20 Environmental Quality and the Sustainability of Growth

For centuries the pressure of population on China's limited natural resources has led to severe environmental degradation. A hundred years ago most of China had already been stripped of forests. Modern economic growth has created another set of challenges, creating massive pollution and apparently unsustainable demands on natural resources. Many regions of China present a picture of rapid economic growth and severe environmental damage. How serious are China's environmental problems? Do they threaten to undermine the progress being made toward a higher quality of life for the majority of Chinese citizens? This chapter provides an introduction to China's environmental problems without attempting to provide a definitive answer to these questions.

Economists frequently view environmental issues through the lens of the "environmental Kuznets curve." According to this conception, pollution and other environmental problems worsen during the early stages of economic growth and then begin to improve as a country reaches middle-income status. There are technological and preference-related arguments for this pattern. In terms of technology, early stages of industrialization often involve rapid spread of relatively crude production techniques that, while relatively easy to master, produce lots of by-products and pollution. Subsequently a broader technological capability gives access to cleaner and more efficient production techniques. In terms of preferences, poor people understandably place priority on economic growth to increase income and consumption. Public environmental quality is a "luxury good," and demand for environmental quality at low income levels is therefore initially limited, but it increases rapidly as incomes grow above a certain level. This viewpoint implies a certain degree of optimism about environmental problems, because it suggests that countries will develop the means and the will to tackle their own environmental issues as they develop.

There is considerable debate as to whether the environmental Kuznets curve accurately describes the variety of developing-country experiences

(Stern 2004). Nevertheless, it is a good tool for organizing a brief discussion of China's environmental problems. Clearly, China has experienced significant environmental deterioration over the past 20 years. Thus there is evidence to support the idea that China is on the downslope of the Kuznets environmental quality curve. But the Kuznets curve reminds us of that ultimate environmental quality is the outcome of many contending economic, technological, and social forces. There have been significant areas of environmental progress in China over the past 20 years, and there is growing concern among the population and in government policy-making circles about environmental problems in China. The capability to analyze environmental problems and the ability to implement and pay for cleaner and more efficient production techniques have grown. It is sometimes said that China's breakneck growth has been purchased at the cost of the environment but this contrast is far too simple. Growth has worsened many environmental problems but development has also brought China the means to address other environmental problems. We cannot yet discern whether these contending forces have enabled China to turn the corner to the upslope of the environmental Kuznets curve.

Emblematic of the growing environmental awareness in China is the growth of a national environmental policy and administrative structure. Environmental agencies were created during the 1980s, and the National Environmental Policy Agency (NEPA) gained administrative independence in 1988. During the March 1998 government downsizing, environment bucked the small-government trend, and the renamed State Environmental Policy Agency (SEPA) was promoted to ministerial status. Local governments down through the county level all have environmental bureaus. NEPA (1993) laid out a daunting list of China's major environmental problems, all of which are likely to have long-term effects both on natural ecosystems and on economic growth.

We can divide environment problems into two broad groups (Figure 20.1). The first group refers to pollution in the broad sense. Pollution causes the largest current costs. Urban air pollution causes more than 100,000 excess deaths annually, and millions of dollars in health costs. China's air is dirty, and getting dirtier. At the same time, pollution is the aspect of the environment most susceptible to a degree of optimism based on economic development and changing population preferences. China's urban air today is not dirtier than the air in major Western cities in the 1950s, and China's citydwellers are beginning to demand improvements in the air they breathe. The second group refers to the sustainability of resource use. In these cases, economic activities result in impairment of the natural system's ability to replenish itself, but the costs of this resource depletion are not necessarily apparent in today's economy.

