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*The Economic Costs of
Ecological Deficits*

(part 1 of 3)

As populations have multiplied and incomes have risen, demands on the natural support systems of many economies have become excessive, generating ecological deficits. The effects of these deficits are first seen at the local level as deforestation leads to fuelwood shortages, overplowing leads to falling crop yields, overgrazing leads to emaciated herds of cattle, or overpumping drops water tables and dries up wells.

At some point, these expanding deficits begin to reinforce each other, creating an ecological disaster of national proportions. This is now happening in China—where disappearing forests, deteriorating rangelands, eroding croplands, and falling water tables are converging to create a dust bowl of historic dimensions. China's sheer geographic size, the weight of its 1.3 billion people on the land, and the pace of its economic expansion put it on the frontline of the deteriorating relationship between the global economy and the earth's ecosystem.

Although China is not well prepared for it, it is now at war. It is not invading armies that are claiming its territory, but expanding deserts. Old deserts are advancing and new ones are forming, like guerrilla forces striking unexpectedly, forcing Beijing to fight on several fronts.

And China is losing the war. Not only are the deserts advancing, but their advance is gaining momentum, claiming an ever larger piece of territory each year. The flow of refugees has already begun, as villages in several provinces are overrun by sand dunes.

Mounting ecological deficits are taking an economic toll in other countries as well. Algeria, suffering from the same complex of deficits as China, is trying to convert the southern one fifth of its grainland to orchard crops in an effort to halt the advancing Sahara. On the Sahara's southern fringe, Nigeria is fighting a similar battle.

Among other things, these ecological deficits are producing refugees. Villages are being abandoned as aquifers are depleted in Iran and India. Kazakhstan has surrendered half of its cropland to the desert.

On another front in this war, if sea level rises by 1 meter during this century, which is now clearly a possibility, Bangladesh will lose half of its riceland, scores of other Asian countries will lose their rice-growing river deltas, and some island countries will become uninhabitable. Modern civilization, with its growing population, is being squeezed into an ever smaller area by expanding deserts and rising seas.

The first section of Part 1 of *The Earth Policy Reader* describes how ecological deficits are converging to expand deserts in China. The second section looks at the negative effect of ecological deficits on the food prospect and how to eliminate both soil and water deficits. The third section describes how nature's inability to fix carbon as fast as we release it is destabilizing climate. It then discusses how to restructure the energy economy and eliminate this deficit by reducing carbon emissions. And finally we discuss how to fix the market to achieve environmental sustainability.

DESERTS INVADING CHINA

Lester R. Brown

On April 12, 2002, South Korea was engulfed by a huge dust storm from China that left residents of Seoul literally gasping for breath. Schools were closed, airline flights were cancelled, and clinics were overrun with patients who were having difficulty breathing.¹

The health effect was pervasive. When the amount of particulate matter in the air—normally 70 micrograms of dust per cubic meter in Seoul—reaches 1,000, respiratory stress disables the elderly and those with impaired respiratory systems. At the 2,070 micrograms recorded in this particular dust storm, breathing was labored for the able-bodied as well as the infirm. Many people were afraid to venture outside.²

New York Times correspondent Howard French reports that these suffocating dust storms, once seen as a nuisance in Korea, are now considered an economic threat as they boost worker absenteeism, curb travel, reduce retail sales, and adversely affect dust-sensitive industries, such as semi-conductor manufacturing. The automobile maker Hyundai began to shrink-wrap cars destined for export as soon as they came off the assembly line lest they arrive in foreign markets saturated with dust. Both business and tourist travel are reduced when

the country is besieged by these dust storms. Airline flight cancellations are increasingly common.³

Koreans have come to dread the arrival of what they now call “the fifth season”—the season of dust storms that occupies the months on the calendar once considered late winter and early spring. Japan also suffers from dust storms originating in China. Although not as directly exposed as Koreans are, the Japanese complain about yellow snow and the brown rain that streaks their windshields and windows. It is Korean and Japanese frustration with Chinese dust that led to the launch of a trilateral ministerial consultation between South Korea, China, and Japan in 1999.⁴

