

Eroding Soils Darkening Our Future

In 1938 Walter Lowdermilk, a senior official in the Soil Conservation Service of the U.S. Department of Agriculture, traveled abroad to look at lands that had been cultivated for thousands of years, seeking to learn how these older civilizations had coped with soil erosion. He found that some had managed their land well, maintaining its fertility over long stretches of history, and were thriving. Others had failed to do so and left only remnants of their illustrious pasts.¹

In a section of his report entitled “The Hundred Dead Cities,” he describes a site in northern Syria, near Aleppo, where ancient buildings are still standing in stark isolated relief, but they are on bare rock. During the seventh century, the thriving region had been invaded, initially by a Persian army and later by nomads out of the Arabian Desert. In the process, soil and water conservation practices used for centuries were abandoned. Lowdermilk noted, “Here erosion had done its worst. If the soils had remained, even though the cities were destroyed and the populations dispersed, the area might be repopled again and the cities rebuilt. But now that the soils are gone, all is gone.”²

The thin layer of topsoil that covers the earth’s land surface was formed over long stretches of geological time

as new soil formation exceeded the natural rate of erosion. Sometime within the last century, soil erosion began to exceed new soil formation. Now, nearly a third of the world's cropland is losing topsoil faster than new soil is forming, reducing the land's inherent fertility. Soil that was formed on a geological time scale is being lost on a human time scale.³

Scarcely six inches thick, this thin film of soil is the foundation of civilization. Geomorphologist David Montgomery, in *Dirt: The Erosion of Civilizations*, describes soil as “the skin of the earth—the frontier between geology and biology.”⁴

The erosion of soil by wind and water is a worldwide challenge. For the rangelands that support 3.4 billion head of cattle, sheep, and goats, the threat comes from the overgrazing that destroys vegetation, leaving the land vulnerable to erosion. Rangelands, located mostly in semiarid regions of the world, are particularly vulnerable to wind erosion.⁵

In farming, erosion results from plowing land that is steeply sloping or too dry to support agriculture. Steeply sloping land that is not protected by terraces, perennial crops, strip cropping, or in some other way loses soil during heavy rains. Thus the land hunger that drives farmers up mountainsides fuels erosion.

In the United States, wind erosion is common in the semiarid Great Plains, where the country's wheat production is concentrated. In the U.S. Corn Belt, in contrast, where most of the country's corn and soybeans are grown, the principal threat to soil is water erosion. This is particularly true in the states with rolling land and plentiful rainfall, such as Iowa and Missouri.⁶

Water erosion of soil has indirect negative effects, which can be seen in the silting of reservoirs and in muddy, silt-laden rivers flowing into the sea. Pakistan's two large reservoirs, Mangla and Tarbela, which store Indus River

water for the country's vast irrigation network, have lost a third of their storage capacity over the last 40 years as they fill with silt from deforested watersheds.⁷

Evidence of wind erosion is highly visible in the form of dust storms. When vegetation is removed either by overgrazing or overplowing, the wind begins to blow soil particles away, sometimes creating dust storms. Because the particles are small, they can remain airborne over great distances. Once they are largely gone, leaving mostly larger particles, sandstorms begin. These are local phenomena, often resulting in dune formation and the abandonment of both farming and grazing. The emergence of sandstorms marks the final phase in the desertification process.⁸

The vast twentieth-century expansion in world food production pushed agriculture onto highly vulnerable land in many countries. The overplowing of the U.S. Great Plains during the late nineteenth and early twentieth centuries, for example, led to the 1930s Dust Bowl. This was a tragic era in U.S. history—one that forced hundreds of thousands of farm families to leave the Great Plains. Many migrated to California in search of a new life, a movement immortalized in John Steinbeck's *The Grapes of Wrath*.⁹

Three decades later, history repeated itself in the Soviet Union. The Virgin Lands Project, a huge effort between 1954 and 1960 to convert grassland into grainland, led to the plowing of an area for grain that exceeded the current grainland in Canada and Australia combined. Initially this resulted in an impressive expansion in Soviet grain production, but the success was short-lived, as a dust bowl quickly developed there too.¹⁰

Kazakhstan, at the center of the Virgin Lands Project, saw its grainland area peak at 25 million hectares in the early 1980s. After dropping to 11 million hectares in 1999, the area expanded again, reaching 17 million hectares in 2009, but then began once more to decline. Even on this

reduced area, the average grain yield today is scarcely 1 ton per hectare—a far cry from the 7 tons per hectare that farmers get in France, Western Europe’s leading wheat producer and exporter. The precipitous drop in Kazakhstan’s grain area illustrates the price that countries pay for overplowing and overgrazing.¹¹