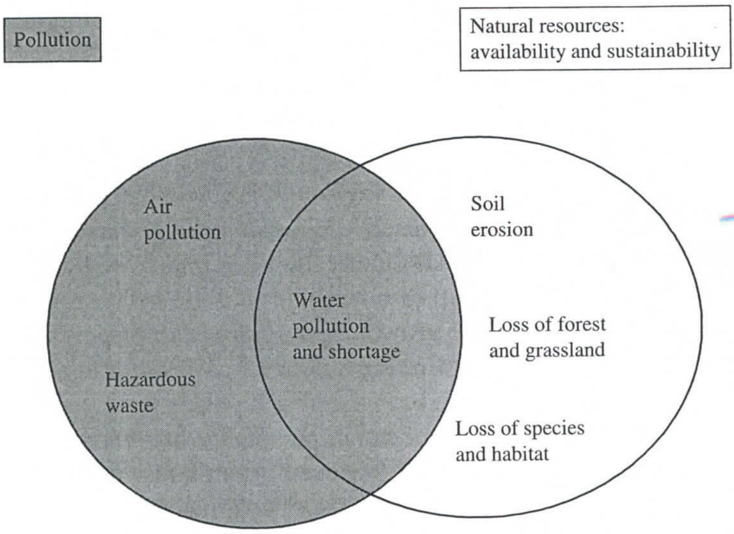

Figure 20.1
Pollution and resource sustainability

Indeed, some degree of depletion of resources might never lead to problems. However, because we do not know exactly where the boundaries of excess depletion begin, or what the carrying capacity of the system will turn out to be, these sustainability issues might present the greatest long-run challenges to well-being. Water is the critical resource in both groups, because it is highly polluted and currently being exploited in an unsustainable fashion. Water is the most important area of intersection between pollution and sustainability concerns. The other area of greatest long-term concern is the impact on the atmosphere from China's enormous and growing reliance on coal for energy production. Even though China has greatly improved the efficiency with which it uses coal, its rapidly growing economy will steadily increase that amount of coal it uses, produce more local air pollution, and contribute to greenhouse gases and global warming.

20.1 POLLUTION

Air and water pollution are damaging to human health, worker productivity, and agricultural output. As the scale of the economy has grown, total waste production has grown. Coal use has doubled since 1990, with production over 2 *billion* tons in 2005. Coal burning discharges particulate matter, sulfur dioxide, and greenhouse gases into the air. Energy consumption, in the form of coal, biomass, and petroleum products, is responsible for most air pollution. At the same time, some efforts to control pollution have begun to have an affect.

20.1.1 Air Pollution

In China's cities today, particularly the larger ones, trends in air quality are shaped by offsetting forces. Air quality has been improved by industrial emission controls and by the shift in household fuel use away from coal. But the growth of industry and the growth of automobile transport are causing an increase in pollutants. The resulting outcomes have differed across cities and specific pollutants.

A major source of improvement in air quality has been the reduction in household use of coal. Until recently even urban households burned coal for heating and cooking, but household use of coal has dropped off dramatically from its peak in 1988. Eighty percent of the urban population now has access to gas for cooking. Indoor air quality in many urban households has improved significantly as gas, electricity, and central heating have spread. In rural areas, indoor air pollution is still a severe problem. About half of the rural population has unimproved stoves that burn raw coal and wood and produce particulates, sulfur and nitrogen oxides, carbon monoxide, and other pollutants. Indoor air pollutants contribute to high rates of respiratory disease, the leading cause of death in rural areas and the third-leading cause in cities.

Ambient (outdoor) air quality has improved in many cities, particularly due to the reduction in total suspended particulates (TSP). Despite the increase in the use of coal, the primary source of particulates, TSP concentrations have declined due to controls and change in the way coal is exploited. A much larger proportion of coal is now burned to generate electricity, in larger and better-equipped facilities. Sulfur dioxide emissions have remained roughly constant, however, because sulfur control measures have not been effective enough to offset growing coal use. Ambient concentrations of particulates and sulfur dioxide in many Chinese cities are among the highest in the world and are significantly above World Health Organization (WHO) guidelines and Chinese air quality standards.

The biggest negative impact on air quality has come from the dramatic increase in trucks and automobiles. The total number of vehicles in China soared from 5.5 million in 1990 to 43 million in 2005 (including 11.5 million motorized tricycles and other low-powered vehicles). Motor vehicles emit particulates, sulfur, carbon monoxide, nitrogen oxides, and volatile organic compounds. Lead is an especially pernicious pollutant because of its irreversible effects on children's intelligence and aptitudes, and China did not eliminate leaded gasoline until 1999. Nitrogen oxides, a major byproduct of the internal combustion engine, have increased steadily since the 1980s. Nitrogen oxides contribute to the formation of ozone, photochemical smog, and greenhouse gas. The European Space Agency recently completed a global mapping project, in which satellite instruments were used to map nitrogen oxide densities for 18 months from 2003–2004. The largest global concentration of nitrogen oxides is the North China Plain, with the area around Beijing in particular standing out. North China now surpasses the northeast United States, where nitrogen oxide emissions are large, but stable (Beirle, Platt, and Wagner 2005). Overall, Chinese cities have become smoggier but less gritty in the past 20 years.

20.1.2 Water Pollution

Since 1980 the quality of China's surface water and groundwater has deteriorated significantly under the pressure of rapid industrial development, brisk population and urban growth, and increased use of chemical fertilizers and pesticides. As a result, water pollution is now a serious problem for urban and rural drinking water. Main sources of pollutants include the following:

Industrial Waste. Pulp and paper, metallurgical, and chemical factories are the worst polluters. Processing of farm products contributes to oxygen-demand pollution, in which water is depleted of oxygen and loses the ability to support healthy plant growth. There has been major progress in cleaning up large-scale factories, and today 90% of industrial wastewater from regulated (large-scale) industries receives some kind of treatment. However, smaller factories, including township and village enterprises, often have no treatment facilities at all.