Occasionally even the United States is affected. In April 2001, a huge dust storm measuring 1,800 kilometers east-west and 1,200 kilometers north-south crossed the Pacific intact, blanketing the western United States from the Arizona border to Canada with dust. Atmospheric scientists in Boulder, Colorado, who sent a plane up to measure dust concentrations at every thousand feet detected dust up to 37,000 feet. In March 2002, another storm from China followed the jet stream east, crossing the western United States before dissipating over Colorado.⁵

Within China, the area affected is expanding as the number and size of the storms has increased in recent years. In late January 2002, an unusually early dust storm moved southward over Tibet, closing the airport in Lhasa for three days, disrupting tourism and other activities. In eastern China, dust storms reach the coastal populations as far south as Shanghai.⁶

While the dust storms can have severe effects in South Korea, they can be even more suffocating for the people of eastern China who are more directly affected. Early each year, residents of eastern cities, such as Beijing and

Tianjin, hunker down as the fifth season begins. Motorists have learned to drive with their lights on during the day as storms impair visibility, and residents routinely cover their faces with surgical masks, shawls, or handkerchiefs.⁷

The fifth season is not a pleasant one for those living in northern and eastern China. Those with respiratory illnesses are particularly burdened, as the breathing stresses intensify their illnesses. Apart from the difficulty breathing and the dust that stings the eyes, there is the constant effort to keep dust out of homes and to clear doorways and sidewalks of dust and sand.

As difficult as life may be for those living in the paths of the dust storms, the real price is paid by the pastoralists and farmers who live at their source. They are bearing the brunt of the dust and sand storms.

Although global media coverage of dust and sand storms in the more remote northern and western regions has been limited, enough time has now passed for the extent of damage from past storms to be measured and recorded in scientific papers. One of these reported on a dust and sand storm occurring on May 5, 1993, in the Hexi corridor of Gansu Province in China's northwest. This intense sand and dust storm reduced visibility to zero and the daytime sky was described as “dark as a winter night.” The storm destroyed 170,000 hectares of standing crops, damaged 40,000 trees, killed 6,700 cattle and sheep, blew away 27,000 hectares of plastic greenhouses, injured 278 people and killed 49. Forty-two trains, both passenger and freight, were either cancelled, delayed, or simply parked to wait until the storm passed and the tracks were cleared of sand.⁸

A detailed record of the effect of a dust-sandstorm on April 5, 1998, in Alxa Prefecture in Inner Mongolia describes the damage from a storm that lasted for 12

hours. Some 10,600 hectares of crops were destroyed, including 330 hectares of wheat covered by shifting sand; 134 plastic greenhouses were damaged; 400 drinking wells were filled with sand; 130 hectares of fruit orchards were destroyed; 800 tons of hay and dry forage stored in open fields were simply carried away; 600 sheep sheds were damaged; 1,000 yurts were destroyed; and 7,000 sheep were killed. These accounts describe just two of the scores of sand and dust storms that have occurred in the last decade or so.⁹

Data are now becoming available on ecosystem decline in at least some locations in the more severely affected areas. In Alxa Prefecture, more than 3 million hectares of grazing land are degraded, of which 60 percent is seriously degraded. Fodder production in the region has decreased by 43 percent and the carrying capacity of the grazing land has declined by 46 percent. And perhaps most telling of all, the body weight of the average draft animal has been reduced by almost half, suggesting rather emaciated animals. The forested area in the region, which totaled 1.13 million hectares in the 1950s, has now shrunk to 530,000 hectares—most of which is in an unhealthy state. This sort of ecosystem deterioration can be found in numerous prefectures and counties in northern and western China.¹⁰

Advancing Deserts Gaining Momentum

Desertification in China is the product of excessive human and livestock pressure on the land in a country whose population will reach 1.3 billion next year—nearly as large as the world population of 1.5 billion when the twentieth century began. Under this demographic pressure, China is running up ecological deficits on many fronts: overgrazing its rangelands, overplowing its land, overcutting its forests, and overpumping its aquifers.

With little vegetation left in parts of northern and western China, the strong winds of late winter and early spring can generate a dust storm that removes literally millions of tons of topsoil in a single day, soil that can take centuries to replace.¹¹

Desertification is the degradation of land associated with the loss of topsoil that follows loss of vegetation. The fine particles in soil exposed to the wind are the first to blow away, creating dust storms. Once the fine particles are gone, leaving only the coarse particles or sand, then sand storms occur. Dust storms can cover vast areas and travel great distances, whereas sand storms are more localized.

