2) standards for the daily (24 h) average of hourly values are in the range of 0.04–0.06 ppm, compared to China's 0.039 ppm or lower. China also establishes a yearly average for environmental quality standards, and the evaluations are based on these.

The Grade III value of SO_2 is equivalent to the yearly average of 0.035 ppm. Based on Japan's pollution experience in Yokkaichi and other areas during the 1960s, residents could have two to three times or more the rate of occurrence of asthma or other respiratory ailments in areas where the yearly average exceeds 0.04 ppm. According to this fact, areas that fail to meet Grade III standards are cause for concern regarding the health effects on residents, but there has been little research on these levels (Committee on Japan's Experience in the Battle against Air Pollution 1997).

5.1.2 Air Pollution in Beijing

The past data for SO_2 and NO_2 observations in Beijing shows that even Grade III standards for SO_2 were not met during most of the 1990s (OECD 2007). The

pollution levels exceeded by far the Grade II standards, which are rather generously deemed to be "good." These levels could never satisfy Japanese standards for SO_2 and resemble the high pollution levels experienced in Tokyo during the 1960s (Committee on Japan's Experience in the Battle against Air Pollution 1997). Moreover, ozone (important index of photochemical smog) and PM 2.5 were not included in the air quality standards until February 2012, and continuous monitoring data were not available for these indexes.

From 1999 onward, Beijing's air quality in terms of SO_2 and PM 10 made a consecutive improvement. Since the year 2000, it generally satisfied the Grade II standard. This represents an improvement to the levels experienced in Tokyo during the 1970s. This improvement appears to have been the result of moving a steel factory (Capital Iron and Steel Co.) out of the city, converting households to the use of natural gas, and replacing bus fuel from oil to natural gas. In October 2011 and January 2013, however, air pollution indexes in Beijing reached dangerous levels. Monitors at the US Embassy in Beijing recorded a very high level of airborne PM 2.5 particulates, and the city was shrouded in thicker-than-usual pollution and heavy haze. It was shocking that the data was not released by the Chinese authority but by the US Embassy, and monitoring data of PM 2.5 in Japanese cities such as Tokyo and Yokohama showed significant increases and aroused Japanese people's concern about the transport of air pollutants from China to Japan.

In contrast to the improvement in SO_2 levels, NO_2 and particulate levels have either worsened or stayed the same and fail to meet both Grades I and II standards. There is no doubt that the source of the NO_2 and particulate, especially PM 2.5, is rising automobile usage, which continues to grow. Because NO_2 concentrations vary considerably with the distance from roads, the positioning of monitoring stations is very important. In Japan, monitoring stations for vehicle emissions are placed on the roadsides of major roads, while ambient environment monitoring stations are placed in locations that are not significantly affected by roads. In the case of China, no such distinction is made and no information is provided about the location of each monitoring station.

It is difficult to make a direct comparison of measurement data in Beijing and Japanese cities. Nevertheless, direct observation in Beijing reveals large arterial roads with heavy traffic volumes crisscrossing the city and chronic traffic congestion on weekdays. If we draw deductions from the current vehicle emissions standards, and from the traffic conditions, one could hypothesize that Beijing's air pollution in terms of NO_2 and particulate levels is considerably worse than in Tokyo. If all over Beijing high pollution levels are equal to or worse than those near Tokyo's Ring Road 7 and Ring Road 8—which have been problematic in terms of air pollution caused by heavy traffic—it would appear that many locations in Beijing would fail to meet Japan's air quality standards.

Besides SO_2, NO_2, and PM 2.5, there are also issues with TSP. In Beijing, blue sky is not visible very frequently, and one reason for this condition is yellow dust (*kosa*) and other dust blowing in from further inland. TSP contains particles from the burning of coal, and also from vehicle emissions, besides the dust originating from the natural world. Added to this is also the dust billowing up from construction

sites in the midst of a construction boom. A lack of rain is also a factor that raises TSP concentrations. All these factors come into play, but China's standards for TSP are considerably weaker than those of Japan.

Regarding TSP from the ground surface, various measures are being strengthened, such as the use of machines to clean and wash down roads and the use of watering or spraying at construction sites to keep dust down. In view of Beijing's water scarcity, however, care must be taken to avoid wasting water when spraying down construction sites. As for the relationship between TSP and health impacts, there is a need for detailed research regarding the diameter and constituents of particles, and this is a topic for future research. The impacts of PM 2.5 on respiratory organs are a worldwide concern.

5.1.3 Air Pollution in Other Cities

The results of air pollution measurements in 522 cities are announced every year (Ministry of Environment of the People's Republic of China 2010). In the case of 2005, 293 cities of them (56.1 %) were reported to have met Grade II standards for TSP, SO_2, and NO_2. However, 152 cities (29.1 %) just barely satisfied Grade III standards, and 55 (10.6 %) failed to meet even Grade III standards.

The levels of pollution and their causes vary greatly depending on the circumstances in each city and region. Industrial cities still have serious pollution levels of TSP and SO_2 from power plants and factories. This is particularly true in the northeastern region and inland areas that have long been factory towns (Chongqing, Taiyuan, Lanzhou, Shenyang, etc.). Conversely, in large cities with advanced economic development, such as Beijing and Shanghai, pollution from vehicles is the main problem. Generally speaking, in China during the 1990s, many cities had severe SO_2 pollution, but improvements have been observed since the year 2000. However, the amount of SO_2 emissions nationwide has not declined, so the observed changes are isolated improvements in a subset of all cities. The reason for this outcome is that air pollution within a city will be reduced if factories and power plants are moved outside the city, but the total emissions observed nationwide will not go down.

5.1.4 Two Types of Pollution Control Districts

About 90 % of SO_2 emissions in China come from the combustion of coal. Because coal from China is high in sulfur content and low in combustion efficiency, two problems result. The first is acid rain in cities in the south. Acid rain is observed mostly in the provinces of the southwestern region of the country (Hunan, Jiangxi, Guangdong, Sichuan, and Guizhou), and acidification of the soils is occurring over a broad area. In terms of jurisdictions, the most affected are especially around Chengdu, Chongqing, Guiyang, Changsha, and Liuzhou. The second problem is

Fig. 5.1 SO_2 pollution control areas and acid rain control areas. Percent of national territory covered by each category: pH below 5.6 (40 %), acid rain control areas (8.4 %), and SO_2 control areas (3 %) (*Source*: Documents from Chinese government)

pollution during the winter season in the cities of northern China (Jinan, Hohhot, Taiyuan, Tangshan, Zhengzhou, Lanzhou, Changchun, Baotou, Shijiazhuang, Beijing, Jilin, Harbin, Shenyang, etc.). The amount of coal consumption used in heating in China's northern cities is twice in the winter what it is in the summer season, and concentrations of pollutants are also doubled in the winter. However, the high alkaline level of soils in the northern region neutralizes the effects of SO_2, thereby minimizing the damage to soils from acid rain.

Because both of the issues mentioned are caused by SOx emissions from burning coal, in 1998, the Chinese government designated areas as "Acid Rain Control Districts" and "Sulfur Dioxide Control Districts." These two types of zones are referred to as pollution control districts as shown in Fig. 5.1. They include 1.09 million km^2 and are home to more than 500 million people. Included are 27 provinces, direct-controlled municipalities, and autonomous. All combined these two types of districts account for about two-thirds of both economic output and SO_2 emissions nationwide. In both types of control district, the government aims to spread the use of clean fuel and low sulfur coal through energy structure adjustments, and it has prohibited the burning of coal in small private sector furnaces in medium and large cities.

The environmental conditions in both types of districts have become better overall in terms of SO_2 air pollution in cities, but acid rain pollution remains serious. In 2005, the ratio of cities meeting Grade II standards for SO_2 (yearly average)

increased from 32.8 % in 1998 to 45.1 % in the Sulfur Dioxide Control Districts. Meanwhile, the ratio of cities failing to meet Grade III standards for SO_2 (yearly average) decreased from 15.7 % to 4.5 % in the Acid Rain Control Districts. For TSP, more than half of all cities satisfied Grade II standards. SO_2 pollution continues to be a serious problem mainly in Shanxi Province, Hebei Province, Henan Province, Hunan Province, Inner Mongolia, Gansu Province, Guizhou Province, Sichuan Province, and Chongqing City.

5.2 Main Factors Driving Air Pollution

5.2.1 Coal Consumption: It Won't Go Down

China's coal consumption increased from 1.06 billion tons in 1990 to 1.38 billion tons in 2000 and then to 3.56 billion tons in 2010. About half of coal consumption is for coal-fired power plants, and there are about 2,000 of these power plants nationwide. In northern cities, the heat from power plants is also used for district heating. In this case, they are not called electrical power plants but the equivalent of "heat and electricity plants." During the years mentioned, SO_2 emissions increased from 14.9 million tons in 1990 to 19.95 million tons in 2000; it tended to decrease after it peaked at 25.9 million tons in 2006 as shown in Fig. 5.2. Dust and particulate emissions also showed a similar trend.

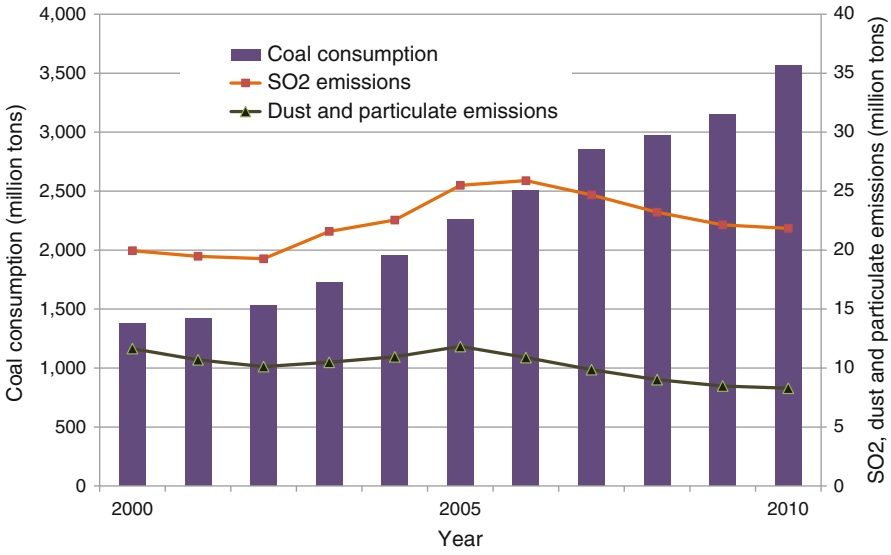

Fig. 5.2 Coal consumption and SO_2 and dust/particulate emissions (*Source*: China Statistical Yearbook 2012)

The Tenth Five-Year Plan included the target of reducing SO_2 emissions to 14.5 million tons by 2005, the final year of the Five-Year Plan, but the final outcome was far below the target. Possible measures to reduce sulfur emissions include (1) shifting to the use of coal with low sulfur content, (2) washing the coal with water before combustion (coal washing) to reduce the sulfur content, (3) using flue gas desulfurization (FGD) equipment to remove sulfur, and (4) improving energy use efficiency.

High SO_2 concentrations can cause asthma and other illnesses, damage the leaves of plants, and can also cause acid rain. A large amount of SO_2 was released into the atmosphere from the volcanic eruption on Japan's Miyake Island in 2000, making it difficult for residents to return to their island; this experience of SO_2 in the natural world provides some perspective on the health risks of high SO_2 levels. There were various circumstances behind China's delay in addressing SO_2 issues, the main reason probably being cost.

FGD requires not only the installation of equipment but is also expensive to operate. The total generation capacity of coal power plants with FGD equipment installed was 45 million kW as of 2005. The total generation capacity of all thermal power generation plants in China was 350 million kW. This means that desulfurization was only being conducted on less than 13 % of the total. The plan is therefore to increase the application of FGD. Almost all thermal electric power plant construction approved in 2004 included installation of FGD equipment. Coal washing is a relatively simple method and can remove about 20 % of sulfur content. However, this method requires water. Inner Mongolia and Shanxi Province are endowed with coal, but they lack adequate water; another problem is the cost of treating the wastewater after coal washing.

5.2.2 Abundant Coal Resources: A Blessing and a Curse

The West–East Electricity Transmission Project is designed to generate electricity in the coal-rich western part of China and then transmit the electricity to eastern China, but if we take Inner Mongolia as one example, FGD equipment is not installed even at large power plants, and coal washing is not being done because of the shortage of water. But even under these conditions, national emissions standards are being met because of the vastness of the region and the low population and the fact that there are currently no other major emitting industries. But even if no direct damage arises locally, the sulfur emitted can be carried great distances by air currents, and fall as acid rain, causing damage in other regions.

