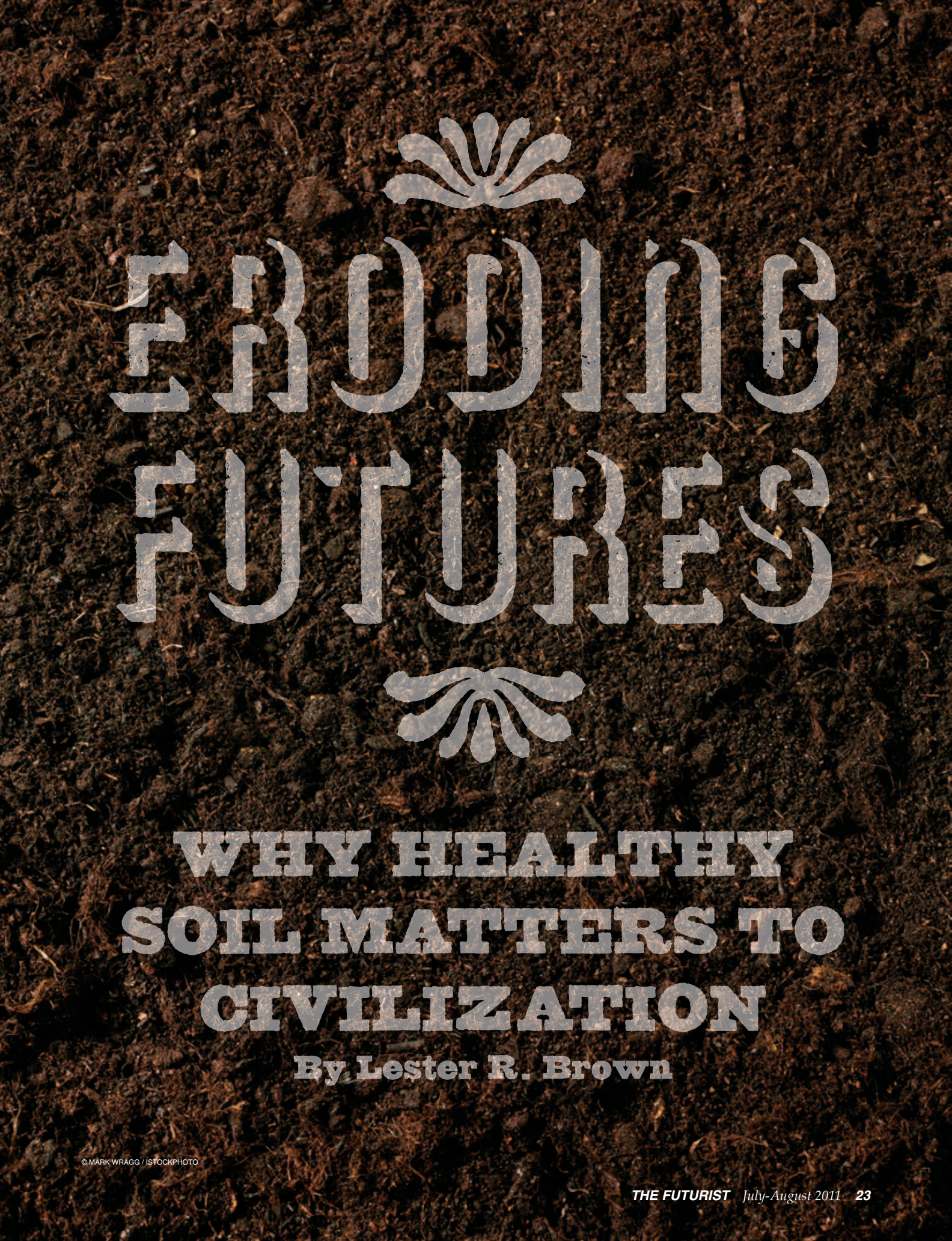


# ERODING FUTURES

## WHY HEALTHY SOIL MATTERS TO CIVILIZATION

By Lester R. Brown

**The earth beneath our feet is the Earth's infrastructure for the resources that sustain our civilizations—and our futures. A leading agricultural policy expert shows what we must do to save the soil.**

The signs that our civilization is in trouble are multiplying. During most of the 6,000 years since civilization began, we lived on the sustainable yield of the Earth's natural systems. In recent decades, however, humanity has overshot the level that those systems can sustain.