This conversion of productive land into wasteland is not new in China. Historical accounts refer to dust storms some 27 centuries ago. What is new is their frequency and scale. Dust storms in 2001 and 2002 were more numerous, larger, and much more disruptive than in previous years.¹²

The process of desertification itself directly affects 40 percent of China's landmass, including Sinkiang Province and Tibet in the far west and Qinghai, Gansu, Ningxia, and Inner Mongolia Provinces in the north-central region. Although desertification is concentrated in these six provinces, it is now spreading into Sichuan, Shaanxi, Shanxi, and Hebei Provinces as well.¹³

Scientists at the Cold and Arid Regions Environmental and Engineering Research Institute (CAREERI) in Lanzhou, the world's premier desertification research institute, believe that desertification is one of the most serious environmental problems. They have charted the nationwide growth of the area converted to desert over the last half-century. Each decade, the area has increased. Wang Tao, Deputy Director of CAREERI, reports that during the 1950s, 1960s, and 1970s, the average rate of

desert spread was 1,560 square kilometers per year. During the 1980s, this expanded to 2,100 square kilometers a year—an increase of 35 percent. During the 1990s, the area converting to desert rose to 2,460 square kilometers per year—a further jump of 17 percent.¹⁴

The scientists in Lanzhou are hoping that the area turning to desert will be reduced during this first decade of the new century. But with the dramatic jump in the number, severity, and size of dust storms in 2000–02, the growth of the deserts appears to be accelerating.

China's Environmental Protection Agency reports that the Gobi Desert expanded by 52,400 square kilometers (20,240 square miles) from 1994 to 1999, an area nearly half the size of Pennsylvania. This figure does not include the spread of the large Taklimakan Desert, which is further west; the five smaller deserts in Inner Mongolia; or the many new deserts that are beginning to form. With the advancing Gobi now only 150 miles from Beijing, China's leaders are beginning to realize the gravity of the situation.¹⁵

Desertification is typically concentrated on the fringes of existing desert, simply because these are the areas of marginal rainfall with the least vegetation. Of even more concern, however, are the new desert areas, replete with sand dunes, forming spontaneously in so many communities in northwestern and northern China. Localized sand dunes forming within 80 kilometers of Beijing are alarming government officials.¹⁶

Data for major dust storms as compiled by the China Meteorological Agency also indicate that desertification is accelerating. After increasing from 5 in the 1950s to 14 during the 1980s, the number leapt to 23 in the 1990s. The new decade has begun with more than 20 major dust storms in 2000 and 2001 alone. If this annual rate continues throughout the decade, the total will jump

to 100—a fourfold increase over the last decade. (See Table 1–1.)¹⁷

In addition to the land already converted to desert, 900,000 square kilometers (347,000 square miles) of the Chinese landscape show a clear “tendency toward desertification,” according to Qu Geping, formerly Minister of Environment and now Chairman of the Environment and Resources Committee of the National People's Congress. This area of 90 million hectares, which consists mostly of rangeland but includes some cropland as well, is roughly equal to the area planted to grain in China.¹⁸

There is a tendency in viewing desert expansion to think of it in linear terms, but it may not in fact be linear beyond a certain point. For example, as livestock numbers increase and the forage supply deteriorates as a result of overgrazing, the situation may reach a point where the degradation accelerates, leading to rapid,

Table 1–1. *Number of Major Dust Storms in China, by Decade, 1950–99, with Projection to 2009*

Decade	Number
1950–59	5
1960–69	8
1970–79	13
1980–89	14
1990–99	23
2000–09	100 ¹

¹Preliminary estimate for decade based on more than 20 storms during 2000 and 2001.

Source: China Meteorological Administration, cited in “Grapes of Wrath in Inner Mongolia,” report from the U.S. Embassy in Beijing, May 2001.

wholesale destruction. Once human and livestock populations start retreating from the advancing desert, the pressures from concentrating human and livestock populations on the desert fringe can become even greater. This, too, can accelerate ecosystem collapse. There is some evidence that this is now happening in China.