Coal was an important export resource for China, but its export is decreasing because of steadily rising demand within the country. In 2005, Japan's import of coal from China amounted to 15 % of the total coal import, but it decreased to only a few percent in 2010.

Coal is used in home heating and cooking, but in cities these uses are gradually being replaced by natural gas. In the past, the main type of gas used in Chinese cities was coal gas manufactured from coal, but recently natural gas has become the main

type of gas thanks to the West–East Gas Pipeline Project. As the use of natural gas becomes more common in cities, pollutant emissions from households are dropping significantly.

Coal contains between 0.1 and 0.5 ppm of mercury. More than 80 % of the coal-fired power plants in China have precipitators installed, which remove about 30 % of the mercury contained in emissions from combustion, but the remainder is emitted into the atmosphere, meaning that every year, about 250 tons of mercury are released. In the United States there has been an issue with the regulations relating to mercury from coal-fired power plants, and there is some debate that perhaps the mercury being emitted from China may be reaching the United States. Besides mercury, fly ash generated after the combustion of coal also contains arsenic, as well as antimony, lead, zinc, copper, and other metals. It is necessary to remove these with the use of efficient dust collection equipment.

Most of the problems Japan experienced with SO_2 during the 1960s and 1970s were caused by oil rather than coal. Japan was able to resolve the problem with desulfurization technologies to remove sulfur content from heavy oil, and FGD equipment to remove sulfur in exhaust emissions after combustion, and also by dramatically improving energy efficiency. After the oil shocks, the construction of new oil-fired power plants was stopped, and instead many coal-fired power plants were constructed. Experts initially said that it would be difficult to remove the sulfur from coal combustion emissions containing fly ash but they were able to develop technologies to that end in the 1980s. There is no doubt that Japanese technologies and experience in this area have also been useful for China.

5.2.3 Vehicle Ownership: Multiplying Quickly

In China, most of the problems relating to stationary sources such as factories and power plants are caused by coal. Of similar importance are problems arising from oil—air pollution caused by vehicle emissions. The number of automobiles in China is growing at a vigorous pace. On observing the types of vehicles being driven in Beijing over time, one would notice dramatic changes. During the 1990s, the majority was Chinese-made light diesel vehicles that emitted black smoke, but since the year 2000, locally made vehicles from German, Japanese, and Korean manufacturers have been increasing in number. Their size is not much different from passenger cars in Europe and Japan.

Regarding vehicle emission controls, China follows European standards. Since the year 2000, it has applied the European Union's Stage 1 standards (Euro I) for new vehicles made in China. In 2004, the EU's Stage 2 standards (Euro II) were applied to all light vehicles (mostly passenger cars). In January 2006, with the exception of light diesel vehicles, Euro III was applied to all vehicles. One can see the Euro standard symbol on the rear of vehicles, indicating that the vehicle complies with those standards. Euro IV standards began to be applied to all gasoline-powered vehicles in 2007 and to all diesel vehicles in 2010. Vehicles that do not

meet the standards cannot obtain vehicle registration. But new standards are applied to new cars, and old standards to old cars, so even if the new standards are being implemented, an owner can continue driving an old vehicle. For this reason, in 2004, the State Environmental Protection Agency launched a model project for regular inspections and a measurement system for vehicles already on the road.

Air pollution from vehicles is particularly bad in Beijing, so the city strengthened its regulations with changes such as introducing the Euro III standard at the end of 2004, before the rest of the country did. In January 2007, Euro IV was applied to light diesel vehicles. At the same time, a ban was ended on the use of diesel vehicles, which had been temporarily prohibited.

Since 1998, the city of Beijing has enforced the mandatory disposal of 38,000 aging vehicles that did not keep up with emissions regulations. This included 14,000 small diesel taxis that used to run on Beijing's streets. The author was surprised in the spring of 1998 at the sudden disappearance of the yellow taxis that once had seemed to be everywhere. Thereafter, when the author traveled to the city of Xi'an, he saw the same taxis operating on the streets, but they too disappeared soon afterward. In Beijing, one frequently sees buses bearing the symbol "natural gas." This indicates that the bus runs on natural gas, and as of 2005, Beijing already had 2,800 such buses on the road. Natural gas vehicles are also being introduced in the city of Chongqing.

5.3 International Cooperation to Tackle Acid Rain

5.3.1 Acid Rain

Strong acids such as sulfuric acid and nitric acid are produced when SOx and NOx from factories, power plants, and automobiles react in the atmosphere with water and oxygen. Acid rain is the result when these acids dissolve in the water droplets in clouds and are deposited on the ground in the form of rain, snow, and fog. Generally speaking, rain with a pH level of 5.6 or less is referred to as "acid rain," but sometimes rather than falling as rain, acidic substances can be deposited on the ground in the form of dust or aerosols, and in the broader sense this too is included in acid rain. In order to distinguish between the two, the former is called wet deposition and the latter dry deposition. SOx, a substance that causes acid rain, is also generated from volcanic activity. The hydrogen chloride generated from the burning of plastics or other chlorine-containing materials is another cause of acid rain.

In China, acid rain has been widely observed primarily in the southwest region of the country—south of the Yangtze River—and in lands including the Sichuan Basin east of the highlands of Qinghai and Tibet. The area affected is as much as one-third of the entire country. Of the 696 cities nationwide that engaged in monitoring, acid rain was recorded in 357 (2005).

From 1995 until the year 2000, the number of cities that observed strong acid rain with a pH of 4.5 or less declined to 2.0 %, but after the year 2000 the figure

began to increase again, to 12.2 % in 2005. This period corresponds to a time when total SO_2 emissions were on the increase nationwide. One of the characteristics of acid rain is that it can be carried on air currents over great distances, and damage can occur in regions that are several thousand kilometers away from the source. Japan's National Institute for Environmental Studies (Kentaro Murano et al.) announced research results indicating that about half of the SOx observed in Japan actually comes from China and that China could be a major cause of acid rain that is measured domestically in Japan (National Institute for Environmental Studies 2004).

5.3.2 Acid Deposition Monitoring Network in East Asia

If we consider the geographical and meteorological characteristics of East Asia, there is a great possibility that acid rain-causing substances generated in China may be transported by air currents to Japan. However, in order to prove this scientifically and encourage the source country to take countermeasures, it is necessary to have mutual understanding.

In Europe during the 1970s, acid rain that was thought to originate in Britain was causing serious damage to forests and lakes in northern European countries and became a major international issue. An international framework to deal with the issue of acid rain in Europe was created through tenacious discussions and deliberations among the countries on the position of both polluters and victims, at the United Nations, the Organization for Economic Cooperation and Development (OECD), and other multilateral fora. With the participation mainly of European countries, in 1979, the Convention on Long-Range Transboundary Air Pollution was established, and in 1985 the Helsinki Protocol was adopted relating to SOx emission reductions. With efforts in East Asia to address the issue of acid rain as well, the experience of Europe in this area has served as a major reference.

As a first step, the Acid Deposition Monitoring Network in East Asia (EANET) was established in 1998 through the initiative of Japan (EANET 2012). The objective of EANET is to form a common understanding relating to the situation of acid rain issues in East Asia and, by providing valuable information for policymaking at the national and regional level, to promote cooperation relating to the acid rain issue in participating countries. EANET has 13 participating countries: Cambodia, China, Indonesia, Japan, Laos, Malaysia, Mongolia, Myanmar, the Philippines, South Korea, Russia, Thailand, and Vietnam. After a 10-year pilot phase, in 2001, it started regular operations. With the acid rain issue in East Asia, China plays an important role as a source. However, simply issuing unilateral demands for China without taking action will not create the path to solve problems. Acid rain damage has occurred extensively within China as well, so the country cannot afford to sit idly and not take action. In order to solve the problems, it is important to use multilateral exchanges of information, to help each country understand the need for countermeasures, and at the same time for countries like Japan to provide scientific knowledge and technologies.

5.3.3 The China–Japan Model City Initiative for Environmental Development

The Sino–Japan Friendship Center for Environmental Protection, established based on an agreement signed in 1988, is an example of major cooperation between China and Japan in the area of the environment. Another example of cooperation equally significant was the China–Japan Model City Initiative for Environmental Development, proposed by Japan (then-Prime Minister Hashimoto Ryutaro) at the China–Japan Summit in 1997. Under this initiative model cities were selected from among cities of China, and in those cities intensive environmental measures were conducted, with the aim of then applying the successes to other cities. To advance the initiative, an expert committee was established with members from both Japan and China, and they selected three cities as models: Chongqing, Guiyang (Guizhou Province) and Dalian (Liaoning Province).

In order to implement the initiatives, the government of Japan offered ODA loans under its official development assistance program. In March 2000, as a starter, a total of 16 billion yen was provided as yen loans for the three cities to implement various projects. The actual details differed with each city, but among them were implementation of such activities as the installation of FGD equipment, switching to cleaner fuels, measures to deal with air pollution from coal combustion, and measures to deal with cement dust. Concessional conditions were applied to these environmental projects, including interest rates ("environmental special rates") set lower than for regular ODA loans, longer repayment periods, and other arrangements.

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Chapter 6
Sustaining China: Agriculture and the Environment

Abstract China has been an agricultural country since ancient times. The role of agriculture is especially important for China to support its very large population, but modernization of agricultural sector has been delayed in contrast to the rapid development and reform of industry sector. Rural population has exhibited a sharp decline in the last 50 years, but farmers still account for more than half of the nation's population. Their incomes are much lower than those of urban residents, and public welfare services in rural villages are significantly inferior to what is offered in cities. A vast area of agricultural land is subject to land erosion that is called *water and soil runoff* in China, and government is promoting nationwide *ecological construction* projects to return farmland to forestry to prevent erosion. The use of fertilizers and pesticides is causing water pollution in rivers and lakes, and people are more concerned about the safety of food, showing greater interest in natural foods.

Keywords Agricultural reform • Chinese agriculture • Ecological construction • Land erosion • Return of farmland to forestry • Water and soil runoff

6.1 China: A Nation of Agriculture

6.1.1 The Land: Transformation and Change

The landscapes of China reveal many faces of the land, depending on the region. The vast farmland of the North China Plain and towering poplar trees lining the roads resemble the rural landscapes of Western Europe such as France. The multitude of paddy fields in the lower reaches of the Yangtze River in the south somewhat resembles the landscapes of Japan. For the Japanese, the plains of Inner Mongolia are somewhat reminiscent of Japan's Hokkaido. And the mountainous and treed landscapes of Yunnan province in the south also somehow resemble Japan. On the other hand, the rough terrain of the Loess Plateau region of the middle reaches of

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the Yellow River and the Gobi and Taklamakan deserts have landscapes never found in Japan. This vast land is the stage for the diversity of human endeavor, including agriculture and forestry, wildlife protection, and more.

China has been an agricultural country since ancient times. It has a large land area, but it also has a large population. Consequently, the amount of land per farmer is small. To increase food production, farmers have toiled to convert every inch of land that could be cultivated into farmland. As a result, even steep slopes not ideally suited for cultivation were converted to farming; forest cover was reduced. The consumption of water for irrigation to boost food production has resulted in reduced river flows and problems in many places like ground subsidence due to excessive pumping of groundwater. One of the causes of the increasing seriousness of eutrophication of lakes is the rising use of fertilizers and agricultural chemicals. In Inner Mongolia, farmers labored to convert steppes and grasslands to farmland. On land where nomads once roamed, farmers (Han Chinese) arrived and settled. With these changes, the area of grassland declined and forests were cut for fuel wood. These are all factors contributing to desertification.

The moisture evaporation rate is high in arid regions, and salts originally dissolved in soil moisture are deposited on the surface, leaving the surface of the ground covered with white salt. In areas so affected, though there was already a shortage of water for irrigation, farmers must use even more water to wash away the salt. The more the land is irrigated, the more salt is deposited on the surface, and in the end the land becomes unusable for farming.

A major cause of the flooding that occurred on the Yangtze River in 1998 was reportedly the reduction in the land's ability to hold water—a consequence of forest logging in the upper reaches of the watershed. In places like the Loess Plateau of the Yellow River basin, rains cause soil erosion, resulting in the runoff of enormous amounts of soil. Policies have been adopted to "return cultivated lands back to forest," by paying compensation to farmers so that they will move away from hilly areas that are vulnerable to topsoil erosion. Forests serve a multitude of functions for ecosystem services—flood prevention, protection of soil erosion by wind and water, the recharging of natural water resources, and amenities for the population (Policies & CCICED 2004). Learning from the significant loss of forests that has occurred in China, the country is now in the process of reforestation and afforestation, having reexamined the other benefits that forests offer to society.