We are liquidating the Earth's natural assets to fuel our consumption. Half of us live in countries where water tables are falling and wells are going dry. Soil erosion exceeds soil formation on one-third of the world's cropland, draining the land of its fertility. The world's ever-growing herds of cattle, sheep, and goats are converting vast stretches of grassland to desert. Forests are shrinking by 13 million acres per year as we clear land for agriculture and cut trees for lumber and paper. Four-fifths of oceanic fisheries are being fished at capacity or overfished and headed for collapse. In system after system, demand is overshooting supply.

For past civilizations, it was sometimes a single environmental trend that was primarily responsible for their decline. Sometimes it was multiple trends. For ancient Sumer, decline could be attributed to rising salt concentrations in the soil as a result of an environmental flaw in the design of their otherwise extraordinary irrigation system. After a point, the salts accumulating in the soil led to a decline in wheat yields. The Sumerians then shifted to barley, a more salt-tolerant crop, but eventually barley yields also began to decline. The collapse of the civilization followed.

Although we live in a highly urbanized, technologically advanced society, we are as dependent on the Earth's natural support systems as the Sumerians and Mayans were. If we continue with business as usual, civilizational collapse is no longer a matter of *whether* but *when.* We now have an economy that is destroying its natural support systems and has put us on a decline and collapse path. We are dangerously close to the edge. Among other actions, we need a worldwide effort to conserve soil, similar to the U.S. response to the Dust Bowl of the 1930s.

On March 20, 2010, 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 when they were outdoors. Visibility was low, forcing motorists to drive with their lights on in daytime.

Beijing was not the only area affected. This particular dust storm engulfed scores of cities in five provinces, directly affecting more than 250 million people. It was not an isolated incident. Every spring, residents of eastern Chinese cities, including Beijing and Tianjin, hunker down as the dust storms begin. Along with the difficulty in breathing and the stinging eyes, there is a constant struggle to keep dust out of homes and to clear doorways and sidewalks of dust and sand. The farmers and herders whose livelihoods are blowing away are paying an even higher price.

These annual dust storms affect not only China, but neighboring countries as well. The March 20 dust storm arrived in South Korea soon after leaving Beijing. It was described by the Korean Meteorological Administration as the worst dust

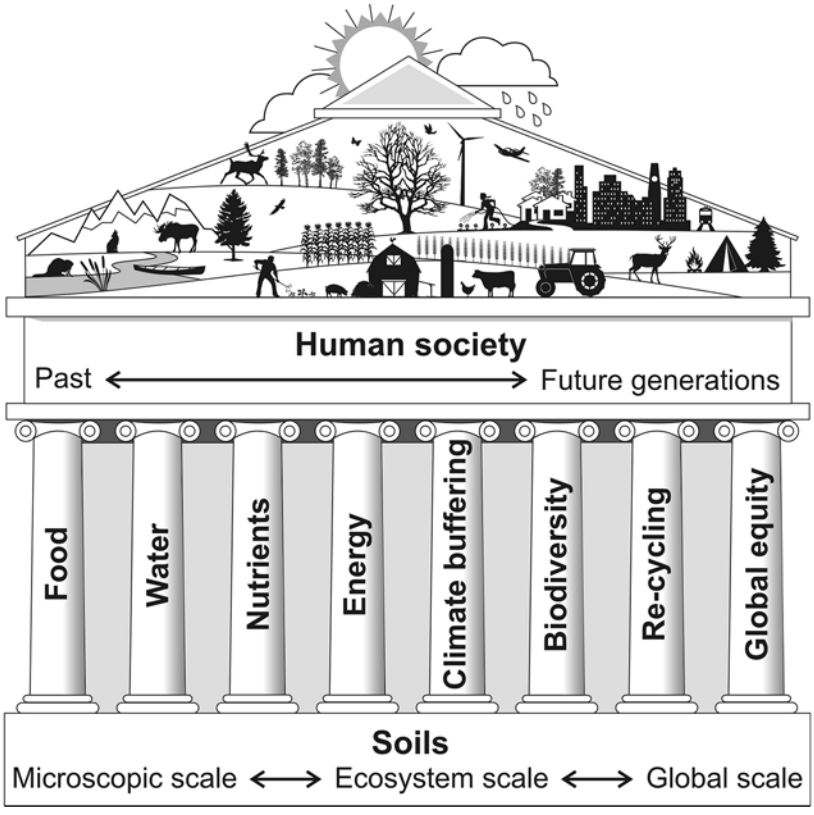



Chart created by Pacific Northwest National Laboratory researchers illustrates the importance of soil as a foundation for society and the future stability of civilizations. Because of soil's importance to so many critical issues, the researchers encourage soil scientists to broaden their focus to entire ecosystems.