From Ecological Deficits to Dust Bowl

As noted earlier, several ecological deficits are converging in China to create a dust bowl on a scale never before witnessed. In its effort to remain self-sufficient in grain, China has tried to avoid any shrinkage in overall cultivated area. As industrialization has claimed cropland in the coastal provinces, the national policy has offset these losses with the cultivation of land elsewhere. Thus the cultivated area in some northern provinces expanded during the 1990s. In Inner Mongolia, for example, it grew by an astonishing 22 percent between 1987 and 1996.¹⁹

China's expanding demand for food has pushed agriculture onto marginal land in the northwestern provinces, much of it land too dry to sustain cultivation. As a result, the soil is blowing away and the land is losing its productivity. Eventually the unproductive cropland is abandoned. Traveling by train through northern and western China in May 2002, I saw many such plots of abandoned land.

Overgrazing may be even more damaging. China's herds of cattle and flocks of sheep and goats have outgrown the carrying capacity of rangelands, leading to a forage deficit. After the 1978 economic reforms, when China shifted to a market economy, the government lost control of livestock numbers. As a result, the livestock population has grown by leaps and bounds, far exceeding that of the United States, a country with a comparable grazing capacity. While the United States has 97 million

cattle, China has 128 million. The United States has 8 million sheep and goats; China has a staggering 290 million. The sheep and goats that range across the land are simply denuding western and northern China, a vast grazing commons. In China, as in many other countries with common grazing areas, there is no administrative mechanism for limiting livestock populations to the sustainable yield of rangelands.²⁰

A report by a U.S. embassy official in May 2001 after a visit to Xilingol Prefecture in Inner Mongolia notes that official data classify 97 percent of the prefecture's 200,000 square kilometers as grassland, but a simple visual survey indicates that a third of the terrain appears to be desert. A similar survey by an aid official for another prefecture in Inner Mongolia indicates that half of the land is now desert. The embassy report on Xilingol describes the livestock population in the prefecture jumping from 2 million as recently as 1977 to 18 million in 2000. (See Table 1–2.)²¹

The report notes that whereas the traditional nomadic herders kept a mix of horses, cattle, sheep, and goats, today's herds consist overwhelmingly of sheep and goats. And *People's Daily* reports that the yield of forage from Inner Mongolia's rangelands has declined by at least 30 percent, and perhaps as much as 70 percent, over the last half-century. A Chinese scientist doing grassland research in Xilingol estimates that if recent trends of desertification continue, Xilingol will be uninhabitable in 15 years.²²

As China's population has grown, so too has the demand for fuelwood and lumber. Throughout most of the country, this demand now exceeds the sustainable growth of trees and shrubs. As a result, vegetation has disappeared in many areas, leaving little to hold the soil when the wind blows or when it rains.²³

Deforestation of the southern provinces may also be

Table 1–2. *Livestock Population of Xilingol Prefecture, Inner Mongolia, 1977–2000*

Year	Number of Livestock (million)
1977	2
1980	6
1989	10
2000	18

Source: “Grapes of Wrath in Inner Mongolia,” report from the U.S. Embassy in Beijing, May 2001.

reducing the amount of rainfall recycled into the interior of the continent. The Yangtze River basin, for example, which occupies much of southern China, has lost 85 percent of its original tree cover. In these circumstances, when moisture-laden air masses move inland from the sea, the rainfall they produce quickly runs off, returning to the sea. When this land was heavily forested, most of the rainfall was retained and evaporated either directly into the atmosphere or indirectly through the transpiration of the trees, to be carried further inland. As Wang Hongchang of the Chinese Academy of Social Sciences points out, the diminished capacity of the deforested land to recycle water inland may be reducing rainfall in the northwestern interior of China.²⁴

China is incurring another costly ecological deficit as the use of water for irrigation, industry, and residential use climbs, exceeding aquifer recharge. When the rising demand for water approaches the sustainable yield of aquifers, governments can avoid overpumping by investing in efforts to stabilize population and by raising water productivity. Unfortunately, the sustainable-yield thresh-

old of aquifers is usually ignored. As a result, water tables are falling throughout the northern half of China as pumping exceeds the natural recharge from precipitation. As the water levels fall, the springs that feed streams dry up. And then the rivers they feed go dry. Lakes disappear. In the northern half of China, thousands of lakes have vanished over the last few decades.²⁵