6.1.2 Issues in Agriculture: "The Big Three"

The population of China increased by 36 % in less than 30 years, from 960 million people in 1978 to 1.34 billion in 2010. The rural population increased from 790 million in 1978 to 860 million in 1995 and thereafter declined to 671 million in 2010. Meanwhile, the urban population increased from 170 million to 670 million, representing an increase from 18 % to 50 % of the total population as shown in Fig. 2.2 in Chap. 2 (National Bureau of Statistics of China 2012). The precise definition of

"urban population" as used for statistical purposes, however, is quite complex and difficult to grasp. Broadly speaking, the definition includes the residents within the area of castle cities (direct-controlled cities, regional-level cities, and county-level cities), except for the rural areas within them, plus the residents of the central parts of townships (these would correspond to towns in Japan). "Residents" are counted as fixed-domicile residents, plus residents who have no fixed domicile but have come from elsewhere and lived in the area for at least 6 months.

Industry is the main player in China's remarkable economic growth, but on the other side of the coin is what might be called the "Achilles heel" of China—"the big three challenges for agriculture": *farmers*, the *farm sector*, and *farm villages*. The central government administration formed by Wen Jiabao and Hu Jintao in 2003 identified these issues as being among its most important challenges to be addressed.

The challenge of *farmers* is the need to address rural poverty. Farmers (residents of farm villages) have very low incomes compared to urban residents, even though farmers account for more than half of the nation's population. The average annual income of farmers per capita is about one-third of that for urban dwellers. This disparity dropped below two times during the mid-1980s but since 1990 has been widening again. The circumstances behind these trends are complex. Increased food production resulted in excess production, which made prices plummet and actually reduced farm income; that has become a problem. Another reason for the low income of farmers is the excessive rural population. It has been said that rural villages have a surplus labor force of 150 million people. Because of this, many farmers would like to go find work in cities, although the opportunities for them there are limited. Until the 1980s, it was not easy to migrate from the country to the city.

All Chinese citizens had their domicile registered either in a city or in a rural village, and the system in place made it difficult to transfer the registration from the village to the city. After the beginning of the 1990s, this restriction was relaxed. Consequently, there was a large increase in the migration of laborers leaving the inland farm villages to work in coastal cities. What really stood out in the latter half of the 1990s was the migration from Sichuan and Hunan to Guangdong Province. But farm workers who migrated to the city to find work encountered serious discrimination in terms of hiring opportunities and wages, as well as unemployment, medical care, pensions, and other social services. They were permitted to go to the city to find work, but in reality, they were not able to find the hoped-for employment, their income failed to increase, and in fact the gap between them and urban dwellers grew even wider.

Moreover, among other things, in elections for representatives to the People's Congress at every level from county on up, each farmer's vote counts for only one-fourth that of each urban dweller's vote; even in terms of political rights, farmers have restrictions placed on them.

The challenges of the *farm sector* are the modernization of agriculture and food security for the enormous population of China. Between 1998 and 2005, the economy grew at 8.9 % per year, and the industrial sector (secondary industry) at 10.0 %, while the agricultural sector (primary industry) grew at only 3.5 %. The agricultural sector has a surplus population, and its productivity remains low. To modernize the

sector, investment is needed to improve irrigation systems and to mechanize agriculture, but there are limits to assistance from government finances, and farmers do not have the capacity to do it all themselves.

The challenge of *farm villages* is that in rural areas, public services such as compulsory education, health, and welfare are significantly inferior to what is offered in cities. This is because of inadequate public investment into rural villages. Infrastructure for rural waterworks and sewerage systems, roads, communications, and cultural facilities is very far behind urban areas. Just a glance at such things as water supply systems or toilets for rural households reveals the inferior conditions there. Compulsory education from primary school to the middle school level in urban areas is covered by public finance, but in rural areas, farmers must bear the burden of education levies. Because poor farmers cannot afford to pay these levies, many children are unable to go to school.

At this point we must touch upon the issue of ownership of farmland. In China, all land belongs to the state. The actual situation is that cooperatives and committees (legacies of the former communes) in each village manage through collective ownership. Because farmland is not personal property, the local government (practically speaking, the local boss or local official) can on its own decide to convert land uses and can expropriate land and forcefully evict farmers. Many farmers have rioted in protest in recent years. The actual details are not fully known, but according to some reports, there have been 10,000 protests and more than 100 riots per year in recent years.

In cities, private ownership of real estate has become a hot topic, and under the Property Law of March 2007, the buying and selling of land-use rights and automatic renewal at the end of the usage period is recognized. In reality, the situation is getting close to private ownership. Farmland is also covered under the Property Law, as it recognizes land-use rights (more precisely, "land contract operation rights") as real property. In the case of farmland, the usage period (contract period) is 30 years, and the rights can be extended at the end of the period. It also became possible to transfer rights. The law also established restrictions on conversion to other land uses and includes provisions for payment of compensation in the event of expropriation.

The real estate law gives equal guarantees for the rights of individuals regarding land use, but the benefits are better for urban residents and less advantageous for farmers. The price of real estate in cities rises, and the associated land-use rights can also be bought and sold for higher prices, but with the exception of some farm villages in the suburbs of large cities, no one can expect land-use rights for farmland to be traded at high prices. On the other hand, there is great pressure to convert farmland for development. Even if it is not formally forced expropriation, it is likely that farmers will continue being forced to relocate and receive scant compensation in return. The wealth gap between the cities and farm villages can only increase in the future.

These challenges relating to *farmers*, the *farming sector*, and *farm villages* are closely connected with environmental issues. Many farm villages still lack adequate waterworks and fuel gas services, and many people still don't have access to safe

Table 6.1 Agriculture and food production in China

Year	1978	1990	2000	2005	2010
Planted area (1,000 km^2)	1,501	1,484	1,563	1,555	1,607
Effective irrigated area (1,000 km^2)	450	474	538	550	603
Chemical fertilizer application (million tons)	8.84	25.9	41.5	47.7	55.6
Grain production (million tons)	305	346	462	484	546
Meat production (million tons)	–	–	–	69.4	79.3
Seafood production (million tons)	–	–	–	44.2	53.7

Note: Food production peaked in 1998 at 512 million tons
Source: China Statistical Yearbook for each year (China Statistics Press)

drinking water, so rural communities are being exposed to the dangers of contamination from heavy metals such as arsenic and mercury, as well as fluorine, and other toxic substances. They are also exposed to the risk of indoor air pollution due to the burning of low-quality coal for cooking and heating. The heavy use of agricultural chemicals also raises concerns about the safety of farm products. Not only are farmers poor and with a low level of education, they also have very little political influence, so if problems arise, they are often unable to find ways to have them addressed.

6.1.3 Food Production

China's biggest concern as a country with such a large population is the issue of food. At the present time, China does not have any food shortages. Nevertheless, the issue of food security is a serious one that continues to concern the country's leaders. China's food production increased from 305 million tons in 1978 to 346 million tons in 1990. Over the subsequent two decades, the country maintained a production level of between 450 million and 550 million tons as shown in Table 6.1. At this point, "food" means grains such as rice, wheat, and corn and non-grain items such as soybean and potato.

If we look at Chinese trade statistics for agricultural products, it is actually difficult to say whether or not China is really food self-sufficient, because not only does this balance change from year to year, but also imports of meat and feed grains are predicted to increase in the future. Exports of Chinese vegetables to Japan are increasing. There are concerns that grain production may drop if there is a further shift toward cash crops. Furthermore, Japan has begun exporting rice to China. Chinese people choose Japanese rice because of its taste and safety, although the amount of trade is still small. If we look at yields per hectare of arable land, one can conclude that China has been maintaining the same high level of yield as Japanese farming, although there is now a declining trend due to urban encroachment on farmland and degradation of the land.

Arid regions in northern China suffer from a serious shortage of water, and even treated water from urban sewerage is used for irrigation in some places. In addition,

to increase food production, it will be necessary to expand the area of irrigated districts and improve crop varieties. The demand for meat is increasing as urban dwellers continue to improve their standard of living, so it will become necessary to increase the production of feed corn in the future. The United States currently has enormous production and export capacity when it comes to corn, so China may eventually find itself depending more on that country for corn imports.

The language of the central government that "China is sustaining 20 % of the world's population, with 7 % of the world's arable land" encapsulates the challenging conditions facing agriculture in this country. China has 1.30 million km^2 of arable land—26 times that of Japan, but only 2.7 times that of Japan in terms of arable land per capita. Arable land per farm is about the same as Japan. Incidentally, arable land worldwide is about 14 million km^2. Arable land per capita in China is 40 % of the global average. China's average annual precipitation for the whole country is about 630 mm, about one-third that of Japan. In northern China, annual rainfall is less than 400 mm in many places. Water resources per unit of arable land are about one-half of the global average. A big issue for China is that although 60 % of its arable land is north of the Yangtze River, 75 % of water resources are south of the Yellow River. Thus, not only is the amount of agricultural land low per capita or as a share of the total land area, there are also geographical imbalances in water resources availability.

Since the People's Republic of China started, the central government has made a great effort to increase food production, but under the socialist structure, it was not entirely effective. Under economic reforms, in 1979, the commune structure was abandoned and the "production contract responsibility system" was introduced. Under this new system, the farm (not the commune) is the basic unit of agricultural production; farmers lease farmland from organizations (villages or communities), and, in principle, on their own initiative engage in agricultural production, and then deliver a certain amount of the production to an organization. Furthermore, the government reformed distribution structures in order to reduce the volume of government allocation purchase items and liberalized distribution and implemented price structure reforms that reduced the volumes and list of items subject to official pricing. These reforms resulted in greater motivation for farmers to produce. There is no question that China has had large success in conquering its challenging natural conditions and achieving food self-sufficiency. However, progress in the agricultural sector is still behind that of the industrial sector. Even though emphasis has been given to farming for food production, one problem is that not enough consideration was given to the quality of life or welfare of farmers and farming communities.

Food supply and demand involves short-term factors and long-term factors. The effects of weather conditions are one example of short-term factors. Long-term factors are determined by such matters as trends in a nation's industrial structure, area of arable land, farming technology, and farming populations. Grain production in any given year is affected by factors such as the amount of sunlight or rainfall in that year. Droughts are also a problem in China, but damage quite frequently occurs from flooding. Fluctuations in annual production, however, can be mitigated by storing crops. If a country was not able to adapt by adding to or removing

from its storage stockpiles, it would have no choice but to depend on imports. Of late, however, there have been no circumstances that would require China to suddenly make massive imports. China's ability to maintain its level of food production even though the amount of arable land is declining is that yields per hectare are increasing. This has been achieved by expanding the area covered by irrigation, applying more fertilizers and agricultural chemicals, promoting mechanization, encouraging double cropping, and other technological developments. Over the 20 years from 1990 until 2010, the irrigated land area increased by a factor of 1.27 and the amount of chemical fertilizer use by a factor of 2.15. China annually consumes 257 kg of fertilizer per hectare of arable land, while the grain production per hectare is about 5 tons. This figure of fertilizer use is about the same as in Japan but much larger than the global average of 92 kg. On the other hand, the use of machinery such as farm tractors, harvesters, and threshers is very low. There are businesses that own one expensive harvesting machine and during harvest season make the rounds of multiple farms to do their harvesting. China's natural conditions are suited to the American style of large-scale farming, but because the farm population is large, and there are many small farms, large-scale farming techniques are difficult to apply here. Because the country went from a collective farming system based on the commune to the contract production system based on individual farms, it has become in some ways more difficult for multiple farms to do things collectively.

Another important topic associated with food production is the food distribution system. Until now, China's transportation infrastructure and crop storage system were not well developed. The result was a large amount of wastage during food storage and during long-distance transport. In China today, the rate of wastage from the time of harvest to the time of consumption is reportedly more than 10 %, but because rapid progress is being made with the construction of a high-speed road network, China will probably approach the international level of 5 %.

6.1.4 Loss of Farmland

Three major concerns about food supply and demand are (1) future population growth, (2) the loss of farmland, and (3) rising demand for feed grains to satisfy rising meat consumption.