Today two giant new dust bowls have formed. One is centered in the Asian heartland in northwestern China and western Mongolia. The other is in the African Sahel—the savannah-like ecosystem that stretches across Africa from Somalia and Ethiopia in the east to Senegal and Mauritania in the west. It separates the Sahara Desert from the tropical rainforests to the south. Both of these newer dust bowls are massive in scale, dwarfing anything the world has seen before.¹²

China may face the biggest challenge of all. After the economic reforms in 1978 that shifted the responsibility for farming from large state-organized production teams to individual farm families, China’s cattle, sheep, and goat numbers spiraled upward. A classic tragedy of the commons was unfolding. The United States, a country with comparable grazing capacity, has 94 million cattle, a somewhat larger herd than China’s 84 million. But when it comes to sheep and goats, the United States has a combined population of only 9 million, whereas China has 285 million. Concentrated in China’s western and northern provinces, these animals are stripping the land of its protective vegetation. The wind then does the rest, removing the soil and converting rangeland into desert.¹³

Wang Tao, one of the world’s leading desert scholars, reports that from 1950 to 1975 an average of 600 square miles of land turned to desert each year. Between 1975 and 1987, this climbed to 810 square miles a year. From then until the century’s end, it jumped to 1,390 square miles of land going to desert annually.¹⁴

A U.S. Embassy report entitled “Desert Mergers and Acquisitions” describes satellite images showing two of China’s largest deserts, the Badain Jaran and Tengger, expanding and merging to form a single, larger desert overlapping Inner Mongolia and Gansu Provinces. To the west in Xinjiang Province, two even larger deserts—the Taklimakan and Kumtag—are also heading for a merger. Highways running through the shrinking region between them are regularly inundated by sand dunes.¹⁵

In some places, people become aware of soil erosion when they suffer through dust storms. On March 20, 2010, for example, a suffocating dust storm enveloped Beijing. The city’s weather bureau took the unusual step of describing the air quality as hazardous, urging people to stay inside or to cover their faces if they were outdoors. Visibility was low, forcing motorists to drive with their lights on in daytime.¹⁶

Beijing was not the only area affected. This particular dust storm engulfed scores of cities in five provinces, directly affecting over 250 million people. Nor was it an isolated incident. Every spring, residents of eastern Chinese cities, including Beijing and Tianjin, hunker down as the dust storms begin. Along with having difficulty breathing and dealing with dust that stings the eyes, people must constantly struggle to keep dust out of their homes and to clear doorways and sidewalks of dust and sand. Farmers and herders whose livelihoods are blowing away are paying an even higher price.¹⁷

These huge dust storms originating in northwestern and north central China and western Mongolia form in the late winter and early spring. On average more than 10 major dust storms leave this region and move across the country’s heavily populated northeast each year. These dust storms affect not only China but neighboring countries as well. The March 2010 dust storm arrived in South

Korea soon after leaving Beijing. It was described by the Korean Meteorological Administration as the worst dust storm on record.¹⁸

Highly detailed media accounts of these storms are not always readily available, but Howard French described in the *New York Times* a Chinese dust storm that had reached South Korea on April 12, 2002. The country, he said, was engulfed by so much dust from China that people in Seoul were literally gasping for breath. Schools were closed, airline flights were cancelled, and clinics were overrun with patients who were having trouble breathing. Retail sales fell. Koreans have come to dread the arrival of what they call “the fifth season”—the dust storms of late winter and early spring.¹⁹

The situation continues to deteriorate. Korea’s Ministry of Environment reports that the country suffered dust storms on average for 39 days in the 1980s, 77 days in the 1990s, and 118 days from 2000 to 2011. These data suggest that the degradation of land is accelerating. Unfortunately, there is nothing in prospect to arrest and reverse this trend.²⁰

While people living in China and South Korea are all too familiar with dust storms, the rest of the world typically only learns about this fast-growing ecological catastrophe when the massive soil-laden storms leave that region. On April 18, 2001, for instance, the western United States—from the Arizona border north to Canada—was blanketed with dust. It came from a huge dust storm that originated in northwestern China and Mongolia on April 5.²¹

Another consequence of dust storms is the economic disruption that they cause in cities, whether it is Beijing or any of dozens of other cities in northeastern China or South Korea. Dust storms can disrupt business, reduce retail sales, close schools, and even temporarily close governments in some cases. Each of these disruptions brings its

own cost. Sometimes the effects are remote from the site of the dust, as when dust particles from African storms damage coral reefs in the Caribbean, adversely affect fishing and tourism.²²