Municipal Waste. A decade ago almost no municipal sewage was properly treated. A major push has been undertaken to improve sewage treatment, but still only a reported 42% of municipal wastewater was treated in 2003.

Agriculture. Intensively used nitrogen fertilizers and pesticides are a serious source of water pollution. Poor-quality fertilizers, excessive use of nitrogen fertilizers (relative to phosphorous and potassium), and especially widespread use of cheap ammonia bicarbonate fertilizer, which is readily soluble and easily washed out to streams, lakes, and aquifers, add to the impact. Pesticide use, more widespread in recent years, has been implicated in species loss (birds) and has polluted some important water bodies. Animal waste from livestock farms is another major source of biological oxygen-demand and coliform pollution. The ecological balance of Hangzhou Bay is seriously threatened, primarily by agriculture-related runoff, which, according to one study, contributed 88% of chemical oxygen-demand pollution.

As a result of these pollutants, water quality is poor, especially in the water-short northern regions. Table 20.1 summarizes the available data. Water quality below class V means that the water is literally toxic: obviously unsafe for human contact, it is unsuitable even for irrigation, and cannot be safely purified for human uses. In the Liao, Hai, and Huai systems, half the water is in this category, as well as a third of the Yellow River. (See Figure 20.2, which shows these river systems.) These rivers have all three of the biggest pollution problems. Waters turn eutrophic from biological oxygen demand and chemical oxygen demand: depleted of oxygen, waters can only support bacteria and flagellates, and no higher life forms. Persistent heavy metals, such as chromium, mercury, and lead, build up in the water and riverbeds. Chlorinated hydrocarbons (such as PCBs and DDT—banned but still used) build up and are also highly persistent. Class IV waters can be used for industrial and some recreational purposes but is not fit for direct human contact. Class III is the standard for direct human contact, and also for intake into purification for drinking water. Class I is pristine. In northern China the water in only about one-third of the river length meets the standard for human contact. Moreover, this is the entire river system; quality is much worse in the downstream, urban areas where most people live.

Water shortage in the north severely compounds the pollution problem. During dry periods local water-use agencies keep water dammed up to retain water for local users, but in doing so they trap all kinds of pollutants. When the first rains come, gate operators open the dam gates and flush their sections of the river, but in so doing they send a highly polluted waste stream into the main river channel. In recent years authorities have reinforced regional coordination to reduce this problem and ensure continuously flowing (and flushing) rivers. As of 2004 the Yellow River had flowed without interruption for

Table 20.1
Water quality class of main river systems, 2003

	River length (kilometers)	Percentage of total distance in each quality class					
		Class I	Class II	Class III	Class IV	Class V	Below V
National	134,593	5.7	30.7	26.2	10.9	5.8	20.7
Songhua	11,135	0.9	9.2	35.5	32.4	5.2	16.8
Liao	4,529	1.6	8.8	17.6	8.6	13.5	49.9
Hai	10,719	3.1	17.3	18.2	6.1	2.8	52.5
Yellow	13,721	7.6	14.1	11.8	17.7	16.8	32.0
Huai	11,621	2.1	8.8	16.8	15.4	8.0	48.9
Yangtze	38,513	8.9	37.3	31.3	6.4	5.8	10.3
Pearl	16,061	2.0	47.2	25.7	9.2	2.1	13.8

five years, reversing the previous pattern in which the river water would be exhausted most dry seasons. Yet these efforts have not yet produced significant improvement in the overall quality of the Yellow River.

The experience in the Huai River basin has been especially alarming. A surge of polluted water on the Huai River in 1994 killed massive numbers of fish, caused widespread illness, and forced municipal and industrial water intakes along the river to shut down. Economy (2004) describes how this event shook up central government leaders and induced them to launch a massive program to clean up the river. Premier Li Peng declared that the Huai would be clean by 2000. Some 60 billion RMB ($7.2 billion) was poured into pollution control in the Huai River over the next decade. However, this expensive program failed utterly to meet its ambitious goals. Indeed, as Table 20.1 shows, the Huai is still one of the most polluted rivers in China. Despite the money made available, local governments protected their local industries and shielded them from costly upgrades or shutdowns. Water quality improvement has been imperceptible.

Southern rivers are less polluted, largely because of the region's more abundant water and the rivers' larger assimilative capacity. Nevertheless, there are many seriously polluted areas. The section of the upper Yangtze River near Chongqing was found in 1993 to have failed NEPA standards for chemical oxygen demand, chromium, mercury, lead, ammonia nitrogen, petroleum, acidity, and coliform. One of the worries associated with the Three Gorges Dam is that it will trap pollutants around the densely populated Chongqing area.