As for the growing population, future projections of China's population are being revised downward to take into account the effects of the nation's one-child-per-couple policy. Previous predictions were for the population to peak at 1.6 billion people in 2030, but more recent predictions have been revised to show the peak at about 1.45 billion (United Nations, Department of Economic and Social Affairs 2010). As for the amount of arable land, figures such as those cited in this book are available in statistical reports, but in reality, accurate numbers may not be fully known. Experts have pointed out differences between findings based on satellite remote sensing data and the numbers aggregated from reports nationwide. It is

therefore difficult to have an accurate discussion on this topic, but there is no question that the amount of farmland is decreasing in the face of industrialization and urban expansion in China. According to the reports from within China, arable land area was 1.3 million km^2 in 1996, but this decreased to 1.22 million km^2 in 2005. This decrease would mean that 8,080 km^2 (808,000 ha) were lost each year on average. This would be larger than the combined area of Tokyo and Chiba Prefecture (7,300 km^2). At this rate, another 44,000 km^2 could be lost over the 5-year period to the year 2010, larger than the total area of such countries as Denmark and Netherland.

Even though the conversion of farmland to other uses is regulated by the country's land management legislation, land is being illegally occupied and used all over the country. Without official approval, farmland is being converted to other uses to construct factories, housing, golf courses, and others. In many cases, local governments and developers are colluding in these types of developments, and a growing number of farmers are having their farmland expropriated unjustly by the local government. Riots by angry farmers have been occurring in various parts of the country, and the government has pledged to crack down on the illegal expropriation of land from farmers.

In the Chinese countryside, the single-minded pursuit of development and economic growth is rampant. Because this is the basic attitude of local governments, they do little to solve the problem. The vastness of China makes it difficult for anyone to monitor or manage everything, so many illegal activities slip by, unnoticed or politically neglected by the authorities. Besides the impacts of urban growth, farmland area is also being reduced as a result of the expansion of industry. The industrialization of rural areas has been entrusted to town and village enterprises. These enterprises are absorbing the surplus workforce of more than 100 million people in rural areas and making a large contribution to industrial production nationwide, but one outcome of this arrangement is the conversion of farmland to factories.

6.2 Environmental Problems and Agriculture: Inextricably Linked

6.2.1 Changing Diets

Eating habits are becoming more luxurious in Chinese cities. People find great joy in dining out with friends in the countless restaurants in any city, and everywhere business is bustling. With rising incomes, major changes are also happening to the diet of the people. As a proportion of total grain production (including rice, wheat, and corn), corn production rose from 26.9 % in 1995 to 32.6 % in 2005. Seventy percent of corn is used for animal feed, and one can see many fields in northern China that have been converted from wheat to corn. Demand for corn and other animal feed has increased rapidly due to the growing consumption of meat. Alcohol is often consumed with meals, and a large amount of grain is needed to produce

distilled spirits like *maotai*, made mainly from fermented sorghum. This is one reason that during the 1990s, the government even issued a notice that government officials should refrain from including spirits when hosting events.

Soybean is an important ingredient for Chinese cuisine, and since 1995, China has been an importer of this commodity. Soybean oil imports are also rising as vegetable oil is an essential ingredient for Chinese cooking. Pork is a typical meat in Chinese cuisine. Pork production in China increased from 36.9 million tons in 1995 to 61.6 million tons in 2005, an increase of 67 % over a period of 10 years. Beef production also increased, doubling from 3.57 million tons to 7.12 million tons over the same period.

Seafood is also an important ingredient in Chinese food. Seafood production doubled from 25.17 million tons to 51.06 million tons during this period (1995–2005). The population has also developed a taste for expensive fish such as tuna, and excessive fishing by Chinese fishing boats is becoming an international concern (Soti-NPC 2013). Freshwater fish account for nearly half of the fish served with meals, and about 90 % of it comes from artificial cultivation. Once when the author was dining at a restaurant in the desert oasis town of Dunhuang, fish appeared as part of the menu. The fish was raised locally: surprisingly there was a large fish farm in the town, even though this town in the middle of the desert suffered from a shortage of water. Such changes in the diet are connected to an increase in the burden on the environment. Animal waste from piggeries and other livestock is a major cause of water pollution. Fish cultivation in fish farms or ponds requires scarce freshwater resources and is also a source of water pollution. In Taihu Lake, the cultivation of the Shanghai crab has become an issue because it has been identified as a major source of water pollution in the lake.

6.2.2 Environmental Protection in Agricultural Communities

When one considers the vast area of farmland and the huge rural population in China, it is easy to see that environmental initiatives in rural areas are an important part of environmental protection in this country. This is why the Chinese government is conducting extensive model projects at the village level under the concepts of "environmental townships and villages" and "villages of eco-civilization."

The government is also conducting model projects to improve the infrastructure to deal with nonpoint-source pollution around the "Three Lakes" (targeted for strategic pollution control measures, as described in Chap. 4) as well as the Yangtze River Delta, the Pearl River Delta, and the Yellow River Delta. The main target of these projects is the pollution from pig farms, poultry farms, and fish farms. The government is also carrying out policies at the village level to deal with the supply of drinking water, treatment of domestic wastewater, and treatment of waste. Considering the fact that public investment at the village level was small to begin with, it is significant that the government is now promoting projects that combine the goals of regional development with environmental improvement. Given the

enormous size of China, however, it could take a long time for the results of these model projects to have a ripple effect across the country.

The government is also conducting supervision and safety inspections of farm products for the safe management of agricultural chemicals and chemical fertilizers as well as pesticide residues, but it is also difficult to completely enforce such programs across the entire country. It is also putting into practice environmentally friendly farming methods in more than 400 counties nationwide and constructing eco-model districts in more than 500 counties (2005). Organic food products are also becoming more popular, so there are efforts underway to develop standards and certify organic food producers.

Even in Chinese farm villages that have been electrified, biomass (firewood and straw) and coal are often used for cooking, which come with environmental impacts. Instead, the government is promoting projects to produce methane gas using livestock manure and other inputs. This program has already involved 17 million households, and 60 million tons of livestock manure is processed per year, while methane production is more than 6.5 billion cubic meters (2005). Besides this, the government is also working to promote the use of renewable energy, including the recovery and use of methane gas from domestic wastewater treatment facilities, kilns, and furnaces that use less firewood, solar-powered water heaters, wind power, geothermal energy, and so on.

6.2.3 Programs to Tackle Erosion

One special Chinese term for "land erosion" is "water and soil runoff," an expression unique to the Chinese language to describe soil erosion and mud flows. Anyone who sees the water of the Yellow River will notice that it contains large amounts of sediment and can truly grasp the meaning of these words; the soil and water become one in the river. In particular, in the Loess Plateau region in the middle reaches of the Yellow River, when the rain falls, soil is stripped off and washed away. In the Loess Plateau region, the soil looks like hardened clay, and one rarely sees rocks. Here and there on the plateau, deep gorges abruptly break the landscape and appear carved into it, caused by water erosion. The problem of water and soil runoff is prevalent in many places in China. One of the major causes is the clearing of land for farming by removing grass, bush, and trees.

"Water and soil erosion areas" are defined as areas where erosion is causing a loss of 1,000 tons or more of soil per square kilometer per year. Under this definition, this amounts to 1.5 million km^2 nationwide. In the Yellow River basin, 544,000 km^2, or about two-thirds of the land area, fits into this category. Measures to deal with erosion are being implemented based on three principles: (1) taking detailed measures in individual "blocks" with small river basins as the basic unit; (2) planting vegetation to cover the ground surface with grass, trees, and forests; and (3) using an integrated approach to manage activities on mountains, along rivers, in fields and forests, and along roads.

The government of China has designated model areas for these efforts and is implementing measures with the participation of farmers. For these efforts, the World Bank, the Japan Bank for International Cooperation (JBIC), and other funders have provided international assistance. For example, in "Jinghui Irrigation District" (located north of the city of Xi'an), which draws water from the Jinghe River (which runs into the Weihe River, a tributary of the Yellow River), it is said that the amount of sediment in the water increased during the Song Dynasty (tenth to thirteenth century CE), but during the earlier Tang Dynasty (seventh to tenth century CE) the water was still clean. In order to stop erosion, it is necessary to carry out projects over large areas where it is particularly severe in order to return farmland to forest.

At the center of these efforts are government projects to "return farmland to forest," which is described in more detail below. Projects such as these are referred to generally as "ecological construction" projects, and as an important pillar of inland and western development, they are a key component of the Tenth and Eleventh Five-Year Plans (2001–2005 and 2006–2010). According to the Management Bureau for the Upper and Middle Stream of the Yellow River, these projects have played a part in reducing erosion from 1.6 billion tons of soil per year during the 1970s to 1.3 billion tons per year in 2000. The bureau plans to reduce this to one billion tons per year in 2030 and 800 million tons per year in 2050.

6.2.4 Returning Farmland to Forest and Grassland

China is a country with a relatively small ratio of forest cover; it accounted for only 12.5 % of the nation's land area in 1982. Excessive logging of forests and clearing for agriculture have resulted in a steady loss of forest resources, and in many areas the effects have led to disruptions in metrological conditions and ecological balance. As a result, natural disasters occurred frequently in this country, including floods in the Yangtze River basin in the south and droughts in the Yellow River basin in the north.

In "Returning Farmland to Forest" projects, farmers living in areas that slope at 25° or greater and have significant soil erosion are moved and resettled elsewhere in return for monetary compensation; where the farmers once lived, trees are planted instead. In areas more suited to grassland, the farmland is returned to grass cover. These are "Returning Farmland to Grassland" projects. These projects were started on a trial basis in 1999 in Sichuan Province, Gansu Province, and Shaanxi Province and later expanded almost nationwide.

The Tenth Five-Year Plan (2000–2005) included targets of returning 113,000 km^2 of farmland to forest, afforesting 133,000 km^2 of degraded land, and conducting erosion prevention work on 667,000 km^2. This was a huge program covering the entire country. As a result of these efforts, forest cover increased to 18.2 % in 2005. The government is providing food assistance (in the form of rice provisions) and livelihood assistance (cash payments) to farmers who have stopped farming as a result of these projects. Although the compensation details vary by region, as an

example, in Shaanxi Province, farmers are receiving the equivalent of about 3150 yuan annually per hectare of farmland for 8 years. Mass resettlement is also being conducted for farmers who are forced to abandon farming and can no longer make a living. For example, a decision was made to relocate 16,000 people who were living in the water catchment area of a reservoir that serves the city of Xi'an. These people are referred to as "ecological migrants"; the government is providing them financial assistance for the construction of a new settlement.

Projects to return farmland to forest were continued during the Eleventh Five-Year Plan (2006–2010); the budget for the years 2003–2010 is more than 337.2 billion yuan, and direct compensation to farmers for livelihood compensation and resettlement compensation is included in this amount, even though some may say it is insufficient. People have to take notice, however, that farmers—who are often made the victims of government policies—are being paid financial compensation in this case.

6.2.5 Desertification and Yellow Dust: No Easy Solutions

Northwestern China is a land of the vast Gobi and Taklamakan deserts. The author once rode the night train for a distance of over 1,000 km from Urumqi in Xinjiang Uyghur Autonomous Region to Dunhuang in Gansu Province. When we awoke in the morning and looked out the window, a desert scene stretched before our eyes. At first, it looked more like a dry, rocky landscape, but as we continued to roll the scenery transformed into a real desert. Dunhuang had no train station, so we had to travel more than 100 km by car from the nearest station. Every here and there in the land, white salt was visible on the ground, and in the distance we saw a mirage.

According to research, the desert we see here today was not always this way. Five to eight thousand years ago this was apparently a grassland that received more rain than it does today. There is a fascinating story in the historical novel *Lou-Lan* by Japanese writer Yasushi Inoue, who uses the Loulan Kingdom and a desert lake known as Lop Nur (now the Tarim Basin) as the setting for his book (Inoue et al. 1979). This "lost" lake in the novel was made famous by Swedish explorer Sven Hedin who led expeditions to Central Asia over a 100 years ago (Hedin 2010). An episode in the novel makes one think about the connections between the Earth's climate, civilization, and human activities.

For many people, the word "desert" evokes images of exotic places in distant lands, but life in the desert is harsh. There is water in an oasis town like Dunhuang, and the shade of trees on a hot summer day is cool and comfortable, but those who have experienced a sandstorm say these storms are so fierce that people and animals can barely breathe. Desertification is caused by the retreat of grasslands due to the clearing of land for farming, grazing livestock, and similar activities, but direct human activities are not the only cause; desertification also is related to the climatic change that is occurring on a global scale.