PNNL, WWW.PNL.GOV

JAMES YOUNG / USDA-ARS

In a U.S. pasture, the land shown on the right has been stripped by grazing goats. With more than 30 times as many goats and sheep as the United States has, northern and western China's farmlands are at risk, as the loss of protective vegetation exposes topsoil to wind erosion.

JACK DYKINGA USDA-ARS

Low-till farming versus deep-till? Conventional deep-tilling techniques (right) expose soil to erosion and disrupt the work of microbes and earthworms, according to the U.S. Agricultural Research Service. But low-till farming and covering land with crop residue offer greater protections for the soil.

storm on record. In a similar event in 2002, South Korea was engulfed by so much dust from China that people in Seoul were literally gasping for breath, reported Howard French for *The New York Times*. Schools were closed, airline flights were canceled, retail sales fell, and clinics were overrun with patients having difficulty breathing. Koreans have come to dread the arrival of what they call "the fifth season"—the dust storms of late winter and early spring.

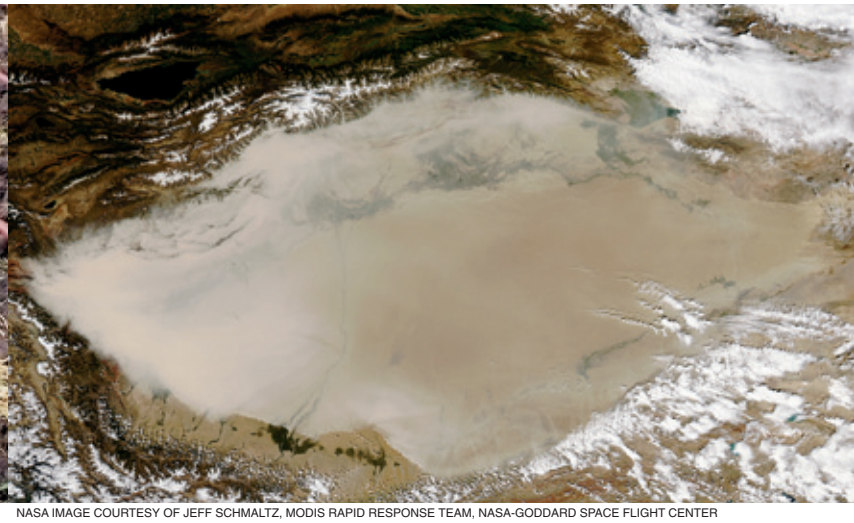
While people living in China and South Korea are all too familiar with dust storms, the rest of the world typically learns about this fast-growing ecological catastrophe when the massive soil-laden storms leave the region. In April 2010, a National Aeronautics and Space Administration (NASA) satellite tracked a dust storm from China as it journeyed to the east coast of the United States. Originating in the Taklimakan and Gobi deserts, it ultimately covered an area stretching from North Carolina to Pennsylvania. Such huge dust storms carry off millions of tons of topsoil, a resource that will take centuries to replace.

### Civilization's Earthy Foundation

The thin layer of topsoil that covers much of the planet's land surface and is typically measured in inches is the foundation of civilization. Soil is "the skin of the earth—the frontier between geology and biology," writes geomorphologist David Montgomery in *Dirt: The Erosion of Civilizations*. After the Earth was created, soil formed slowly over geological time from the weathering of rocks. This soil supported early plant life on land. As plant life spread, the plants protected the soil from wind and water erosion, permitting it to accumulate and to support even more vegetation. This relationship facilitated an accumulation of topsoil that could support a rich diversity of

C. G. WAGNER / WFS

The People's Garden at U.S. Department of Agriculture headquarters in Washington, D.C., displays examples of soil-friendly agricultural techniques, including drip irrigation and coverage with crop residue.