Africa is suffering heavy losses of soil from wind erosion. Andrew Goudie, Emeritus Professor in Geography at Oxford University, reports that dust storms originating over the Sahara—once rare—are now commonplace. He estimates they have increased tenfold during the last half-century. Among the countries most affected by topsoil loss via dust storms are Niger, Chad, northern Nigeria, and Burkina Faso. In Mauritania, in Africa’s far west, the number of dust storms jumped from 2 a year in the early 1960s to 80 in 2004.²³

The Bodélé Depression, a vast low-lying region in northeastern Chad, is the source of an estimated 1.3 billion tons of dust a year, up tenfold from 1947, when measurements began. Dust storms leaving Africa typically travel west across the Atlantic, depositing dust in the Caribbean. The 2–3 billion tons of fine soil particles that leave Africa each year in dust storms are slowly draining the continent of its fertility and hence its biological productivity.²⁴

Nigeria, Africa’s most populous country, is losing 868,000 acres of rangeland and cropland to desertification each year. The government considers the loss of productive land to desert to be far and away its leading environmental problem. No other environmental change threatens to undermine its economic future so directly. Conditions will only get worse if Nigeria continues on its current population trajectory toward 390 million people by 2050.²⁵

While Nigeria’s human population has increased from 47 million in 1961 to 167 million in 2012, nearly a fourfold expansion, its population of livestock has grown from roughly 8 million to 109 million head. With the forage needs of Nigeria’s 17 million head of cattle and 92 mil-

lion sheep and goats exceeding the sustainable yield of the country's grasslands, the country is slowly turning to desert. (See Figure 5–1.)²⁶

In fact, Nigeria presents a textbook case of how mounting human and livestock population pressures reduce vegetative cover. Most notably, growth in the goat population relative to sheep and cattle is a telltale indicator of grassland ecosystem deterioration. As grasslands deteriorate from overgrazing, grass is typically replaced by desert shrubs. In such a degraded environment as Nigeria's, sheep and cattle do not fare well, but goats—being particularly hardy ruminants—forage on the shrubs.²⁷

Between 1970 and 2010, the world cattle population increased by 32 percent, the sheep population was unchanged, but the goat population more than doubled. This dramatic shift in the composition of the livestock herd, with goats now in such a dominant role, promises continuing grassland deterioration and accelerating soil erosion.²⁸

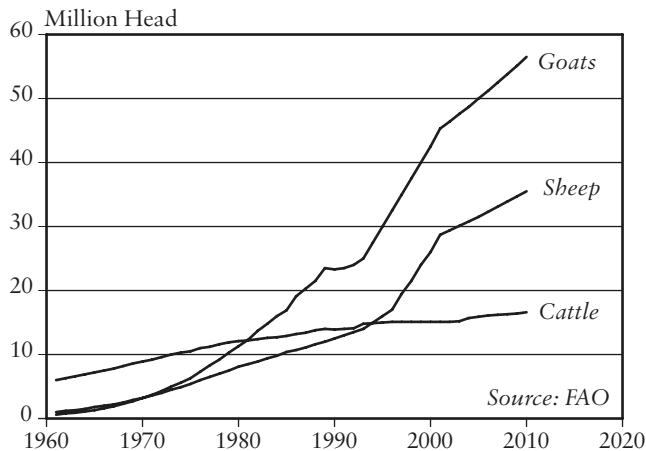


Figure 5–1. *Grazing Livestock in Nigeria, 1961–2010*

Growth in the goat population has been dramatic in some other developing countries as well, particularly in Africa and Asia, which combined account for 90 percent of the world's goats. While Pakistan's cattle population more than doubled between 1961 and 2010, and the sheep population nearly tripled, the goat population grew almost sevenfold. In Bangladesh, cattle and sheep populations have grown only modestly since 1980, while the population of goats has quadrupled. In 1985, Mali had roughly equal populations of cattle, sheep, and goats, but while its cattle and sheep populations have remained relatively stable since then, its goat population has more than tripled.²⁹

Meanwhile, on the northern fringe of the Sahara, countries such as Algeria and Morocco are attempting to halt the desertification that is threatening their fertile croplands. Algerian president Abdelaziz Bouteflika says that Algeria is losing 100,000 acres of its most fertile lands to desertification each year. For a country that has only 7.7 million acres of grainland, this is not a trivial loss. Among other measures, Algeria is planting its southernmost cropland in perennials, such as fruit orchards, olive orchards, and vineyards—crops that can help keep the soil in place.³⁰

India is also in a war with expanding deserts. With scarcely 2 percent of the world's land area, India is struggling to support 18 percent of the world's people and 15 percent of its cattle. According to a team of scientists at the Indian Space Research Organization, 25 percent of India's land surface is slowly turning into desert. It thus comes as no surprise that many of India's cattle are emaciated.³¹

In Afghanistan, a U.N. Environment Programme (UNEP) team reports that in the Sistan region in the country's southwest "up to 100 villages have been submerged by windblown dust and sand." The Registan Desert is migrating westward, encroaching on agricultural areas.