The expanding deserts are also a source of the yellow dust that afflicts Japan from time to time. People often associate "desertification" with deserts like the Gobi and Takalakan, but this is actually a much larger issue. Desertification is occurring in about 900 counties of China's 30 provinces. According to the Third National Desertification and Land Monitoring Report (2005), deserts cover 1.74 million km^2 in China, or 18 % of the land area, and affect almost 400 million people. Just more than 70 km northwest of Beijing lies a desert covering about 87 ha in Huailai County (Hebai Province). Each year it grows from the accumulation of yellow dust blowing in from the north. Twenty years ago it was only 3 ha in size, but as it grows every year it is gradually creeping toward Beijing.

On the Tibetan Plateau—the headwaters of the Yangtze River and Yellow River—a reported 8.3 % of the total land area has turned to desert in the last 30 years. The country's State Forestry Administration took a leading role in conducting a series of priority projects to combat desertification, including protection forest projects in northern China (northwest, central, and northeast areas), countermeasures to reduce the sources of sandstorms around Beijing and Tianjin, and projects to return farmland to forest. As a result, the rate of desert expansion was reportedly reduced from an average of 3,436 km^2/year at the end of the 1990s to 1,283 km^2/year (2005). The Chinese government's view is that it has at least slowed the pace of desertification. It remains to be seen whether or not these efforts have done much to slow the spread of deserts and the problem of yellow dust, but with deserts covering 18 % of the country, the need for further efforts is a serious issue.

Of this area, there is the potential for implementing countermeasures, such as the planting of vegetation on 530,000 km^2 (twice the size of UK), but if the intention were to take action on all of that land, it would be an enormous undertaking. Even on land where action has already been taken, there is always the risk that human efforts will be reversed and the land turns back into desert, because the ecosystems are fragile. And of course, any actions will cost money. Also, efforts like these affect the livelihoods of local people; it is not easy to stop agricultural developments and the grazing of livestock. Measures to fight desertification have begun, but so far they have been unable to stop the yellow dust and the damage caused by sandstorms. To prevent yellow dust, the most important action is to reduce the loss of topsoil and reduce the size of areas that are sources of the dust, but it is difficult to implement such actions completely. The source of the yellow dust is not only limited to the inland areas of China but also in other countries such as Mongolia. International cooperation is therefore a necessity. Another factor causing the yellow dust phenomenon is the occurrence of very strong winds, and these are related to complex meteorological factors each year. Complete control of all these factors is impossible.

6.2.6 A Country Rich in Biodiversity

China is a land with a great diversity of flora and fauna thanks to its vast land area, with climate zones stretching from the tropics to the subarctic, and a highly varied

topography. On the other hand, as a result of a growing population and human developments, pressure on natural ecosystems is also growing, giving cause for concern about the extinction of rare species. China is one of the most biodiversity-rich countries in the world. It is home to 6,266 species of vertebrates (about 10 % of the world total). Among them, there are 500 larger species (11.8 % of the world total) and 1,258 species of birds (13.7 % the world total), more bird species than any other country. China also has 376 species of reptiles, 284 species of amphibians, and 3,862 species of fish (20 % of the world total). Furthermore, China's 30,000 species of higher plants rank it third in the world (Ministry of Environmental Protection of the People's Republic of China 2007).

The development of traditional Chinese medicine is rooted in this wealth of biological diversity, attracting the interest of the world's pharmaceutical companies. While China is a country with some of the greatest diversity of living things in the entire world, it is also a country where biological diversity faces serious threats. Among the wildlife that once lived in China, those that have already gone extinct include the Xinjiang tiger, the Mongolian horse, the Gaobi antelope, and the rhinoceros. Furthermore, between 4,000 and 5,000 species of higher plants are threatened by extinction. Meanwhile, like Japan, human mobility and the expansion of international trade has led to problems with the invasion of alien species here.

China's governmental portfolio for nature protection was first established on the basis of the administration of forests. Nature reserves established with the objective of nature protection were originally created in order to regulate the logging of forests. Thereafter, in the context of the nation's reform policies, the concept of forest protection was broadened to include the protection of nature. The national Forest Law of 1979 includes provisions stating, "It is necessary to establish nature reserves in place with special protection value, such as representative forest ecosystems, forest areas that are habitat to rare flora and fauna, and natural tropical rainforests, etc.," which led to a rapid increase in the number of nature reserves. In 1998, the Environmental Protection Bureau was reorganized as the State Environmental Protection Administration (SEPA), and at that time the Nature Protection Department that had been associated with the State Forest Bureau was transferred to SEPA.

By comparison, the nature protection portfolio in the Japanese government began in 1971 when the Environment Agency was established, and the National Park Department which was in the then-Ministry of Health and Welfare at the time was transferred over to the Environment Agency (the precedent of today's Ministry of Environment). In that process, the forest portfolio, which had been under the then-Ministry of Agriculture and Forestry, became distanced from the nature protection portfolio. By comparison, nature protection in China is under the forestry portfolio, so it is worth noting that new areas such as wildlife and wetland protection were incorporated into it.

As of 2005, there were 2,349 nature reserves nationwide, with a total area of 1.5 million km^2, more than 15 % of the total national territory. Among them, 243 were designated as being particularly important state-level nature reserves, covering 890,000 km^2. Besides these, scenic areas and forest park have been designated. Wetlands such as swamps, lakes, rivers, and estuaries, and coastal mudflats, tidal

flats, and places alike, are distributed broadly with a total area of 660,000 km^2, accounting for 10 % of the land area of the world's wetlands. Among these, 29 locations accounting for 36,000 km^2 are designated as Wetlands of International Importance. Of the nature reserves nationwide, 26 are incorporated into the United Nations Educational, Scientific and Cultural Organization (UNESCO) Man and Biosphere (MAB) program and 14 are registered as World Natural Heritage Sites. Fifteen species, including the giant panda and orchids have received designation under state priority protection projects, 617 sites have been established for raising rare species, and 52 wildlife zoos and parks have been established.

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Chapter 7
Environmental Management Systems: In Place, but Must Be Implemented

Abstract This chapter discusses environmental governance issues in China in terms of administrative organizations, laws, and institutions. China learned a lot of things from the experiences and practices in the United States, Europe, and Japan. China has adopted progressive principles regarding environmental management, and good legislation is in place. In terms of implementation and operation of the systems, however, there is still much to be desired. Human and technical capacity that forms the basis for the systems is still inadequate, especially at the local level. There are gaps between principle and practice, and systems may not operate exactly the way intended. As China's economic power is expanding, the role of Chinese corporations has become decisively important not only to comply with national environmental regulations but also to pay due attention to corporate social responsibility for protecting the global environment.

Keywords Corporate social responsibility • Environmental governance • Environmental management

7.1 Central Authority vs. Local Authorities

7.1.1 Legislation and Organizational Structure

China first launched upon the path of systematic policies for environmental protection after the storm of the Cultural Revolution had passed and economic reforms began. It participated in the United Nations Conference on the Human Environment in Stockholm in 1972 and was for the first time exposed there to international debate about environmental issues. There is no question that when the time came for economic reforms, leaders understood the importance of environmental issues because of the information they had learned about industrial pollution in Japan and elsewhere.

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When China's constitution was amended in 1978, these words were included: "The State protects and improves the living and natural environment, and takes steps to control environmental pollution." During the 1970s, it was in the midst of economic stagnation difficult to imagine now when looking back from today's growing economic prosperity of the country. As such, the founders of environmental policies deserve praise for their foresight, considering the national conditions at the time. In 1979, the Environmental Protection Law was given a "trial entry into force." This means that before the law formally went into force, it was implemented on a trial basis and its impacts and problems investigated—a common practice in China—but finally, the law fully entered into force in 1989. The Water Pollution Prevention Law was enacted in 1984, and the Air Pollution Prevention Law in 1987, establishing environmental quality standards for air and water. Other laws were also enacted, including the Solid Waste Treatment and Control Law and the Environmental Impact Assessment Law.

As an administrative body for the environment, in 1984, the "Environmental Protection Committee" was established under the State Council, and as a permanent office of the Committee, the Environmental Protection Bureau was established. In 1988, it was promoted to fall under the direct supervision of the State Council. This is similar to what happened in Japan when the Environment Agency under the Prime Minister's office was promoted to become the Ministry of the Environment. In 1998, the name of the Environmental Protection Bureau was changed to the State Environmental Protection Administration (SEPA). Under this restructuring, some government departments in charge of the forestry portfolio were also transferred to SEPA. In 2008, SEPA was further upgraded to Ministry of Environmental Protection (MOE).

The State Council is China's highest administrative organ. It is similar to the Cabinet Office in Japan, except that it has much more authority. China's Premier of the State Council becomes the Prime Minister of the country. Under the State Council there are ministries equivalent to those in Japan and other countries: the Ministry of Foreign Affairs, Ministry of Water Resources, Ministry of Health, Ministry of Transport, MOE, and others. Each is independently in charge of its own sector, but in terms of government structure, all fall under the State Council. In addition to these, many "bureaus" and "administrations" are directly supervised by the State Council, such as the National Bureau of Statistics, the State Forestry Administration, and other organizations. The State Council has three vice-premiers, each in charge of several ministries, bureaus, and administrations. In the case of Japan, ministries are highly independent and the Cabinet Office has only limited power to coordinate them. In contrast, China's State Council is positioned above and controls all ministries, allowing the Prime Minister to exert the power to take strong leadership.

7.1.2 Ministry of Environmental Protection (MOE)

MOE has extensive duties. Above all is the work of preparing the basic guidelines, policies, and legislation of the country relating to environmental protection. When

the state government is developing important policies and programs, if there is any possible environmental concern, upon the request of the State Council, MOE assesses the impacts. It also prepares programs and plans of the national government relating to environmental protection, as well as programs targeting pollution control and priority areas for ecological protection, and other important issues. It also prepares legislation and regulation relating to air, water, soil, noise, solid waste, and hazardous substances and establishes regulatory standards. Other important work includes overseeing matters relating to environmental observation and monitoring.

MOE is also responsible for nature protection and restoring ecosystems. In addition, it compiles environmental information and every year publishes China's State of the Environment Report, which is similar to Japan's Annual Report on the Environment (Ministry of Environmental Protection of the People's Republic of China, Department of Pollution Emission Control 2012). In recent years, basic policies and international cooperation relating to global environmental issues such as climate change have also been important work. MOE is also responsible for managing nuclear safety, radiation in the environment, and radioactive wastes.

From the perspective of Japan, another important function in relation to MOE has to do with the Sino–Japan Friendship Center for Environmental Protection, first proposed in 1988 by Japan (under then-Prime Minister Noboru Takeshita). Japan provided about 10.5 billion yen in grant funding for the building's materials and construction, and it was completed in 1996. This center is treated as an external body of MOE. Under request and instructions from MOE, it conducts research relating to important policy issues, developing environmental technologies, collecting and analyzing national environmental monitoring data, and promoting environmental education activities.

Inside the center are a number of other centers of various sizes, including the Center for Environmental Policy Research and an Environmental Education Promotion Center. In the same general wave of privatization of state-run enterprises in China, government organizations were also restructured to be more efficient. This process was similar to the Japanese government's actions in the late 1990s to turn what were previously institutions and organizations completely funded by the government into "independent administrative institutions." A similar situation now exists with the Sino–Japan Friendship Center for Environmental Protection; the center to some extent must secure the resources it needs for its projects and cover its own staff salaries and activity costs. It is proactive in carrying out research projects that can obtain funding from overseas funding organizations. To some extent, personnel have a double identity, as they follow instructions from MOE at the same time as carrying out the center's own activities. Japanese experts were dispatched to the center for environmental technology cooperation between Japan and China, and they played a role in promoting environmental cooperation between the two countries. But regardless of "Japan" in the center's name, this is a Chinese organization under MOE.

7.1.3 Local Capacity of Environmental Management

As many environmental problems are ultimately manifested at the local level, the role of local governments relating to environmental protection is extremely important. This is even truer in a country as large as China. At the local level, provincial governments and municipal governments have an environmental office, department, or bureau that has functions similar to those of MOE in the central government. At the local level, besides the environmental protection bureaus, there are also environmental pollution measurement and monitoring offices and research institutes. The total number of these organizations is rather large, with 2,019 at the provincial and municipal level or higher and 7,655 at the county level (2005) (China Environmental Yearbook Company 2006). The major work of the local environmental protection bureaus includes monitoring the state of pollution and developing a variety of measures for pollution control. In recent years, nature protection and recycling have also been added to their mandate.