NASA IMAGE COURTESY OF JEFF SCHMALTZ, MODIS RAPID RESPONSE TEAM, NASA-GODDARD SPACE FLIGHT CENTER

Thick dust clogs the air over China's Taklimakan Desert, September 2010. Soil erosion is not just a local problem (and one that may take centuries to repair), but also a global problem, as the wind carries away topsoil to the other side of the world.

plant and animal life.

As long as soil erosion on cropland does not exceed new soil formation, all is well. But once it does, it leads to falling soil fertility and eventually to land abandonment. Sadly, soil formed on a geological time scale is being removed on a human time scale.

Soil erosion is "the silent global crisis," observes journalist Stephen Leahy in *Earth Island Journal.* "It is akin to tire wear on your car—a gradual, unobserved process that has potentially catastrophic consequences if ignored for too long."

Losing productive topsoil means losing both organic matter in the soil and vegetation on the land, thus releasing carbon into the atmosphere. The 2,500 billion tons of carbon stored in soils dwarfs the 760 billion tons in the atmosphere, according to soil scientist Rattan Lal of Ohio State University. The bottom line is that land degradation is helping drive climate change.

Soil erosion is not new. It is as old as the Earth itself. What is new is that it has gradually accelerated ever since agriculture began. At some point, probably during the nineteenth century, the loss of topsoil from erosion surpassed the new soil that is formed through natural processes.

Today, roughly a third of the world's cropland is losing topsoil at an excessive rate, thereby reducing the land's inherent productivity. An analysis of several studies on soil erosion's effect on U.S. crop yields concluded that, for each inch of topsoil lost, wheat and corn yields declined by close to 6%.

In August 2010, the United Nations announced that desertification now affects 25% of the Earth's land area, threatening the livelihoods of more than 1 billion people—the families of farmers and herders in roughly 100 countries.

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 populations spiraled upward. The United States,

## ✿ ✿ ✿ ✿ ✿ Dust Bowl Redux ✿ ✿ ✿ ✿ ✿ ✿

Dust storms provide highly visible evidence of soil erosion and desertification. Once vegetation is removed either by overgrazing or overplowing, the wind begins to blow the small soil particles away. Because the particles are small, they can remain airborne over great distances. Once they are largely gone, leaving only larger particles, sandstorms begin. These are local phenomena, often resulting in dune formation and the abandonment of both farming and grazing. Sandstorms are the final phase in the desertification process.

In some situations, the threat to topsoil comes primarily from overplowing, as in the U.S. Dust Bowl, but in other situations, such as in northern China, the cause is primarily overgrazing. In either case, permanent vegetation is destroyed and soils become vulnerable to both wind and water erosion.

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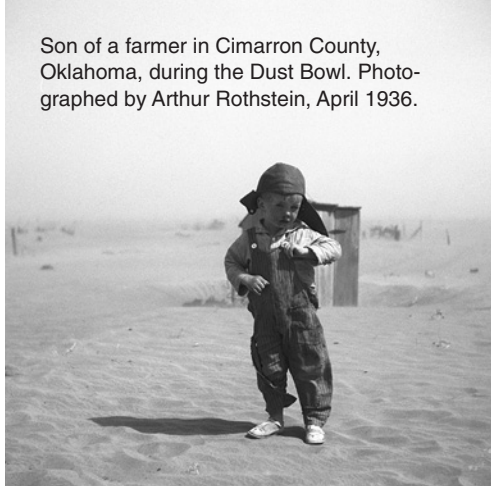

Son of a farmer in Cimarron County, Oklahoma, during the Dust Bowl. Photographed by Arthur Rothstein, April 1936.

Giant dust bowls are historically new, confined to the last century or so. During the late nineteenth century, millions of Americans pushed westward, homesteading on the Great Plains, plowing vast areas of grassland to produce wheat. Much of this land—highly erodible when plowed—should have remained in grass. Exacerbated by a prolonged drought, this overexpansion culminated in the 1930s Dust Bowl, a traumatic period chronicled in John Steinbeck's novel *The Grapes of Wrath.* In a crash program to save its soils, the United States returned large areas of eroded cropland to grass, adopted strip-cropping, and planted thousands of miles of tree shelterbelts.