A World Bank study of key river basins that make up much of the North China Plain—the Hai, which contains both Beijing and Tianjin, two of China’s largest industrial cities; the Yellow, which originates on the Tibet-Qinghai plateau and eventually empties into the Yellow Sea; and the Huai, the next river basin south—found that the three together have an annual deficit of 37 billion tons of water.²⁶

Assuming 1,000 tons of water to produce 1 ton of grain, this water deficit is equal to 37 million tons of grain, which at current consumption levels is enough to feed 111 million Chinese. Stated otherwise, 111 million Chinese are being fed with grain produced with the unsustainable use of water. Not only is this water deficit large, but it is growing progressively larger. With virtually all water now spoken for in northern China, the growing demand for water in cities and industry is satisfied by taking irrigation water from agriculture. For example, rice production is being phased out in the region surrounding Beijing and farmers are shifting to less water-intensive crops simply because the water is needed for the city, which now has 10 million people.²⁷

The first three ecological deficits—overplowing, overgrazing, and overcutting—are destroying the vegetation that protects the soils of China. The fourth—overpumping—is drying out the land. Water shortages also make any water-dependent reclamation efforts, such as tree planting, more difficult, accelerating the desertification process.

In addition to the four ecological deficits just described, the worldwide rise in temperature may also be contributing to the desertification of China. Higher temperatures appear to be raising evaporation rates and drying out the country's interior. Warmer winters both reduce snow cover and lead to the earlier loss of snow cover in the spring, which may explain why the dust storms have started earlier in recent years. Simply stated, China may also be battling the effects of global warming.²⁸

China's ecological deficits reflect three dangerous weaknesses of markets: their inability to recognize and respect the sustainable-yield thresholds of natural systems; their inability to value nature's services, such as the role of natural vegetation in protecting the land; and their inability to incorporate the indirect environmental costs of various economic activities, such as overplowing. Driven by a combination of population and income growth, these ecological deficits are setting the stage for an ecological meltdown in China on a scale that has no historical precedent.

Spreading Deserts: The Response

Until recently, coping with desertification was left largely to provincial and local governments. But the dust storms reaching Beijing in the last few years have gotten the attention of Chinese leaders. Now the federal government is beginning to commit substantial amounts of resources. The Ministry of Forestry has been designated the lead agency in the effort to arrest the spreading deserts. For example, the government is now paying farmers in the threatened provinces to abandon grain production and to plant their land in trees. In 2000 and 2001, 1.5 million hectares of cropland were planted to trees. An estimated 2 million hectares are scheduled for conversion in 2002. By 2010, 7 million additional hectares

of cropland are to be covered with trees. Altogether these 10.5 million hectares represent more than a tenth of China's grainland.²⁹

Halting the advancing sand dunes will not be easy. Research by Chinese scientists indicates that the millions of sheep and goats traversing the land not only strip it of vegetation but also loosen the soil through their constant trampling, leaving it particularly vulnerable to wind erosion. Without the sheep and goats, rainfall interacting with the soil forms a protective crust that helps prevent the blowing of the soil.³⁰

Efforts to arrest the desertification and to reclaim the land for productive uses involve planting the land to desert shrubs that help stabilize the dunes and, in many situations, banning sheep and goats entirely. In Helin County, south of the Inner Mongolian capital of Hohhot, such a strategy is beginning to yield results. The planting of desert shrubs on cropland, which was abandoned earlier because sand dunes were forming, has now stabilized the county's first 7,000-hectare reclamation plot. The second and third 7,000-hectare reclamation efforts are under way, with a fourth to be launched before the end of 2002.³¹

A plan to deal with desertification in the threatened parts of China is complicated by the prevalence of poverty in these same regions. The situation calls for a carefully formulated strategy that will lead both to environmental stability and to economic improvement.

The strategy for Helin County, with a population of 150,000 people, is to shift the emphasis from sheep and goats to dairy cattle, increasing from 30,000 dairy animals to 150,000 over the next five years, while gradually reducing the number of sheep and goats. In contrast to the sheep and goats, which range across the landscape consuming any available vegetation, the cattle will be stall-fed, eating cornstalks, straw from the spring wheat crop,

and the harvest from a drought-tolerant leguminous forage crop resembling alfalfa, which is growing on reclaimed land. Local officials estimate that this strategy will double incomes within the county during this decade.³²