The powers and capacity of local governments for environmental management, however, are certainly not adequate to accurately and scientifically monitor the state of pollution of air and water and at the same time to monitor and inspect activities of factories and plants. MOE has the role of researching new policy issues and proposing methods of environmental management. When it wants to implement a new policy, it often begins with a pilot project in cooperation with the local environmental bureaus concerned. Thus, through MOE, the central government has a close relationship with the regional environmental bureaus. The central government does not give instructions directly to the local governments, however, and is not able to determine their regional budgets and staffing. This structure does not force local environmental bureaus to follow orders from MOE.

It appears that institutional independence is recognized at the local level, but the fact is that local capacity is always far from sufficient. There is much that the central government could do in order to raise local capacity. A person who travels to the countryside in China may be surprised to find an environmental bureau even in rural counties and towns and, frankly, may be surprised at the number of staff. The number of personnel associated with organizations related to environmental protection nationwide totals 167,000 people (2005). By level, there were 2,452 with the national government, 10,616 at the provincial level, 43,000 at the local municipality level, and 106,000 at the county level. Incidentally, MOE has a surprisingly small number of personnel at only 225 persons (as of 2005).

If we see numbers like this, we find an impressive number of staff in China in environmental administration bodies at the state and local levels. That is not the whole story, however. If you visit the more progressive environmental bureaus in places like Beijing, Shanghai and Shenzhen, you will notice same business-like seriousness that you would find in the environmental department of a prefecture or large city in Japan. They have computer systems to receive and audit notification data from factories and analyze and present air and water environmental monitoring data. They also have public relations functions and educational activities for the

public. When you visit a county-level environmental department, however, you may find an organization and personnel, but it is difficult to see what they are actually doing. And if you visit environmental monitoring offices and stations, you get the impression that they have not been provided with good equipment and materials.

In Japan, when government first began to set up the functions to deal with industrial pollution, from the 1960s through the 1970s, because there was no organization in place to conduct measurements and analysis of air and water, a local prefecture would establish its own new organization, a pollution monitoring laboratory, for example. Because there was a shortage of expert staff, they were hired very quickly. In order to ensure the reliability of measurements and analysis, budgetary measures were taken to obtain the latest analytical and telemetry equipment, and efforts were put into raising the technical abilities of personnel. Through the cooperation of the national and local governments, reliable environmental observation data was obtained, thereby enabling a scientifically sound environmental administration. In comparison, in China today, it often occurs that even if an organization is created and staffed with personnel, it still lacks the required equipment and trained expertise. Another issue at the local level is the very strong bias in favor of development. Under this situation, how much influence do environmental bureaus really have?

China is a large country, and a powerful central government is needed to manage it. But the central government is not able to control everything from the center, so it does yield a large amount of discretion to the local government. Because the central government does not have a lot of financial power and cannot respond to every local need, it has no choice but to leave local governments with a large degree of freedom. Deng Xiaoping's principle of "allowing some regions to prosper before others" has created this regional disparity between rich and poor regions. The local governments tend to give the priority to economic development and then be forced to play a game of catch-up only after environmental problems occur.

7.1.4 The Bias of Local Governments Towards Development: Environmental Riots

In recent years, foreign newspapers have frequently reported about riots in the Chinese countryside. The typical situation is that a local government has ordered forcible evictions in order to force through an aggressive development plan or farmers victimized by the impacts of pollution protest en masse. Then, local authorities or the police arrive to break up the riots, thus leading to further confrontations. These have been called "environmental riots." An incident that occurred in 2005 in the city of Dongyang, in Zhejiang Province, is one example. The municipal government was forcing through a plan to construct an industrial park without having obtained the consensus of farmers, and the companies involved were dumping hazardous wastes. A confrontation erupted between the protesting farmers and the

police. The provincial government got involved and ordered the factory to stop operations, but in the end the farmers' rights were not restored, no compensation was paid for damages, and the issues were left unresolved.

Economic development has spawned a countless number of development proposals, large and small, all over the country. In large cities, there are many people around to notice large developments being started or in progress, but in the countryside, for land developments and factory construction, local governments have a tendency to ignore the interests of the local people and instead go ahead and approve the proposed developments. Residents are compelled to meekly accept their fate when their health suffers from factory pollution or when their land is forcibly taken away. When a problem arises, locals are able to submit complaints and opinions in writing to MOE in the national government or to the environmental bureau of their province or municipality. There were more than 600,000 letters of this kind received by the authorities in 2005. This was double the number 5 years earlier. Depending on the content of each letter, the environmental bureau at the city or provincial level is supposed to investigate, and if the problem is found to be serious, the central government's MOE is supposed to become involved. In many cases, however, the authorities fail to conduct adequate investigations into the actual situation or to identify the cause, and conflicts are left unresolved.

The official response to a water pollution disaster caused by a factory explosion along the Songhua River at the end of 2005 is a prime example. The authorities initially failed to disclose information and attempted to contain information on the situation, but as the damage grew larger, it became an international issue, and suddenly SEPA (the precedent of MOE) decided to get involved.

7.1.5 Weak Local Environmental Governance

Corruption and bribery in the central and local governments in China is another serious issue. In September 2007, a national organization (National Bureau of Corruption Prevention of China) was established, and it directly accepts complaints from citizens regarding such problems (National Bureau of Corruption Prevention Bureau 2012). Near the entrance of the building, however, persons connected with local governments stand in wait, and they physically attempt to prevent the entry of citizens into the building trying to make a complaint. Scenes such as these have been broadcasted on Japanese television. To deal with corruption, the central government is responding with the principle of applying severe punishments, including even capital punishment. Perhaps this is a sign of how deeply rooted the problem is, and the environmental administration sector is likely no exception.

The capacity to implement environmental management, or "environmental governance," is not simply a question of the existence of environment-related legislation and organizations. The key is whether or not through those arrangements

citizens' rights, health, and welfare are being protected. There are many cases in which, even after a problem has been discovered, further investigations are not conducted, information is not disclosed, or data is manipulated. In many cases, local governments wouldn't have the capacity to do the proper research even if they can do. In this sense, perhaps China is still at the developing country stage.

7.2 Progressive Approach to Environmental Management

7.2.1 Environmental Management: Principles and Methods

In contrast to the actual situation on the ground, China has adopted very progressive principles regarding environment management, and good legislation is in place. The principles of environmental policy, which provide common guidance for all of humanity, have been developed and enriched through numerous international meetings and discussions. Examples of these include the "Declaration of the United Nations Conference on the Human Environment" (Stockholm Declaration) in 1972, and the "Rio Declaration" and "Agenda 21" adopted at the Earth Summit in Rio de Janeiro in 1992 (UN Documentation Centre 1992). The presence of China at international meetings like this is strongly felt. China is a permanent member of the United Nations Security Council, and this country's statements are usually treated as important.

The Chinese government acts as quickly as possible to introduce the principles and policies of environmental protection agreed at these international meetings. China's leaders, in policy speeches at the National People's Congress and other occasions, repeatedly state that environmental protection is a basic principle of the nation's policy and that the nation will seek economic growth and a balanced development of cities and rural areas, at the same time as it pursues environmental protection.

China uses the following three principles as its fundamental principles of environmental protection: (1) prevent pollution before it occurs, (2) make polluters (developers) pay costs, and (3) strengthen environmental management. These principles have been incorporated into the provisions of individual pieces of legislation relating to the environment.

7.2.2 Environmental Management Systems: China's Way

China has adopted the following eight systems in order to put environmental management into practice. Systems similar to these do indeed exist in Japan and other countries, but China has applied them in the country's own way.

7.2.2.1 "Simultaneous Three System" (Concurrently Design, Build, and Operate Pollution Prevention Facilities)

Anyone constructing a factory or facility is required to conduct the "design," "build," and "operate" concurrently with pollution prevention facilities. In other words, it is not acceptable to treat the pollution prevention equipment as being separate from the primary facility and not acceptable to postpone the design, construction, or start of operation of pollution prevention equipment. The status of concurrent implementation is to be reported to the local environmental bureau. More than 70,000 projects are subject to these rules every year, and the achievement rate is reportedly 99 % (2005) (China Environmental Yearbook Company 2006).

But these reported numbers seem to differ dramatically from the impression one receives when observing the actual pollution conditions on site. The issue seems to be that equipment may be declared to be a pollution countermeasure, but the exact details of environmental effectiveness of that equipment may be questionable.

7.2.2.2 Environmental Impact Assessment System

China's Environmental Impact Assessment Law entered into force in 2003. Under this system, before anyone implements a development project, the proponent is required to conduct an investigation and comprehensive analysis and evaluation of the social, environmental, and ecological impacts, prepare a report that describes what measures will be taken to mitigate them, and then undergo the review and approval of MOE or the local environmental bureau.

Projects subject to these rules include construction or expansion of industrial parks, construction or expansion of urban areas, planning and construction of large hydropower projects, large-scale clearing of land for agriculture, construction of transportation routes, and the construction or expansion of factories.

The environmental impact assessment report must contain the details concerning long-term and short-term impacts of the proposed projects, proposal for environmental monitoring, and economic costs of environmental impacts. The environmental impact assessment system has two dimensions: a scientific and technical dimension and a procedural dimension with public involvement in the decision-making process. Although this Chinese system applies only to projects with large environmental impacts, it proposes that proponents must listen to the opinions of citizens. A question one may pose here is how democratically and effectively this public involvement such as public hearing process is ensured in China's current political regime.

7.2.2.3 Pollution Charge System

Facilities that emit more pollutants than permitted by national or local emission standards are required to pay a surcharge (referred to as a "pollution fee" or "emissions fee") for the amount of emissions or discharges. This system has been implemented since 1979 and has 73 items under five categories of environmental

pollution: waste water, exhaust gas, solid waste, noise, and radioactive waste. For example, for reducing the total missions of SO_2, the surcharge applies to SO_2 emissions in the exhaust smoke from coal combustion.

The number of factories subject to emission fees in 2005 numbered 746,000 nationwide, and the fees amounted to 12.32 billion yuan (China Environmental Yearbook Company 2006). These figures represent a huge increase from the 6.0 billion yuan in 2000. A portion of these fees collected is provided for the budgets of environmental bureaus in the region where they are collected. A large portion of the remainder is used as funding to provide assistance for environmental protection measures of facilities.

The emission fees have a strong nuance of being a penalty for emitting pollution, and it has been pointed out that this may be sending out the message that polluters are permitted to pollute if only they pay a fee. The practical side of this from the corporate perspective is that it is cheaper to pay the fees than to pay the cost of taking measures to prevent pollution. As a means of raising funds to tackle environmental pollution, these fees are an effective tool, but there is still a debate as to whether or not this system is effective as an economic incentive to make corporations take measures against pollution (Lee 2010).

7.2.2.4 Institutional Responsibility for Environmental Protection Targets

This is a system to ask the top of local governments to set environmental targets and make *self-commitments* to achieve them. The heads of provinces, cities, and counties sign a declaration of specific environmental protection *targets* that they intend to achieve during their terms in office and to take responsibility for achieving them. Later, they conduct a self-assessment of the degree to which they have achieved their targets.

7.2.2.5 Quantitative Audits for Comprehensive Improvements of Urban Environments

This system is designed to evaluate projects using quantitative indicators of the environmental quality of cities. A point system is used to evaluate urban environmental quality using a total of 21 quantitative indicators in five areas: air quality, water quality, noise, solid waste, and urban greenery. This system is used as the standard for evaluation of the achievement of responsibilities under the System of Institutional Responsibility for Environmental Protection Targets described above. Under this system, the state government undertakes direct audits of a total of 37 cities, and provincial governments undertake the audits of 230 priority cities under their jurisdiction.

7.2.2.6 Pollutant Discharge Permit System

This is a system designed for the quantitative management and control of a total amount of environmental pollutants. The total amount of emissions of pollutants

allowable in a given area is determined, and allowances are issued to individual factories based on the pollutant emission allowances calculated to ensure that the total volumes are not exceeded. Factories that do not have an emission allowance are not permitted to operate.

In areas such as the Yellow River basin that has a shortage of water, a similar system for water withdrawal allowances is used to strictly manage the use of water.

Even with the use of the pollutant discharge permit system, the state of pollution is not improving in many places. Also, there may not be enough pollutants covered by such systems to deal with eutrophication of water bodies. There are also doubts as to whether the amount of pollution coming from factories is actually being measured and determined accurately.

7.2.2.7 Centralized Treatment System for Polluting Substances

This is a system to conduct efficient centralized treatment by accumulating pollutants into one place, instead of letting them spread out in the environment. More specifically, this method implies centralized treatment of urban wastewater in sewage treatment plants or collective treatment by constructing a wastewater treatment plant to serve a group of similar industries. In Japan, as well, there are cases where small- and medium-sized factories are gathered together into one industrial park, for wastewater treatment to be done collectively.