Three decades later, history repeated itself in the Soviet Union. In an all-out effort to expand grain production in the late 1950s, the Soviets plowed an area of grassland roughly equal to the wheat area of Australia and Canada combined. The result, as Soviet agronomists had predicted, was an ecological disaster—another Dust Bowl.

Kazakhstan, which was at the center of this Soviet Virgin Lands Project, saw its grainland area peak at just over 25 million hectares in the mid-1980s. (One hectare equals 2.47 acres.) It then shrank to less than 11 million hectares in 1999. It is now slowly expanding, and grainland area is back up to 17 million hectares. Even on the remaining land, however, the average wheat yield 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.

Today, two giant dust bowls are forming. One is in the Asian heartland in northern and western China, western Mongolia, and central Asia. The other is in central Africa in the Sahel—the savannah-like ecosystem that stretches across Africa, separating the Sahara Desert from the tropical rain forests to the south. Both are massive in scale, dwarfing anything the world has seen before. They are caused, in varying degrees, by overgrazing, overplowing, and deforestation. *—Lester R. Brown*

a country with comparable grazing capacity, has 94 million cattle, a slightly larger herd than China's 92 million. But when it comes to sheep and goats, the United States has a combined population of only 9 million, whereas China has 281 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.

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.

China 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.

While major dust storms make the news when they affect cities, the heavy damage is in the area of origin. These regions are affected by storms of dust and sand combined. An intense 1993 sandstorm in Gansu Province in China's northwest destroyed 430,000 acres of standing crops, damaged 40,000 trees, killed 67,000 cattle and sheep, blew away 67,000 acres of plastic greenhouses, injured 278 people, and killed 49 individuals. Forty-two passenger and freight trains were either canceled or delayed, or simply parked to wait until the storm passed and the tracks were cleared of sand dunes.

### Other Regions in the Dust

While China is battling its expanding deserts, India, with scarcely 2% of the world's land area, is struggling to support 17% of the world's people and 18% of its cattle. According to a team of scientists at the Indian Space Research Organization, 24% of India's land area is slowly turning into desert. It thus comes as no surprise that many of India's cattle are emaciated and over 40% of its children are chronically hungry and underweight.

Africa, too, is suffering heavily from unsustainable demands on its croplands and grasslands. Soil scientist Rattan Lal made the first estimate of continental yield losses due to soil erosion. He concluded that soil erosion and other forms of land degradation have cost Africa 8 million tons of grain per year, or roughly 8% of its annual harvest. Lal expects the loss to climb to 16 million tons by 2020 if soil erosion continues unabated.

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. Algeria is losing 100,000 acres of its most fertile lands to desertification each year, according to President Abdelaziz Bouteflika. For a country that has only 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.

Mounting population pressures are evident everywhere on this continent where the growth in livestock numbers closely tracks that in human numbers. In 1950, Africa was home to 227 million people and about 300 million livestock. By 2009, there were 1 billion people and 862 million livestock. With livestock demands now often exceeding grassland carrying capacity by half or more, grassland is turning into desert. In addition to overgrazing, parts of the Sahel are suffering from an extended drought, one that scientists link to climate change.

The incidence of Saharan dust storms—once rare—has increased 10-fold during the last half century, reports Andrew Goudie, professor of geography at Oxford University. Among the African countries most affected by soil loss from wind erosion are Niger, Chad, Mauritania, northern Nigeria, and Burkina Faso. In Mauritania, in Africa's far west, the number of dust storms jumped from two a year in the early 1960s to 80 a year recently.

And the impacts are global. Dust storms leaving Africa travel westward across the Atlantic, depositing so much dust in the Caribbean that they cloud the water and damage coral reefs.

Nigeria, Africa's most populous country, reports losing 867,000 acres of rangeland and cropland to desertification each year. While Nigeria's human population was growing from 37 million in 1950 to 151 million in 2008, a fourfold expansion, its livestock population grew from 6 million to 104 million, a 17-fold jump. With the forage needs of Nigeria's 16 million cattle and 88 million sheep and goats exceeding the sustainable yield of grasslands, the northern part of the country is slowly turning to desert. If Nigeria's population keeps growing as projected, the associated land degradation will eventually undermine herding and farming.

In East Africa, Kenya is being squeezed by spreading deserts. Desertification affects up to a fourth of the country's 39 million people. As elsewhere, the combination of overgrazing, overcutting, and overplowing is eroding soils, costing the country valuable productive land.