20.1.3 Costs of Pollution

Air and water pollution damages the health of people exposed to it, lowers the productivity of workers, and degrades natural resources. What are the costs of these damages, and which damages should worry Chinese policy-makers the most? A number of studies have attempted to quantify the costs of pollution to the Chinese economy, without achieving much consensus.

World Bank (1997) was an ambitious attempt to calculate the costs of pollution in China. According to this study, total air and water pollution costs were estimated at $54 billion a year, or roughly 8% of GDP. These costs do not make the growth rate lower or less meaningful; instead, they are ongoing costs that reduce the well-being of China's population in every year. The largest losses were due to

- Health losses associated with urban air pollution—particularly debilitating chronic bronchitis

- Health losses associated with indoor air pollution
- Chronic disease from water pollution—especially heavy metals and toxins
- Crop and forestry damage from acid rain
- Nervous system damage and reduced intelligence among children exposed to high levels of lead.

The study calculated that the total health and productivity losses associated with urban air pollution, including hospital and emergency room visits, lost work days, and the debilitating effects of chronic bronchitis, cost more than $20 billion a year, making them the single largest pollution cost in China today. It would be possible to avoid 178,000 premature deaths each year if China met its own class II air pollution standards, and 4.5 million person-years are lost because of illnesses associated with urban air pollution levels that exceed standards. Estimates based on conservative assumptions about indoor air pollution suggest that it causes 111,000 premature deaths a year. The health problems caused by indoor fuel use are on a scale roughly comparable to that posed by smoking. Water pollution damages human health, fisheries, and agriculture (from polluted irrigation water) and increases spending on clean water supplies. Improvements in water supply and sanitation can substantially reduce the incidence and severity of diseases, such as hepatitis, as well as the infant mortality associated with diarrhea. Surprisingly, though, water-related diseases are less common in China than in other developing countries, and they appear to be a less significant cost than respiratory diseases plausibly related to air pollution. There are other hidden costs to pollution. For example, China is estimated to have at least 5,000 so-called brownfields—chemical- or solid-waste dump sites. Virtually none of these have been cleaned up, and little is known about the potential costs.

20.1.4. Pollution Control

China put into place a significant pollution-control effort during the course of the 1980s. The resources actually flowing into that effort, stepped up considerably after 1997–1998, when the combination of government reorganization (which made SEPA into a national ministerial-level organization) and a series of environment-linked disasters, including flooding on the Yangtze, increased the priority given to the environment. Overall, Chinese official data indicate that 1.4% of GDP went into investment in pollution control in 2003, a substantial sum. The bulk of this went for urban infrastructure, with water and sewage the largest chunk, followed by greenification. Lesser amounts go to abate industrial pollution and fit new factories with pollution control equipment (Environmental Statistics 2004, 7, 96).

China was an early adopter of a system of fees for discharges of pollutants. That system has generated a steadily increasing flow of funds that are earmarked for pollution abatement. The total sum surpassed 6 billion RMB (about $750 million) in 2002. Pollution fees have some obvious benefits, since they encourage firms to find least-cost methods to improve their environmental performance. Chinese fees have been criticized, however. Fees are frequently rebated to the polluting firm in order to fund investment in pollution abatement, but oversight of actual spending is weak. Corruption and diversion of fees have been a problem in some areas—moreover, local environmental officials actually have an incentive to keep polluters polluting, since allowing these practices to continue generates revenues for them. Nevertheless, some important achievements have been made. Generally speaking, the abatement of industrial wastes from large factories has been a relatively positive part of China's environmental policy. According to SEPA (2004), total wastes have stabilized even as industrial output has grown sharply. Total industrial pollution of water, as measured by chemical oxygen demand, has declined somewhat. Industrial heavy-metal pollution has declined very significantly since 1997, and discharge of petroleum products has been significantly reduced. If maintained, these are significant achievements.

20.2 SUSTAINABILITY

Not all environmental problems can be traced to pollution, nor can they be appropriately evaluated in terms of their current costs or expressed as a percent of GDP. Critical environmental problems in China relate to the coordination of enormous demands on China's natural resources. These problems are more difficult to quantify because a large but unknown share of costs are deferred to the future. There are no markets that reflect the true costs of activities. In some cases, designing such markets would be difficult or impossible. In other cases, because China is a transitional and a developing economy, markets are simply incomplete. There is a significant danger that slowly increasing costs might suddenly reach a "tipping point": Rather than increasing in a linear relation with demands on resources, costs may increase qualitatively once the level of "carrying capacity" of an environment is reached.