7.2.2.8 Pollution Treatment System with a Deadline

This system was introduced in the end of the 1970s, whereby an improvement order is issued with a deadline to companies that have emitted serious pollution. Polluting companies that fail to take pollution prevention actions even after the deadline can be subject to fines, a halt of operations, or even closure. This approach also can be used to change the location of factories and industrial structure. This system has been frequently applied recently to corporations that have caused major environmental pollution accidents.

7.3 Environmental Governance and Management in China

7.3.1 Key Issues

As shown in the above, from the institutional perspective, China's environmental management systems are well designed. Considering that China is still a developing country, one could even say that it is among the best around. However, China today is the second largest economy in the world, and it should not be simply regarded as

a developing country. In terms of the implementation and operation of the systems, there is still much to be desired. The below will describe some issues specific to the country.

- *Insufficient Human and Technical Capacity:* Even though it has excellent systems in terms of principles, when it comes to implementation, there are inadequacies in terms of personnel and technologies that form the basis for the systems. The problem is not in the number of personnel but rather in their level of education and training. Equipment and materials are also inadequate for effective environmental monitoring. Because of this, a system like Japan's pollution prevention administrator system, requiring each factory to have qualified experts, is being considered for adoption.
- *Gaps Between Principle and Practice:* The existence of legislation and regulations and compliance with them are sometimes considered to be unrelated. On-site managers are responsible to respect legislation, but it is very often up to an official's discretion whether or not to comply, and systems may not operate exactly the way intended. This is why the Chinese government is taking a very strong stance regarding corruption and bribery.
- *Inadequate Management and Operation of Facilities:* In some cases, good facilities and equipment are not being operated properly because of lack of knowledge about how to operate them or even lack of ability to change parts. There have even been reports, for example, of a sewage treatment plant that was not operating because of a shortage of electricity to run it.
- *Low Priority Given to Human Health:* Concern about injury to health due to environmental degradation may be low, because of the lack of adequate knowledge of public health concepts such as air pollution, drinking water, food hygiene, and hazardous waste. This has resulted in deficiencies in food safety management and instances in which Japan and other countries have halted imports of food products made in China (2007). More recently, rising standards of living are associated with rising public concern about the safety of drinking water, food, and air, although some businesses still have a low level of awareness.
- *Weak Local Capacity:* There are many examples of local governments that gave top priority to economic development but were deficient when it came to environmental consideration. The capacity of local governments' environmental bureaus is generally low.
- *Weak Environmental Awareness and Sense of Responsibility of Enterprises:* Environmental awareness is inadequate among business managers, particularly in small enterprises such as township and village enterprises. Some corporations cannot break free of the attitudes learned when for so many years they were operated as state-run enterprises, and their sense of responsibility is low even when damage arises from environmental pollution they have caused. Because the concept of liability and property rights is not firmly established, compensation systems for damages are also deficient.

7.3.2 China's New Era in Environmental Management

China is often described as a developing country today, even though it has become the second largest economy in the world. Made-in-China products are now being exported all over the world, and some Chinese corporations have a large market share on the global market. Foreign companies have also entered the country to participate in the Chinese market. Based on this situation, corporate social responsibility (CSR) is gaining attention, and corporate environmental management systems—a major new international trend—are being actively introduced in China.

Environmental management systems originated mainly among European corporations, which established their own internal rules for environmental management and then endeavored to implement them. But if they were going to do this voluntarily, then many expected them to establish clear and standardized rules and commit to their implementation. In response, in 1996 the International Organization for Standardization (ISO) established environmental management system standards (14001 and 14004) (International Organization for Standardization 2012).

In countries around the world today, certification bodies have been established to certify ISO environmental management systems, and it is now necessary to obtain certification on a site-by-site basis for business units. Some people may be surprised to hear that more than 39,000 sites in China have acquired certification (as of December 2009). This is larger than the number of certification in Japan (35,573), which currently ranks second, and much larger than the number of EU countries (Technofer Ltd 2009).

As we can see in this example, China is eager to introduce these new approaches to environmental management. For example, noting the principle to utilize economic incentives in environmental policies (Baarde 1994), such as environmental taxes and emissions trading, the government very quickly began to consider those ideas. China is also investigating new approaches such as cleaner production technologies, a circulation-based economy with sound material cycles, strategic environmental assessment (SEA), and other concepts and approaches, and applying them in ways suited to China. One senses that China has the attitude of desiring to learn the good things from other countries as quickly as possible—and adopt them just as quickly—as well as an ardent desire to swiftly acquire the most advanced concepts and tools from developed countries. This attitude is a very good thing, but it is important to remember that systems come with their own histories and processes that brought them into being.

The ISO environmental management systems themselves also are based on the social and technical basis that makes them able to be implemented well: they are based on experience of enforcing regulatory standards and based on a knowledge of the strengths and weaknesses of legislation and regulation. In China today, many corporations are not yet adequately implementing measures to comply with regulatory standards, and the enforcement of legislation is still far from satisfactory, so we are very interested in seeing the outcomes as this goes forward. Is it truly possible to realize environmental improvements with an ISO type of system that is based on trust in the self-controlling actions of corporations?

Japanese corporations that enter China to do business must give adequate consideration to CSR relating to the environment. With China being such a giant country, because competition with companies from the West will become more fierce in the future, CSR will be a big factor that determines a corporation's image both for Chinese companies in the global market and foreign companies in Chinese market.

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Chapter 8
Epilogue: Memoirs of China

Abstract This chapter is an epilogue of the book. It starts with memories of trips to China that gave strong impression to the author and enriched his understanding about China. Then it takes up intangibles which were not fully covered in other parts of the book. It poses a question whether China after the coming of well-off society can nurture new environmental thought and achieve environmentally sound development. It also touches upon the special feature of China–Japan relation and discusses direction of the bilateral cooperation.

Keywords China • Japan and China • Urban–rural gaps • Well-off society

8.1 Journey to China

8.1.1 Northeast China: Places of China–Japan History

It was in the early 1990s that I began to travel to China. Since then I have made numerous trips to many places in that country, but because of its vastness there was a limit to the number of places I could visit. After visiting Beijing and Shanghai, the next place I really wanted to travel was northeastern China which was once called Manchuria. This desire came to me, because as a student I had been touched by Junpei Gomikawa's *The Human Condition*, a well-known novel about the tragic fate of citizens and the soldiers who were both victims and perpetrators in a war of aggression during the Showa era politics relating to Manchuria and the behind-the-scenes activity of the Japanese military (The Human Condition (Ningen-no joken, The Criterion) 1961). The novel had really made me think about the history of China and Japan.

Also, as a child, I often heard mention of places in northeastern China—Changchun, Mukden, Dalian, and other cities—in the conversations of the adults around me. Many of them or their relatives actually had lived in Manchuria and it was just fortunate that they were able to return to the mainland Japan in the turmoil

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soon after the Second World War. Their words still echo in my mind. In 1993, I visited Dalian, Anshan, Fushun, and Shenyang (formerly Mukden). On a flight from Japan to Dalian, I overheard the conversation of neighboring old passengers. It was a group of graduates from the Dalian No. 1 Middle School, run by the Japanese during the Japanese occupation of Manchuria until the end of the war, and they were excitedly sharing stories from their childhood in Dalian. Upon arriving in town, I saw that the façade of the company housing of the former Manchuria Railway was still intact. In the center of town there was a roundabout with roads radiating outwards, with an old classic hotel on one side—formerly the Yamato Hotel—which once had hotels located in major cities in Manchuria. An old, stately building, the city still uses it to entertain guests. The former Yamato Hotel was also still remaining in Fushun, and I stayed there for a night. The room was somewhat small, but prior to the war this was undoubtedly a rare Western-style hotel.

Shenyang and Dalian still have quite a number of continental-style buildings designed by Japanese architects (Yasuhiko 1996; Yasuhiko 1999), and they somehow resemble the style of older prefectural offices such as those in Kanagawa and Aichi in Japan. The Anshan Iron and Steel Mill is the former Showa Steel Mill run by Japanese, on which construction was begun in 1918. At the time it was larger than the largest inland steel mill, run by Yahata Steel in Japan. I imagined that this was the kind of place where the main character in *The Human Condition* worked. Old equipment from before the war was still operating, and the smell of smoke from the steel mill hung in the air in town. In the evening, I went down into the street, where the air pollution made it hard to breathe. In the local public square were a few hundred men and women enjoying Western-style ballroom dancing.

In Fushun there was an open-pit coal mine with a spiral-track rail on the gentle conical slope of the gargantuan pit, and on the tracks was a train carrying coal. China's steel industry has major centers in many places around the country, including Shanghai, Taiyuan, and Changchun. They are located that way partly to be close to the sources of coal and iron ore—the essential raw materials to make steel—but it was also part of the strategy of Mao Zedong's era to ensure that each region could be self-sufficient in the case of war. More than anything, a rapidly growing China today needs steel. Providing that steel are plants that range from the modern mills of Bao Steel in Shanghai to those like the large but aging mills of Anshan Iron and Steel. When Chinese domestic production could not keep up with demand, the Japanese steel industry sometime boomed for exporting their product to China.

8.1.2 Huaxi Village: China's No. 1 Village

The first place to succeed in starting a factory to make metal goods from recycled scrap iron is Huaxi Village—labeled "China's No. 1 Village"—in the southern part of Jiangsu Province. It was at first a small village of just less than 400 houses in a rural setting, but the factory met with great success in quietly running as a side business in the village before the country's economic reforms began (Huaxi village 2012). One gets the impression that everyone here is wealthy, as every household in

the village has a car, and, apparently, all their children study abroad. They do not make particularly high-end products, but it was the rapidly rising demand for consumer goods that brought them success.

I first visited the village in 2000. At that time the village was still small with two thousand villagers and had only one tall building amid the typical agricultural fields. I visited the site again in 2012 and was surprised by a number of skyscrapers standing in the middle of rural area: the tallest one called the Zengdi Kongzhong is 74 stories high. There are also houses newly built for more than twenty thousand migrant workers.

This town is a model of Deng Xiaoping's theory of letting some regions prosper before others. But it is posing a question about the distribution of wealth: it is only the family members of old Huaxi Village that are wealthy as shareholders of the village-run company, and migrant workers and nearby villagers are mere workers although they are lucky to have jobs there.

8.1.3 Dunhuang

Another novel that stoked my imagination about China was *Dunhuang* (or *Tunhuan)*, by Yasushi Inoue. It is a work of superb historical mediation on the mystery of the thousands of Buddhism documents found in the famous *Mogao Caves*, also known as the *Caves of the Thousand Buddhas* (Inoue et al 2010; New York Review 2013). To get to the oasis city of Dunhuang in the desert, first I flew to Urumqi in the Xinjiang Uyghur Autonomous Region and then took an overnight train before arriving. The scene from the train was a desert of dirt and rocks. From the train station to the town, I traveled more than 100 km by car, and on the way I saw a mirage. The ground was white, damaged by salt.

In Dunhuang on that September day the weather was comfortable and the shade refreshing. The population that this oasis city can sustain is limited to a few tens of thousands of people. The use of water here is not sparing: groundwater is used for agriculture here, and during a meal I was presented with some fish, which I was surprised to find came from a fish farm in the city.

There are also solar energy research facilities here. In Japan, research was conducted on Yakushima Island about the potential for self-sufficiency in energy and resources. From this perspective, I think the research on Dunhuang about its input and output of energy, food, and other resources seems quite interesting.

8.1.4 Yellow River and Yangtze River

One of my academic research topics relates to economic development and the supply and demand for water resources in the Yellow River basin (Kusuda 2010). In connection with that work, I have visited many places in the basin, including Xian which was long ago called Zhonyuan. When I see the scenery at famous historical

places, I feel like I am peering at layer upon layer of history. Perhaps it is because I have read *Xiang Yu and Liu Bang* by Ryotaro Shiba (Shiba 1984) and many famous stories in *Shiji* (*"Records of the Grand Scribe"*) by Sima Qian (or Ssu-ma Ch'ien) which were set in the Spring and Autumn Period/Warring States Period and Han Dynasty Period (Chinese 2013; Watson 1958).

The area around Taiyuan in Shanxi Province has many historical sites of the mighty *Jin* powers during the Warring States Period, so car license plates today carry the *Jin* symbol. And license plates in Shandong Province bear the symbol of *Lu*, the country where Confucius was born. Having traveled there, I can now more easily imagine the scenes in this land long ago, when the countries of *Qin*, *Jin* (later divided into *Zhao*, *Wei*, and *Kan*) and *Qi*, *Chu*, and *Yan* went through many tribulations of diplomacy and warfare, and reading novels about them now has become even more interesting.