In Afghanistan, a UN Environment Programme (UNEP) team reports that in the Sistan region "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.

An Afghan Ministry of Agriculture and Food report reads like an epitaph on a gravestone: "Soil fertility is declining,... water tables have dramatically fallen, de-vegetation is extensive and soil erosion by water and wind is widespread." After nearly 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 authority to implement them.

Neighboring Iran illustrates the pressures facing the Middle East. With 8 million cattle and 79 million sheep and goats—the source of wool for its fabled Persian carpet-making industry—Iran's rangelands are deteriorating from overstocking. In the southeastern province of Sistan-Balochistan, sandstorms have buried 124 villages, forcing their abandonment. Drifting sands have covered grazing areas, starving livestock and depriving villagers of their livelihood.

In Iraq, suffering from nearly a decade of war and recent drought, a new dust bowl appears to be forming. Chronically plagued by overgrazing and overplowing, Iraq is now losing irrigation water to its upstream riparian neighbors—Turkey, Syria, and Iran. The reduced river flow—combined with the drying up of marshlands, the deterioration of irrigation infrastructure, and the shrinking irrigated area—is drying out Iraq. The Fertile Crescent, the cradle of civilization, may be turning into a dust bowl.

Dust storms are occurring with increasing frequency in 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 central Africa, it is nonetheless an unsettling new development in this region.

### Food and Forage

One indicator that helps us assess grassland health is changes in the goat population relative to those of sheep and cattle. As grasslands deteriorate, grass is typically replaced by desert shrubs. In such a degraded environment, cattle and sheep do not fare well, but goats—being particularly hardy ruminants—forage on the shrubs. Between 1970 and 2009, the world cattle population increased by 28% and the sheep population stayed relatively static, but the goat population more than doubled.

In some developing countries, the growth in the goat population is dramatic. While Pakistan's cattle population doubled between 1961 and 2009, and the sheep population nearly tripled, the goat population grew more than sixfold and is now equal to that of the cattle and sheep populations combined.

As countries lose their topsoil, they eventually lose the capacity to feed themselves. Among those facing this problem are Lesotho, Haiti, Mongolia, and North Korea.

Lesotho—one of Africa's smallest countries, with only 2 million people—is paying a heavy price for its soil losses. A UN team visited in 2002 to assess its food prospect. Their finding was straightforward: "Agriculture in Lesotho faces a catastrophic future; crop production is declining and could cease altogether over large tracts of country if steps are not taken to reverse soil erosion, degradation, and the decline in soil fertility."

During the last 10 years, Lesotho's grain harvest dropped by half as its soil fertility fell. Its collapsing agriculture has left the country heavily dependent on food imports. As Michael Grunwald reported in the *Washington Post,* nearly half of the children under five in Lesotho are stunted physically. "Many," he wrote, "are too weak to walk to school."

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. Lesotho and Haiti are both dependent on UN World Food Programme lifelines.

A similar situation exists in Mongolia, where over the last 20 years nearly three-fourths of the wheatland has been abandoned and wheat yields have started to fall, shrinking the harvest by four-fifths. Mongolia now imports nearly 70% of its wheat.

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 5 million tons during the 1980s to scarcely 3.5 million tons during the first decade of this century.

Soil erosion is taking a human toll. Whether the degraded land is in Haiti, Lesotho, Mongolia, North Korea, or any of the many other countries losing their soil, the health of the people cannot be separated from the health of the land itself.

### Restoring Earth's Soil Foundation

Restoring the Earth will take an enormous international effort, one far more demanding than the Marshall Plan that helped rebuild wartorn Europe and Japan after World War II. And such an initiative must be undertaken at wartime speed before environmental deterioration translates into economic decline, just as it did for the Sumerians, the Mayans, and many other early civilizations whose archaeological sites we study today.

Protecting the 10 billion acres of remaining forests on Earth and replanting many of those already lost, for example, are both essential for restoring the planet's health. Since 2000, the Earth's forest cover has shrunk by a net 13 million acres each year, with annual losses of 32 million acres far exceeding the regrowth of 19 million acres.

Thus, protecting the Earth's soil warrants a worldwide ban on the clear-cutting of forests in favor of selective harvesting, simply because each successive clear-cut brings heavy soil loss and eventual forest degeneration. Restoring the Earth's tree and grass cover, as well as practicing conservation agriculture, protects soil from erosion, reduces flooding, and sequesters carbon.