20.2.1 Broad Impact of Pollution and Global Warming

As China's economy has become large, the implications of Chinese pollution and resource use have also grown. Air pollution, for example, has regional and global consequences. When fossil fuels are burned, oxides of sulfur and nitrogen combine with other chemicals in the air to form sulfuric acid and nitric acid, which precipitate as acid rain. These gaseous emissions can stay in the atmosphere for several days and travel hundreds or thousands of kilometers before falling back to the earth's surface as acid rain. Acidity is highest in southern China, particularly in Sichuan, Guizhou, Guangxi, and Hunan, both because of extensive use of high-sulfur coal and because of naturally acidic soils.

China is a significant contributor to the problem of global warming. China is the second-largest source of greenhouse gases, after the United States, and its carbon emissions are growing rapidly. By most estimates, China accounts for about 15% of global carbon emissions, compared to 23% for the United States. As described in Chapter 14, the breakdown of Chinese statistical reporting led to a significant underestimate of coal use at the end of the 1990s, which led to excessive optimism about China's ability to limit carbon emissions. We now know that total carbon emissions have continued to grow. Assuming that Chinese statistics for 2005 accurately measure total coal production, as seems likely, then China's production of coal energy—and thus carbon emissions—have been growing since 1996 somewhat *faster* than they were growing before 1996, at 5.1% annually compared to 4.6%. At this growth rate, China will catch up with the United States and become the largest single contributor of carbon dioxide emissions some time between 2015 and 2020.

There is significant debate about China's role in a global climate-control regime. In the Kyoto Treaty, developing countries including China and India are not required to control their carbon emissions. Critics of the treaty argue that no global regime can be meaningful without Chinese and Indian participation. Chinese policy-makers have argued, in the general spirit of the environmental Kuznets curve, that development should come first, and that developing countries should be unconstrained during the development process, deferring their contribution to this global public good until a later date. They also point out that even when Chinese carbon emissions catch up with those of the United States, per capita carbon emissions will only be one-quarter the level of the United States. In the middle ground are those who point out that China, since it contains pockets of extremely backward technique, presents opportunities for reduction of carbon emission at potentially extremely low cost. An international regime that would create incentives for China to abate, either through tradable emissions credits or through alternative mechanisms, would be in the interests of all parties.

China continues to be a relatively energy-intensive economy. As described in Chapter 14, China in 2002 required about 0.23 kilograms of oil equivalent to produce one dollar of PPP-adjusted GDP. That figure compares to about

0.15–0.25 kilograms for a number of large lower- and middle-income industrializing countries. China's energy efficiency is likely to continue to improve, since over the past 25 years China has been steadily reducing the amount of energy input required to produce a given value of GDP. There are still many opportunities to improve energy efficiency. However, it is likely that China will remain a comparatively energy-intensive economy. The fundamental problem is China's enormous dependence on coal for power generation (Chapter 14). Coal is cheap to burn, but much more expensive to burn cleanly. Some areas of coastal China will shift to imported petroleum products, and there is scope for alternative and less-polluting techniques. However, most parts of China will continue to be dependent on coal for the foreseeable future. Improvement, therefore, must rely on a combination of more-efficient coal use (especially through concentration in larger and cleaner electricity-generation facilities) combined with larger investments in pollution-control equipment. In addition, the fact that China has such an extraordinarily large share of its total output in industry (Chapter 6) also inevitably implies higher energy use per unit of GDP. Industries such as steel, cement, and chemicals are by far the largest users of energy in an economy. It seems inevitable that Chinese greenhouse gas emissions will continue to grow and eventually make China the largest single contributor to global warming. In the meantime, global warming is already a reality.

20.2.2 Sustainability of Land and Water Resources

Further broad issues of sustainability relate to the intertwined questions of sustainability of land and water resources. Since China has virtually no unexploited potentially arable land, any reductions in existing farmland must be viewed very seriously. At the same time, the productivity and value of existing (and remaining) farm land has been increasing. Simple land availability is unlikely to be the major obstacle to agricultural output or food availability. In addition to conversion of agricultural land to nonagricultural uses (housing, roads, and factories), degradation of farm land is a substantial cause of the reduction in farmland. Pollution is significant, but by no means the most important factor. Rather, issues relating to appropriate water supply dominate the problem of land degradation. Too much water in the wrong times and places causes erosion, and too little causes desertification (Table 20.2). Erosion is concentrated in western regions of China, where overall water supply is deficient, ground cover is sparse, and seasonal rainfall causes huge soil losses due to erosion. Serious flooding on the Yangtze in 1998 was directly linked to the degradation of the upstream environment due to deforestation and erosion.