The successes in arresting and reversing the spread of the desert tend to be local and small-scale, typically in a village, a cluster of villages, or an oasis. Wang Tao, Deputy Director of CAREERI, describes two such cases. First, after rehabilitation of the Naiman Banner experimental plot in Inner Mongolia, the village's 1,000 hectares of shifting sand land decreased to 330 hectares, vegetation cover increased from 10 percent to 70 percent, the grain harvest climbed from 150 tons to 450 tons, and per capita income increased from 174 yuan per year to 1,290 yuan.³³

Second, in a project in Ningxia Province, rehabilitation brought the 4,822 hectares of desertifying land under control. Of this, 667 hectares of shifting sand land was transformed into woodland. Vegetation cover overall increased from 30 percent to 50 percent. The grain harvest increased from 139 tons to 219 tons. Per capita income increased from less than 500 yuan per year to 1,175 yuan.³⁴

Some remediation and reclamation efforts are working. Others are not. One of the difficulties with farmers planting trees to stabilize the remaining soil is that often there is not enough soil left to support the trees. The result is mortality rates that sometimes reach 80 percent in the first year. Another disadvantage is that the dust storms are concentrated in the early months of the year, from January into early May, when the deciduous trees planted as windbreaks lack the foliage needed to slow the wind.³⁵

One weakness of having the Ministry of Forestry manage the land reclamation effort is that it focuses on planting trees. While tree planting has a key role to play, there are doubts as to whether it should be the core strat-

egy. Yet in mid-May 2002, the government announced that it would be investing \$12 billion in a decade-long tree planting effort to reduce wind erosion and the spread of deserts. This ambitious planting program includes all regions of the country.³⁶

All too often, efforts to arrest desertification focus on the symptoms rather than the causes. There is in Beijing something of a "great wall" mentality, one that emphasizes planting a belt of trees to protect Beijing and nearby Tianjin—two of China's largest cities—from dust storms. Shi Yuanchun, a soil scientist at the China Academy of Sciences challenges this approach. "Putting hundreds of millions of dollars into the Beijing-Tianjin Sand Prevention and Forest Belt Project and ignoring the major sand source regions is...practicing self deception," he wrote. This planting of trees around Beijing is being justified partly in terms of wanting to green the city and clean the air before the city hosts the Olympics in 2008.³⁷

A similar situation exists in Lanzhou, where the mountainsides that line the valley en route to the airport—mountains that have never been forested—are being covered with newly planted trees. To enhance their chances of survival, the seedlings are irrigated with large overhead sprinklers using powerful pumps to draw the water from the Yellow River far below. There are widespread doubts as to whether this prodigal use of scarce water resources to make the drive to the airport more scenic warrants the huge drain on fiscal resources it represents.

Planting trees anywhere in China is an obvious environmental plus if the trees survive. They hold the soil and retain rainfall, reducing runoff and flooding. But unless the root causes of desertification—particularly the overgrazing and overplowing in the west and north—are addressed directly, then the tree belts bordering Beijing will not protect it from dust storms.

The prevailing scientific opinion appears to be that the key to arresting the spread of deserts is to relieve the pressure posed by China's 290 million sheep and goats. Owners are being encouraged to reduce their flocks by 40 percent. In parts of the country where wealth is measured not in annual income but in the number of livestock owned and where a majority of families are living under the poverty line, such cuts are not easy. Flocks are indeed being reduced in many areas, but the reductions appear to be more like 20 percent than the suggested 40 percent. Whether even a 40-percent reduction in herd size is sufficient to arrest the desertification of land is doubtful.³⁸

Arresting desertification may depend more on grass than trees—in terms of both permitting existing grasses to recover and planting grass in areas that have been denuded. The problem, as one observer has noted, is that there is a Ministry of Forestry but no Ministry of Grass. One of the common components of successful land reclamation efforts involves not merely reducing the number of sheep and goats that traverse the land, but banning them entirely until the indigenous grasses and shrubs can recover. The plan to plant marginal cropland in trees involves paying farmers 1,500 kilograms of grain per year for five years for each hectare they convert from grain to trees, providing the tree survival rate is 80 percent at the end of the first year. They will also receive a small cash allowance. This helps correct some of the mistakes of overplowing, but it does not deal with the overgrazing issue.³⁹