The place where the Yellow River, flowing from the west, makes a sharp turn to the south is the northern part of the Loess Plateau, near the borders of Shaanxi Province, Shanxi Province, and Inner Mongolia. Long ago, this was where the nomads lived, and it was also the battleground for wars between them and the agrarian Han tribes. Although this arid land receives little rain, irrigated farming today makes it possible to have expansive farms in the Hetao Irrigation District and others like it. Here also, a highway cuts across the land from east to west. This is the route from Beijing to Lhasa in Tibet via Hohhot in Inner Mongolia. The age is now here in which people can traverse the land by highway where only horses once galloped. There is little traffic on the highway through Inner Mongolia, but roads become congested as we approach to the Beijing area.

I had really hoped to travel by boat on the Yangtze River before the Three Gorges Dam was completed and the reservoir was filled, but I missed my chance. I had agreed to a Chinese friend's proposal to hold a seminar on board a boat, but we were not able to arrange our schedules to make it work. Nevertheless, I was fortunate to have another opportunity to travel by boat to the world-famous Guilin. I was fascinated to see the people of ethnic minorities living along the riverbanks. Recently, a Chinese friend has invited me to visit Qinghai Province. Efforts are underway to preserve the precious environment there, a treasure trove of biodiversity that also happens to provide the ingredients for medicinal plants. The photos I have seen of the fields of flowers are very impressive; in the sunshine the golden flowers seem to be large sea.

8.2 Well-Off Society: Can it Create a New Environmental Thought

8.2.1 Grow First, Clean Up Later

Many high-end villas have appeared on the outskirts of Beijing, and a new wealthy class of people drives there by car on weekends. In scenic locations on the outskirts, new "ecological farms" and "nature villages" have been constructed, and a growing

number of people are attracted here to seek a connection with nature. People in China say that their country has come of age as a "well-off society." Somehow there are many similarities here to the dominant mentality in Japan during the period of rapid economic growth in the 1960s.

Things seem to change so quickly in China now, and everything is hectic. Incomes are higher and people's purchasing power has grown stronger; if you make something, it will sell. But protection of the environment and product safety tend to be an afterthought. The country is too big, so the hand of proper governance cannot reach everywhere, and the government itself is dragging its feet—so much so that some problems escalate to the point of causing damage to people's health and becoming international concerns. Cities are seeing labor shortages, and they act as a magnet attracting multitudes from the countryside to find work. This too resembles Japan during its own period of rapid economic growth, when the cities absorbed rural laborers, who left their villages behind with declining populations.

8.2.2 Urban–Rural Gaps

In the case of China, the rural population is still too big, making the problem of excess farm labor a difficult one to solve. The urban–rural disparities seem unlikely to shrink. The national economic growth rate has been almost 10 %, but in the coastal areas, cities like Ningbo and Weihai had annual growth rates of 20 % or even larger. The cities are being built quickly, and the lives of citizens are growing more affluent—just visit in person and you will feel this tangibly. This is a country without elections; mayors are chosen by the province or by the state. If your results as mayor are good, you can be promoted, and the most important thing for getting good results is to be successful in attracting foreign companies. If your city is on the coast and has port facilities, these are advantages, as foreign companies can be attracted without much effort. But the further inland your city is, the more difficult it becomes. Thus, cities located far inland from the coast force impractical development projects upon their people.

The farmers struggle with the authorities, and injustices and corruption easily occur. One situation that can cause injustice, according to some observers, is the peculiar Chinese conception of the law: rather than the rule of law, it is the rule of men that applies. In the enforcement of laws and regulations, local governments are left with a considerable degree of discretion, it is said. In rural villages, money is collected from the people through the overcharging of fees. Without any significant industry, many villages have little source of revenue and cannot even pay the salaries of teachers in the village school. The authorities create some excuse and collect money from the farmers. In reality, it is a tax increase, and often the money is improperly used by the village leaders. There have been many such cases, and many disputes with angry farmers. Something similar also occurs in cities, I am told. For instance, managers of new factories are asked by the authorities to pay a special fee on some false pretext. We hear that things have a little improved recently, but the application of rules is still discretional up to the decision of local governments

8.2.3 Disconnection of Theory and Practice

When considering the issues of China, it is always useful to think in terms of two extremes—the gap between the advanced and the backward (or underdeveloped) and the disconnection between theory and practice. That is what it's all about. We should not look only at those things that are more advanced and progressive lest we overestimate the situation. And at the same time, we should not point out only the things that are backward. I have a Chinese friend who says, "Chinese people are great at working as individuals, but Japanese are great at working as a group." Perhaps that is a good observation about the differences between Chinese and Japanese ways of doing things. Generally speaking, Chinese persons assert themselves quite strongly as individuals. This differs generally from the Japanese who by nature seem to put an emphasis on harmony. This plays out when it comes to dealing with the environment as well.

Take, for example, the way the Japanese government dealt with industrial pollution in the 1960s. After consensus was reached in what was called the "Pollution Diet" (an intensive parliamentary session completely focused on dealing with the crisis of industrial pollution at the time), the government and companies moved very quickly to address the problems (Imura and Schreurs 2005). In China meanwhile, because of its political regime ruled by Communist Party and strong individualism, the top-down approach from the government seems to be more effective. Once the leader makes a firm decision, people will act. In Japan, Japan's way, in China, China's way—each has its own approach to producing results.

The thing that Chinese leaders are concerned about is that China may be treated as an outcast in international society. It appears as if the cold reaction from international society about the government reaction to the Tiananmen Square protests of 1989 actually had considerable effect.

8.2.4 China Council or CCICED

What is called the China Council (short for "China Council of International Cooperation on Environment and Development," or CCICED) was launched in 1992 as an attempt to reopen the lines of communication with international society after the Tiananmen massacre. The Canadian International Development Agency (CIDA) and other organizations from multiple countries provided funding for a series of studies and meetings on the theme of environment and development. High-level persons from countries of the world became members of the council and made proposals directly to China's leaders (CCICED 2012).

Under the parent council, task forces were created with a variety of themes, and I participated in some of these. After 1997, I participated in discussions about how environmental consideration should be incorporated into the Tenth Five-Year Plan, which went into effect in 2001. Later, I had the opportunity to participate in the

"Task Force on Financial Mechanisms for Urban Environmental Management" and "Task Force on Ecological Compensation" as the international co-chair. After the plenary session of the council, we had meetings with the Chinese premier in either Zhongnanhai (a complex of buildings in Beijing that houses the central headquarters of the government) or the Great Hall of the People (similar to the Diet Building in Japan and parliament buildings in other countries), though admittedly it was in groups and for short periods of time. Thanks to these opportunities, I had the good fortune to have an audience with both former Premier Zhu Rongji and Wen Jiabao.

8.2.5 Special Feature of China–Japan Relation

Anyone present where the top leaders of China and experts from Japan and the West are together discussing matters may recognize a difference in perspective between Western people and Japanese regarding China as a country. Conversely, one may also notice a difference in the Chinese attitude towards Western countries compared with the Chinese attitude toward Japan. Perhaps it is because both Japan and China are neighboring Asian countries. More probably, it is because of the adversity experienced in the Sino–Japanese war. At any rate, it is a complex relationship. One gets the impression that Western countries can have a more straightforward relationship with China.

Furthermore, anyone who has participated in meetings like this every year can clearly see that China has gained a sense of confidence along with its economic growth. The tone of seeking advice or assistance from foreign countries has quickly faded, and in its place, one now sees a sense of self-assurance among the Chinese when they say that they will do on their own what must be done. Furthermore, there is now less of a role for Japanese official development assistance as a basis for Japanese interactions with China. Japan must seriously think about the political and economic relationships with China, identify the fields or sectors in which it can contribute to environmental management in China, and must also think about Japan's advantages or strengths in comparison with the countries of the West.

8.2.6 Chinese Corporations and International Code of Conduct

From now on, private sectors will have a more important role to play in the area of environmental management. Chinese corporations can no longer flaunt indifference to the Western style of corporate social responsibility (CSR). For instance, international criticism erupted when food products and pharmaceuticals made in China were found to contain toxic substances. The Chinese government takes notice and gets concerned. But many Chinese companies are still indifferent. Some people

have said that the problem is with the government, as it is in the position to regulate and monitor corporations. The critics say that even if the government creates legislation and standards, the systems to regulate and monitor corporate compliance are inadequate.

If you look only at the outward appearance of China's environmental management systems, they may compare favorably with those of developed countries. But there are serious problems if the system fails to function properly no matter how many times the government encourages corporations to comply. During the 1960s and 1970s in Japan as well, there were thousands of pollution crimes every year such as nighttime discharge of untreated toxic factory effluent. In fact even today, the illegal dumping of industrial waste shows little significant sign of decline, so Japan cannot pretend to be perfect. Yet no matter how many laws and regulations are created, they have no effect if there is no ethical standard to comply with them. Therefore, environmental ethics and market forces are needed that will cull out those corporations that have little CSR awareness. Consumers must also be vigilant to ensure better corporate behavior. Where mechanisms such as these do not function, there will always be companies that believe they can do anything as long as their transgressions are not discovered and also believe that they can get away with a light penalty even if a transgression happens to be discovered.

8.3 Environmental Data and Information

8.3.1 Statistical Yearbooks

One thing that may surprise a person about China is the situation relating to statistical data. The *China Statistical Yearbook* and other statistical reports are published every year, and anyone can even access them for free via the Internet (National Bureau of Statistics of China 2012). Other statistical yearbooks are also published annually in various sectors, such as the *China Environment Yearbook*, the *China Energy Yearbook*, and the *China Transportation Yearbook*. Similarly, statistical yearbooks are published in each province and city around the country.

Proper structures are well in place to collect and compile statistical data. Examples of such a level of organization for statistics are rare in the world and beyond imagination in developing countries. Almost all of the statistical data used in this book are based on these types of statistical yearbooks. Nevertheless, some doubts have been raised about the reliability of Chinese statistical data. An observer may in some respects agree with such an opinion, but there will be little merit in doubting in totality all of the data published by the government. When a person has discovered an apparent contradiction in data, the best thing to do would be to attempt one's own careful analysis, though at times that is difficult to do. The original data that served as the basis for the published data may not be available at all, and even if you could obtain it and compare, you may not be convinced of its accuracy.

8.3.2 Need of Environmental Monitoring Data

Environmental monitoring of air and water is conducted by local governments, and data are sent to the center (Ministry of Environment). The number of monitoring stations is not enough, however, compared with the large size of land area to be covered, and there has not been a system to assure the data quality and reliability. For most cities, raw data such as hourly values of air pollutants have not been systematically collected, and even in the case that measurement is conducted, the data have not been released properly; many of such data were treated as confidential and public access to data was limited.

The heavy air pollution which happed in Beijing and other cities in October 2011 and January 2013 aroused people's concern about the environmental monitoring data; the level of air pollution reached a hazardous point to cause serious effect on human health, but the proper data were not made public. It was too late; however, China started to issue daily report on air quality in 74 major cities by adopting more extensive monitoring standards, adding new items such as PM 2.5.

In addition to local governments, large industrial corporations must also invest in environmental monitoring to deal with their own pollution problems. Environmental protection sector including environmental monitoring and analysis is growing in China, due to increasing public and government concerns on environmental pollution.

Public access to environmental monitoring data is a key for people to know about the quality of air they breathe and water they drink. People's "right to know" is generally limited in China due to its special political system. People want to know more, and government will be forced to publicize more data. Then, there will be a crucial question about the accuracy and reliability of the data government publishes.

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Dr. Hidefumi Imura, Emeritus Professor, Nagoya University After Hidefumi Imura received his doctoral degree (1974) in applied physics at the University of Tokyo, he joined the Japan Environment Agency and subsequently worked for the Ministry of Foreign Affairs and the Yokohama Municipal Government. After 14 years of being engaged in environmental policymaking in national, international, and local institutions, Dr. Imura moved to Kyushu University in 1988, where he was a professor at the Institute of Environmental Systems until August 2000.

From September 2000 until 2011, he was a professor at Nagoya University, moving to Yokohama City University in 2011. Dr. Imura has a wide range of expertise covering domestic and international environmental policy issues, environmental technologies, economics, and information on Japan, China, and other East Asian countries. His research focuses on energy and material flow analysis of human activities in cities, life-cycle assessment of civil infrastructures, and modeling of human and environmental interactions. Dr. Imura served as a lead author of Working Group III of the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

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