Table 20.2
Major causes of arable land degradation

	Percent of total
Erosion	48
Desertification	18
Salinization and waterlogging	7
Pollution	12

20.2.2.1 Desertification

Desertification is an enormous problem. China, as stressed in Chapter 1, is an arid country. West of the Aihui–Tengchong line much of the land is desert. However, the desert has been moving east, primarily because of the impact of human activity in China. The overexploitation of grass and forest lands has greatly reduced the regenerative capacity of the land's plant cover. With weakened biological buffer zones, deserts have spread significantly. The State Forestry Administration did large-scale surveys of desert areas in 1994 and 1999, and discovered that deserts had grown by 52,000 square kilometers in just that five-year period. One of the most dramatic results has been an increased frequency of sand and dust storms. In March 2002, two huge dust storms blew across northern China, reducing visibility for days and pushing airborne particulate matter over the top of all measurement scales in Beijing. These storms blew clouds of dust beyond China, affecting Korea and Japan, causing school closings, and coating some cities with a thin layer of dust.

The single most important factor aggravating desertification in recent years has been overgrazing in the grasslands of Inner Mongolia and other pastoral regions of northern China. The dissolution of the collectives in these areas led to the distribution of herds of grazing animals to individual households and an explosion in the size of herds. The "tragedy of the commons" was exacerbated as each individual household sought to maximize its own individual income from animal husbandry. Vast areas of China are classified as grasslands: over 40% of the entire land area. The impact of intensified exploitation on marginal grasslands on the edge of the desert has been catastrophic in some areas. Chinese policy has recognized the danger of desertification for more than 20 years, but policies have not been sufficient to arrest the advance of the deserts. "Shelter belts" of planted trees seek to halt the encroaching desert. Indeed, the expansion of the desert during 1994–1999 came despite the successful rehabilitation of 5,700 square kilometers through reforestation, grass seeding, and expanded irrigation. Most of the rehabilitation took place in central China, in areas not too distant from major watercourses. Most of the spread of the desert took place in northern China, especially in the vast border areas populated by herders.

20.2.2.2 Forests and Grasslands

Away from the frontiers of expanding deserts, the efficacy of Chinese sustainability policy has been substantially better. For many years tree planting has been emphasized as a government policy, as a civic responsibility, and, on several occasions, as a campaign of mass mobilization. Over the long term this consistent emphasis has had a significant payoff, and China's overall forest cover has grown substantially over the past 40 years. The sixth national inventory of forest resources, over the 1999–2003 period, found that forest cover had grown to 18.2% of the national territory (175 million hectares), up substantially even from the 16.6% in the previous (1994–1998) inventory. Indeed, the lowest forest cover was found in the first such national inventory, in 1962, which found that only 8.9% of China was forested (Roumasset, Wang, and Burnett 2004). But these statistics obscure a substantial deterioration in the quality of forestland. The newly planted forest cover tends to be composed of a relatively small number of fast-growing species, scattered through densely settled parts of China. At the same time, considerable acreage of old-growth forest, with diverse species and big trees, has been lost. In 1998, Chinese policy-makers prohibited logging in a broad swath of forests in Southwest China. They were reacting with alarm to devastating floods of the Yangtze that were linked to erosion and deforestation in the upstream reaches of the river. This drastic measure slowed the exploitation of China's largest remaining natural forests. However, in the long run, protection of these forests depends on further developing a system of property rights, rules, and rewards that give local residents incentives to protect forestlands.

Since the turn of the millennium the Chinese government has encouraged the conversion of marginal farmlands to forest or grassland through a variety of programs. The most important program is "grain for green," which provides farmers compensation for five to eight years when land is converted from grain farming to forest or pasturage, while also allowing the farmer to maintain ownership of the land. Pilot implementation began in three western provinces of Sichuan, Shaanxi, and Gansu in October 1999, and farmers in those provinces removed a total of 1.24 million hectares from grain production through the end of 2001. Nationwide, the amount taken out of agriculture in this way was over 2 million hectares in 2002 and 2003, before dropping to only 733,000 hectares in 2004 (because of higher farm prices and less enthusiastic implementation). Altogether, this program has taken almost 5% of China's cropland out of production, providing a recuperative opportunity for a significant area of China's marginal lands.