Qu Geping, the Chairman of the Environment and Resources Committee of the National People's Congress, has said that the remediation of land in the areas where it is technically feasible would cost \$28.3 billion. This dwarfs anything the government has allocated to date, raising questions about whether the government, focused on making the capital city "green" for the 2008

Olympics, has fully recognized yet the scale of the effort needed to win the war with the advancing deserts.⁴⁰

The National Costs of Failure

The fallout from the dust storms is social as well as economic. Millions of rural Chinese may be uprooted and forced to migrate eastward as the deserts claim their land. Wang Tao reports that desertification is already producing refugees in Gansu, Inner Mongolia, and Ningxia Provinces. A preliminary Asian Development Bank assessment of desertification in Gansu Province reports that 4,000 villages risk being overrun by drifting sands.⁴¹

The U.S. Dust Bowl of the 1930s forced some 3 million "Okies" and other refugees to leave the land, many of them heading west from Oklahoma, Texas, and Kansas to California. But the dust bowl forming in China is much larger than that in the United States, and during the 1930s the U.S. population was only 150 million—compared with China's 1.3 billion. Whereas the U.S. migration was measured in the millions, China's may measure in the tens of millions. And as a U.S. embassy report noted, "unfortunately, China's 21st-century 'Okies' have no California to escape to—at least not in China."⁴²

Not only are spreading deserts disrupting air travel, as noted earlier, but sand dunes are also encroaching on highways and railways. Along the railroad from Hohhot, the capital of Inner Mongolia, to Lanzhou in Gansu Province, stones can be seen piled in fences two or three feet high to serve as sand traps. These are designed to prevent the drifting sand from covering the railroad, much as highway departments in the United States use snow fences along highways to prevent drifting snow from disrupting road transportation.⁴³

The ecological deficits building in China suggest that not only will this nation continue to lose land to invading

deserts, but that the loss will be greater each year. These expanding deserts affect every facet of life in China, including food production, transportation, and population distribution. As noted earlier, the government is planning to convert 10.5 million hectares of cropland to trees during this decade, which is roughly one tenth of China's cropland.

Two other trends are also shrinking the cropland area. In addition to the planned conversion of cropland to trees, other low-productivity land is simply being abandoned. A combination of low productivity and a reduction in government grain support prices has eliminated any profit on the more marginal land, compelling many farmers to look for jobs off the land. Cropland is also being abandoned because it is covered by drifting sand or overrun by sand dunes. For example, an Asian Development Bank document reports that in one area of Gansu, 133,000 hectares of cropland have been abandoned to drifting sand. These three trends are combining to shrink China's cropland base.⁴⁴

As rangeland turns to desert, the number of livestock that can be supported will diminish. In areas where cattle are being favored over sheep and goats, flocks of the latter will be substantially reduced. All in all, China's pastoral economy and its animal population will likely shrink dramatically in the years ahead either because livestock numbers are reduced by policy as efforts to control desertification acquire momentum or because rangelands are simply overrun by deserts.

In the end, the desertification of China is diminishing the country's food supply. As marginal cropland is systematically converted to trees or is abandoned for economic reasons, and as cropland and rangeland are abandoned to advancing deserts, the country's agricultural land area is shrinking.

The loss of productive land to desertification, along with the depletion of aquifers and the diversion of irrigation water to cities and industry, makes it increasingly difficult to expand food production. These trends are combining with economic developments—including the lowering of grain support prices in recent years, the rising wages in off-farm employment that pull labor from agriculture, and the shift to more intensive cropping, such as vegetable production, to reduce China's grain harvest.

After increasing more than fourfold from 90 million tons in 1950 to 392 million tons in 1998, China's grain production has dropped, falling to 338 million tons in 2001. (See Figure 1–1.) Even as China loses cropland, its grain consumption is rising by roughly 4 million tons each year as population expands and as people continue to use more grain-dependent livestock, poultry, and fish products. With some improvement in rainfall, the grain harvest