We also need a tree-planting effort to both conserve soil and sequester carbon. To achieve these goals, billions of trees need to be planted on millions of acres of degraded lands that have lost their tree cover and on marginal croplands and pasturelands that are no longer productive.

Planting trees is just one of many activities that will remove meaningful quantities of carbon from the atmosphere. Improved grazing and land management practices that in-

## References and Resources

Data, endnotes, and additional resources can be found on Earth Policy's Web site, at www.earth-policy.org. Also see:

- *Dirt: The Erosion of Civilizations* by David R. Montgomery (University of California Press, 2007). A geomorphologist argues that we are running out of sufficient soil to feed future populations, making a case for organic inputs and conservation.
- *The Grapes of Wrath* by John Steinbeck (Viking Penguin Inc., 1939) puts environmental damage into a human context.
- Food and Agriculture Organization (www.fao.org) provides information on soil and soil resources, conservation, desertification, land assessment, plant and crop nutrition, and more.
- NASA's Earth Observatory site (http://earthobservatory.nasa.gov) offers satellite imagery showing the extent and impacts of dust storms, droughts, and more.
- U.S. Department of Agriculture Agricultural Research Service (www.ars.usda.gov) oversees the National Soil Erosion Research Laboratory, among many other programs promoting innovation in resource management.

crease the organic matter content in soil also sequester carbon.

### Lessons of the Dust Bowl

The 1930s Dust Bowl that threatened to turn the U.S. Great Plains into a vast desert was a traumatic experience that led to revolutionary changes in American agricultural practices, including the planting of tree shelterbelts (rows of trees planted beside fields to slow wind and thus reduce wind erosion) and strip cropping (the planting of wheat on alternate strips with fallowed land each year). Strip cropping permits soil moisture to accumulate on the fallowed strips, while the alternating planted strips reduce wind speed and hence erosion on the idled land.

In 1985, the U.S. Department of Agriculture, with strong support from the environmental community, created the Conservation Reserve Program (CRP) to reduce soil erosion and control overproduction of basic commodities. By 1990, there were some 35 million acres of highly erodible land with permanent vegetative cover under 10-year contracts. Under this program, farmers were paid to plant fragile cropland in grass or trees. The retirement of those 35 million acres under the CRP, together with the use of conservation practices on 37% of all cropland, reduced annual U.S. soil erosion from 3.1 billion tons to 1.9 billion tons between 1982 and 1997. The U.S. approach offers a model for the rest of the world.

Another tool in the soil conservation toolkit is conservation tillage, which includes both no-till and minimum tillage. Instead of the traditional cultural practices of plowing land and discing or harrowing it to prepare the seedbed, and then using a mechanical cultivator to control weeds in row crops, farmers simply drill seeds directly through crop residues into undisturbed soil, controlling weeds with herbicides. The only soil disturbance is the narrow slit in the soil surface where the seeds are inserted, leaving the remainder of the soil covered with crop residue and thus resistant to both water and wind erosion. In addition to reducing erosion, this practice retains water, raises soil carbon content, and greatly reduces energy use for tillage.

In the United States, the no-till area went from 17 million acres in 1990 to 65 million acres in 2007. Now widely used in the production of corn and soybeans, no-till has spread rapidly, covering 63 million acres in Brazil and Argentina and 42 million in Australia. Canada, not far behind, rounds out the five leading no-till countries. Farming practices that reduce soil erosion and raise cropland productivity such as minimum-till, no-till, and mixed crop–livestock farming usually also lead to higher soil carbon content and soil moisture. In Kazakhstan, the 3 million acres in no-till seemed to fare better than land in conventional farming during the great Russian heat wave and drought of 2010.

In sub-Saharan Africa, where the Sahara is moving southward all across the Sahel, countries are concerned about the growing displacement of people as grasslands and croplands turn to desert. As a result, the African Union has launched the Green Wall Sahara Initiative. This plan, originally proposed in 2005 by Olusegun Obasanjo when he was president of Nigeria, calls for planting a 4,300-mile band of trees, nine miles wide, stretching across Africa from Senegal to Djibouti. Senegal, which is losing 124,000 acres of productive land each year and which would anchor the green wall on the western end, has planted 326 miles of the band. A $119-million grant from the Global Environment Facility in June 2010 gave the project a big boost. Senegal's Environment Minister, Modou Fada Diagne, says, "Instead of waiting for the desert to come to us, we need to attack it." One key to the success of this initiative is improving management practices, such as rotational grazing.