20.2.2.3 Water Availability

The interplay of land and water resources is also shown by the fact that irrigation remains by far the biggest human use of water in China, accounting for two-thirds of total water use, although the proportion is slowly declining. Particularly troubling is the fact that to date China has been forced to rely on numerous unsustainable practices to maintain current supplies of water to its cities and agriculture. We have already referred to the intense demands on the rivers of northern China and the intense pollution that already afflicts them. A related serious problem is the overexploitation of groundwater. Using underground water supplies (aquifers and ground water) in such a way that they are gradually depleted is sometimes known as "mining water." This is a very serious problem in northern China (Cheng 2002, 52–63). Large amounts of water have been withdrawn from underground sources beginning in the 1970s for tube-well irrigation in the North China Plain. The water table underneath Beijing fell from only five meters below the surface in 1950 to 50 meters in 1994. It has become more difficult and costly to extract water from these underground sources. Private entrepreneurs now dig deep wells and sell the water, increasing supply but increasing the long-run threat to the sustainability of water supply. The problem is most severe with respect to wheat, which requires water outside the normal rainy season and is thus dependent on irrigation (Lohmar and Wang 2002). Conceivably, the North China Plain might stop growing wheat if food prices stay low and water costs continue to rise.

Cities have been extracting increasing amounts of water. As a result, many cities are now experiencing difficulties extracting water, as well as subsidence of land. Coastal cities including Tianjin and Shanghai have experienced major subsidence problems. Depleted aquifers allow saltwater to intrude into water sources near the coast, requiring the abandonment of thousands of wells. These are very serious problems, and solving them will be expensive. Efficiency improvements are possible at nearly every point in the chain of collecting, storing, and delivering water. Currently, charges to farmers for irrigation water cover an estimated 36% of the cost of supplying the water (Lohmar et al. 2003). Higher prices would help economize on water and shift it toward higher-value nonagricultural uses. However, there is no guarantee that effective measures will be adopted in a timely fashion. China's agriculture is so small-scale, with more than 200 million farms, that charging for volume of water delivered is costly and probably inefficient. Problems with water availability may be compounded by deteriorating dams and irrigation facilities. Many of the facilities in the most populous and prosperous parts of China were constructed in the 1950s. Some are made of earth or brick; they are heavily silted, and need repair and upgrading urgently. According to Nickum, "The primary pressure on irrigated area now, and probably for some time into the future, is project obsolescence within the irrigation sector itself" (1998, 890).

These concerns will probably require larger government investments in water management facilities. In northern cities, the past pattern has been overexploitation of rivers and surface reservoirs, followed by overuse of underground water resources, and finally recourse to long-distance water transfer (Smil 2003, 157). One major initiative, tentatively approved by the Chinese government, is to pump southern water northward to alleviate stress in the North China basin. There are three feasible routes (Figure 20.2). The western route is most expensive but might provide the best water quality; the eastern route is cheapest but provides the lowest water quality. The middle route may be the best compromise, and preparatory construction work is underway. Eventually, the middle route would be connected to the reservoir on the

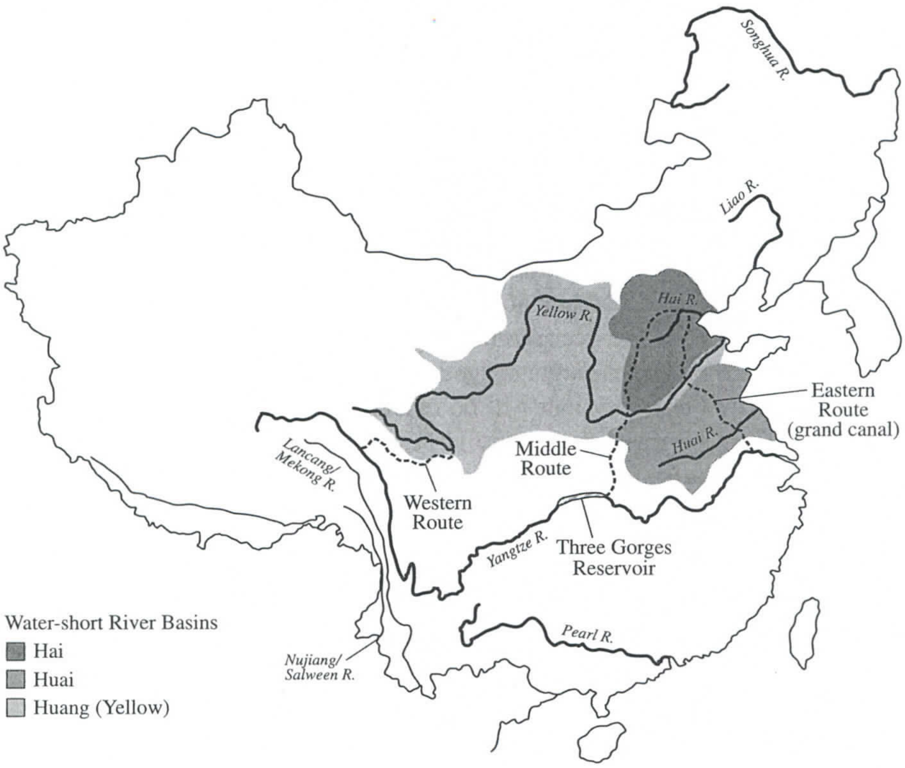

Figure 20.2
South–north water-transfer routes

Yangtze above the Three Gorges Dam. A large volume of water could then be transported north, about twice as much as is shipped to California from the Colorado River in the United States. These grand infrastructure projects are expensive and, in the long run, less important than the hundreds of thousands of small-scale improvements in the efficiency with which water is used, as delivery systems are upgraded, and consumers are given stronger incentives to conserve water.