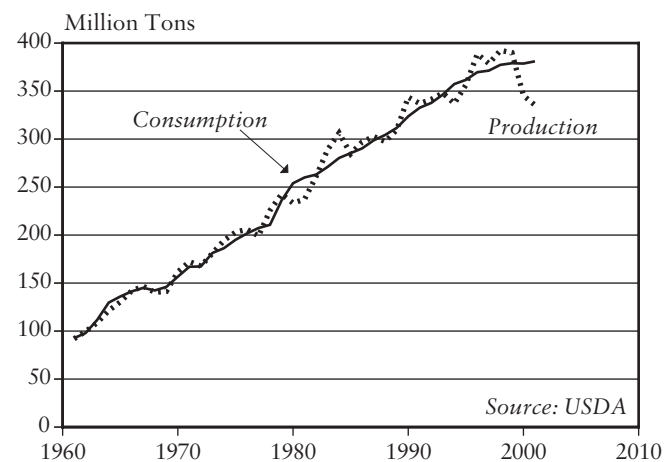


Figure 1–1. Total Grain Production and Consumption in China, 1961–2001

could recover to 350 million tons in 2002. Even so, with consumption now approaching 390 million tons, this will make China's third consecutive year with a shortfall of around 40 million tons. Thus far, this deficit has been filled by drawing down stocks. But if the deficit continues, China will be forced at some point in the not-too-distant future to turn to the world grain market.⁴⁵

The Worldwide Effect of Failure

If dust storms continue on the scale and with the frequency of the last few years, they will continue to affect nearby countries, including North and South Korea, Japan, and eastern Russia. As noted earlier, they are no longer merely a nuisance; they are now taking an economic toll, especially when they disrupt transportation and close schools and factories.

Another potential consequence of desertification's shrinking the inhabitable area while the population continues to expand is that migration could change from internal to international. At some point, if more and more Chinese are squeezed into an ever-smaller area, the pressure to migrate abroad will intensify. Exactly where the dust bowl refugees would migrate to remains to be seen.

But perhaps the most immediate consequence of a failure by China to reverse the desertification of its landscape will be its effect on world grain markets, and thus on world food prices. In 1972, the Soviets decided after a poor harvest that rather than slaughter some of their herds, as they had done in similar situations in the past, they would simply import grain to offset the shortfall. As Soviet wheat imports abruptly climbed from 3 million tons in 1971 to 15 million tons in 1972, the world wheat price per bushel leapt from \$1.90 in 1972 to \$4.89 in 1974.⁴⁶

If China were to import even 10 percent of its total grain supply, or 40 million tons per year, it would be good news for farmers in exporting countries because world grain prices would likely climb off the top of the chart. The bad news is that if grain prices doubled, they could destabilize governments in low-income countries that rely heavily on imports, such as Algeria, Egypt, Indonesia, Iran, or Mexico. This could also impoverish more people in a shorter period of time than any event in history. It would create a world food economy dominated by scarcity rather than by surpluses, as has been the case over most of the last half-century.⁴⁷

And what if China were to someday consider importing 20 percent of its grain, which is still far less than the 40 percent or more imported by Algeria, Egypt, or Iran, or the 70 percent imported by Japan, for example? This would mean importing 80 million tons of grain. But where would such a large quantity of grain come from?

Many of the countries that already import a large share of their grain are still raising their imports. If China moves into the world grain market in a major way, as is now a distinct possibility, then importing countries will be competing for inadequate supplies of exportable grain. In such a world, China would probably fare better than most simply because it has an export surplus with the United States in excess of \$80 billion a year. At a price of \$125 per ton of grain, \$1 billion will buy 8 million tons of grain. China thus could easily afford 80 million tons of grain using only \$10 billion of its trade surplus with the United States. But how would the low-income countries that lack such purchasing power fare in world markets?⁴⁸

No country has ever faced a potential ecological catastrophe on the scale of the dust bowl now developing in China. Merely grasping its dimensions and consequences poses a serious analytical challenge. Fashioning

an effective response is even more demanding. At this point, there is no funded plan in place or on the drawing board that will halt the advancing deserts.

China is taking some of the right steps, such as paying farmers to plant trees on fragile soils. But it still has a long way to go in order to reduce livestock numbers to a sustainable level and to stabilize aquifers. If the government is serious about reversing desertification, it will have to commit a massive amount of human and financial resources. In terms of national priorities, it will have to decide whether to use public resources to complete the Three Gorges Dam and build the costly proposed south-north water diversion project or, instead, to halt the deserts that are marching southward and eastward and that could eventually occupy Beijing. Whether China can effectively respond to this threat may offer some insight as to whether the world as a whole will be able to arrest the deteriorating relationship between the global economy and the earth's ecosystem before it leads to economic decline.