In the end, the only viable way to eliminate overgrazing on the two-fifths of the Earth's land surface classified as rangelands is to reduce the size of flocks and herds. Not only do the excessive numbers of cattle, sheep, and goats remove the vegetation, but their hoofs pulverize the protective crust of soil that is formed by rainfall and that naturally checks wind erosion. In some situations, the preferred option is to keep the animals in restricted areas, bringing the forage to them. India, which has successfully adopted this practice to build the world's largest dairy industry, is a model for other countries.

### A Sustainable Plan to Preserve Soil

Conserving the Earth's topsoil by reducing erosion to the rate of new

## Plan B Budget

| Goal | Funding (billion dollars) |
|---|---|
| **Basic Social Goals** | |
| Universal primary education | 10 |
| Eradication of adult illiteracy | 4 |
| School lunch programs | 3 |
| Aid to women, infants, preschool children | 4 |
| Reproductive health and family planning | 21 |
| Universal basic health care | 33 |
| **Total** | **75** |

| Goal | Funding (billion dollars) |
|---|---|
| **Earth Restoration Goals** | |
| Planting trees | 23 |
| Protecting topsoil on cropland | 24 |
| Restoring rangelands | 9 |
| Restoring fisheries | 13 |
| Stabilizing water tables | 10 |
| Protecting biological diversity | 31 |
| **Total** | **110** |

| | |
|---|---|
| **Grand total** | **185** |
| U.S. Military Budget | 661 |
| Plan B Budget as share of this | 28% |
| World Military Budget | 1,522 |
| Plan B Budget as share of this | 12% |

Source: Military from SIPRI; other data at www.earth-policy.org.

soil formation or below has two parts. One is to retire the highly erodible land that cannot sustain cultivation—the estimated one-tenth of the world's cropland that accounts for perhaps half of all excess erosion. For the United States, that has meant retiring nearly 35 million acres. The cost of keeping this land out of production is close to $50 per acre. In total, annual payments to farmers to plant this land in grass or trees under 10-year contracts approaches $2 billion.

In expanding these estimates to cover the world, it is assumed that roughly 10% of the world's cropland is highly erodible, as in the United States, and should be planted in grass or trees before the topsoil is lost and it becomes barren land. In both the United States and China, which together account for 40% of the world grain harvest, the official goal is to retire one-tenth of all cropland. For the world as a whole, converting 10% of cropland that is highly erodible to grass or trees seems like a reasonable goal. Since this costs roughly $2 billion in the United States, which has one-eighth of the world's cropland, the total for the world would be $16 billion annually.

The second initiative on topsoil consists of adopting conservation practices on the remaining land that is subject to excessive erosion—that is, erosion that exceeds the natural rate of new soil formation. This initiative includes incentives to encourage farmers to adopt conservation practices such as contour farming, strip cropping, and, increasingly, minimum-till or no-till farming. These expenditures in the United States total roughly $1 billion per year. Assuming that the need for erosion control practices elsewhere is similar to that in the United States, we again multiply the U.S. expenditure by eight to get a total of $8 billion for the world as a whole. The two components together—$16 billion for retiring highly erodible land and $8 billion for adopting conservation practices—give an annual total for the world of $24 billion.

Altogether, then, restoring the economy's natural support systems—reforesting the Earth, protecting topsoil, restoring rangelands and fisheries, stabilizing water tables, and protecting biological diversity—will require additional expenditures of just $110 billion per year. Many will ask, Can the world afford these investments? But the only appropriate question is, Can the world afford the consequences of not making these investments? ❑

**About the Author**
Lester R. Brown is president of Earth Policy Institute and author of *World on the Edge: How to Prevent Environmental and Economic Collapse* (W.W. Norton & Company, 2011), from which this article was adapted with permission. He may be contacted at Earth Policy Institute, 1350 Connecticut Avenue, N.W., Suite 403, Washington, D.C. 20036. Web site www.earth-policy.org; e-mail epi@earth-policy.org.