20.3 CONCLUSION

Environmental degradation has imposed serious costs on the Chinese economy and reduced the well-being of the Chinese population. Moreover, there is increasing public concern about environmental issues, and that concern has increasingly been publicly articulated. A milestone of sorts was reached in February 2004, when Premier Wen Jiabao suspended work on a series of dams projected for the Nujiang (Nu River or Salween) in Yunnan. This river flows through a beautiful, rugged area where the upper reaches of three great rivers (the Yangtze, Mekong, and Salween) flow in parallel less than one hundred kilometers apart. It is naturally an area of enormous biodiversity, as well as being the home of several different ethnic groups living in these remote highlands along the border with Myanmar. The release of plans for a cascade of dams along this river triggered significant protests within China, as well as abroad. The government's responsiveness to these protests will be a bellwether of its willingness to let public opinion serve as an input into economic decision-making.

China is currently engaged in a large-scale program of dam building to generate electricity that will be essential if China is to restrain the growth of its fossil fuel use. By far the largest part of China's hydropower potential is in the Southwest. The case of the Nujiang thus represents an ongoing conflict between the needs of economic growth and the obligation to protect biological and human diversity. To navigate this conflict, China will urgently require public input and discussion in the decision-making process. China already has requirements for environmental impact statements: if such statements are to fulfill their potential role, they must be available for public inspection and comment, which has not often been the case in China. The case of Nujiang thus provides an ideal opportunity to give environmental impact statements their proper role. This kind of role for public opinion is also indispensable if something like the environmental Kuznets curve is to prove a reality in China. Perhaps environmental quality is a luxury good, and demand for it increases more than proportionately as income grows. Even so, if citizens have no way to convert their preferences into effective demand and command over society's resources, it is hard to see a consistent motive force behind environmental improvement.

The challenges of water availability, resilience of the natural environment, and atmospheric degradation and climate change are among the most serious that China confronts. In each case it is easy to see that current practices are unsustainable, but it is hard to project when the obvious costs that these practices impose will force serious change. There is still an opportunity for improved environmental policy-making to make a significant difference before further environmental catastrophes develop.

In its most recent planning exercise, the five-year plan for 2006–2010, the Chinese government called for a reorientation of the economic growth model toward a sustainable growth with a lighter environmental impact. By itself, of course, mere adherence to a particular approach to development planning will not dramatically change the quality of China's environment, no matter how friendly to the environment it is proclaimed to be. But this shift in viewpoint suggests that government policy might slowly begin to become one positive element in the complex mix of factors that determine China's environmental trajectory. In combination with many other social, technological, and economic factors, that could turn China in the direction of gradual environmental improvement.

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Suggestions for Further Reading

World Bank (2001) and the special issue of the *China Quarterly*, no. 156: "China's Environment," December 1998, though slightly dated, are still useful balanced introductions to China's environment.

Smil (2003) collects his original pioneering work on the Chinese environment, along with a retrospective reassessment. Though the shifts in time perspective are occasionally bewildering, overall it is an astonishingly rich and stimulating volume that effectively demonstrates the author's prescience.

SEPA, the State Environmental Protection Agency, has a good English-language Web site, http://www.sepa.gov.cn/english/, with annual reports on the environment posted. There are also daily air pollution readings from more than 80 Chinese cities.

An excellent online bulletin on China's environment is put out by the U.S. embassy in Beijing. See the Beijing Environment, Science, and Technology Update at http://www.usembassy-china.org.cn/sandt/estnews020802.htm. The discussion in the chapter on desertification drew on the issues of February 8, and March 29, 2002. Estimate of funds spent to clean up the Huai River from issue of June 30, 2004.

The China Environment Series of the Woodrow Wilson International Center for Scholars China Environment Forum has published regular issues with short pieces on specialized environmental topics.

Sources for Data and Figures

Figure 20.2: Map of south–north water transfer routes. Liu (1998, 902).

Table 20.1: Environmental Statistics (2004, 18).

Table 20.2: Ash and Edmonds (1998, 860).

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