In the country's northwest, sand dunes are moving onto agricultural land in the upper Amu Darya basin, their path cleared by the loss of stabilizing vegetation due to firewood gathering and overgrazing. The UNEP team observed sand dunes as high as a five-story building blocking roads, forcing residents to establish new routes.³²

An Afghan Ministry of Agriculture and Food report sounds the alarm: "Soil fertility is declining,...water tables have dramatically fallen, de-vegetation is extensive and soil erosion by water and wind is widespread." After three decades of armed conflict and the related deprivation and devastation, Afghanistan's forests are nearly gone. Seven southern provinces are losing cropland to encroaching sand dunes. And like many failing states, even if Afghanistan had appropriate environmental policies, it lacks the law enforcement capacity to implement them.³³

Iraq, suffering from nearly a decade of war and recent drought and chronic overgrazing and overplowing, is now losing irrigation water to its upstream riparian neighbor—Turkey. The reduced river flow—combined with the deterioration of irrigation infrastructure, the depletion of aquifers, the shrinking irrigated area, and the drying up of marshlands—is drying out Iraq. The Fertile Crescent, the cradle of civilization, may be turning into a dust bowl.³⁴

Dust storms are forming with increasing frequency in western Syria and northern Iraq. In July 2009 a dust storm raged for several days in what was described as the worst such storm in Iraq's history. As it traveled eastward into Iran, the authorities in Tehran closed government offices, private offices, schools, and factories. Although this new dust bowl is small compared with those centered in northwest China and across central Africa, it is nonetheless an unsettling new development in this region.³⁵

Iran—with 76 million people—illustrates the pressures facing the Middle East. With 9 million cattle and 80 mil-

lion sheep and goats—the source of wool for its famed rug-making industry—Iran's rangelands are deteriorating from overstocking. Mohammad Jarian, who heads Iran's Anti-Desertification Organization, reported in 2002 that sandstorms had buried 124 villages in the southeastern province of Sistan-Balochistan, forcing their abandonment. Drifting sands had covered grazing areas, starving livestock and depriving villagers of their livelihoods.³⁶

As countries lose their topsoil, they eventually lose the capacity to feed themselves. Among those facing this problem are Lesotho, Mongolia, North Korea, and Haiti. Lesotho, one of Africa's smallest countries, with only 2 million people, is paying a heavy price for its soil losses. A U.N. team visited in 2002 to assess its food prospects. Their finding was straightforward: "Agriculture in Lesotho faces a catastrophic future; crop production is declining and could cease altogether over large tracts of the country if steps are not taken to reverse soil erosion, degradation, and the decline in soil fertility."³⁷

Michael Grunwald reported in the *Washington Post* that nearly half of the children under five in Lesotho are stunted physically. "Many," he wrote, "are too weak to walk to school." Over the last decade, Lesotho's grain harvest dropped by half as its soil fertility fell. Its collapsing agriculture has left the country heavily dependent on food imports.³⁸

A similar situation exists in Mongolia, where over the last 20 years more than half of the wheatland has been abandoned and wheat yields have started to fall, shrinking its harvest. Mongolia now imports nearly 20 percent of its wheat. At the same time, North Korea, largely deforested and suffering from flood-induced soil erosion and land degradation, has watched its yearly grain harvest fall from a peak of almost 6 million tons during the 1980s to scarcely 3 million tons per year today.³⁹

In the western hemisphere, Haiti—one of the early failing states—was largely self-sufficient in grain 40 years ago. Since then it has lost nearly all its forests and much of its topsoil, forcing it to import over half of its grain. It is now heavily dependent on U.N. World Food Programme lifelines.⁴⁰

The accelerating loss of topsoil is slowly but surely reducing the earth's inherent biological productivity. The shrinking area of productive land and the earth's steadily expanding human population are on a collision course. Soil erosion and land degradation issues are local, but their effect on food security is global.

Data, endnotes, and additional resources can be found at Earth Policy Institute, www.earth-policy.org.