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## *Eroding Soils and Expanding Deserts*

On March 20th, 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.<sup>1</sup>

Beijing was not the only area affected. This particular dust storm engulfed scores of cities in five provinces, directly affecting over 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 dust that stings the 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.<sup>2</sup>

These annual dust storms affect not only China, but neighboring countries as well. The March 20th dust storm arrived in South Korea soon after leaving Beijing. It was described by the Korean Meteorological Administration (KMA) as the worst dust storm on record.<sup>3</sup>

In a detailed account in the *New York Times*, Howard French described a Chinese dust storm that reached

Korea on April 12, 2002. South Korea, 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 having difficulty 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.<sup>4</sup>

And the situation continues to deteriorate. The KMA reports that Seoul has “suffered ‘dust events’ on 23 days during the 1970s, 41 days in the 1980s, 70 days in the 1990s, and 96 days so far this decade.”<sup>5</sup>

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. 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 5th.<sup>6</sup>

Nine years later, 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. Each of these huge dust storms carried millions of tons of China's topsoil, a resource that will take centuries to replace.<sup>7</sup>

The thin layer of topsoil that covers much of the earth's land surface and is typically measured in inches 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.” After the earth was created, soil formed slowly over geological time from the

weathering of rocks. It was this soil that 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 plant and animal life.<sup>8</sup>

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.

Journalist Stephen Leahy writes in *Earth Island Journal* that soil erosion is “the silent global crisis.” He notes that “it is akin to tire wear on your car—a gradual, unobserved process that has potentially catastrophic consequences if ignored for too long.”<sup>9</sup>

Losing productive topsoil means losing both organic matter in the soil and vegetation on the land, thus releasing carbon into the atmosphere. Rattan Lal, a soil scientist at Ohio State University, notes that the 2,500 billion tons of carbon stored in soils dwarfs the 760 billion tons in the atmosphere. The bottom line is that land degradation is helping drive climate change.<sup>10</sup>

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 percent.<sup>11</sup>

In August 2010, the United Nations announced that

desertification now affects 25 percent of the earth’s land area. And it threatens the livelihoods of more than 1 billion people—the families of farmers and herders in roughly 100 countries.<sup>12</sup>

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, sand storms begin. These are local phenomena, often resulting in dune formation and the abandonment of both farming and grazing. Sand storms 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.

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.<sup>13</sup>

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.<sup>14</sup>

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.<sup>15</sup>

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 rainforests 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.

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, 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.<sup>16</sup>

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.<sup>17</sup>

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.

A U.S. Embassy report entitled "Desert Mergers and Acquisitions" describes satellite images showing two deserts in north-central China 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.<sup>18</sup>

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. A scientific paper describes in vivid detail a 1993 sandstorm in 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." It 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 cancelled, delayed, or simply parked to wait until the storm passed and the tracks were cleared of sand dunes.<sup>19</sup>

While China is battling its expanding deserts, India, with scarcely 2 percent of the world's land area, is struggling to support 17 percent of the world's people and 18 percent of its cattle. According to a team of scientists at

the Indian Space Research Organization, 24 percent 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 percent of its children are chronically hungry and underweight.<sup>20</sup>

Africa, too, is suffering heavily from unsustainable demands on its croplands and grasslands. 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 percent of its annual harvest. Lal expects the loss to climb to 16 million tons by 2020 if soil erosion continues unabated.<sup>21</sup>

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 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.<sup>22</sup>

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.<sup>23</sup>

There is no need to visit soil-devastated countries in order to see the evidence of severe erosion in Africa. Dust storms originating in the new dust bowls are now faith-

fully recorded in satellite images. On January 9, 2005, NASA released images of a vast dust storm moving westward out of central Africa. This huge cloud of tan-colored dust extended over 3,300 miles—enough to stretch across the United States from coast to coast.<sup>24</sup>

Andrew Goudie, professor of geography at Oxford University, reports that the incidence of Saharan dust storms—once rare—has increased 10-fold during the last half-century. 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 2 a year in the early 1960s to 80 a year recently.<sup>25</sup>

The Bodélé Depression in Chad is the source of an estimated 1.3 billion tons of wind-borne soil a year, up 10-fold since measurements began in 1947. The nearly 3 billion tons of fine soil particles that leave Africa each year in dust storms are slowly draining the continent of its fertility and biological productivity. In addition, 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.<sup>26</sup>

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.<sup>27</sup>

In East Africa, Kenya is being squeezed by spreading deserts. Desertification affects up to a fourth of the coun-

try's 39 million people. As elsewhere, the combination of overgrazing, overcutting, and overplowing is eroding soils, costing the country valuable productive land.<sup>28</sup>

In Afghanistan, a U.N. 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.<sup>29</sup>

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.<sup>30</sup>

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, sand storms have buried 124 villages, forcing their abandonment. Drifting sands have covered grazing areas, starving livestock and depriving villagers of their livelihood.<sup>31</sup>

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.<sup>32</sup>

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.<sup>33</sup>

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 percent and the sheep population stayed relatively static, but the goat population more than doubled.<sup>34</sup>

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.<sup>35</sup>

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 U.N. 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.”<sup>36</sup>

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.” 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.<sup>37</sup>

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 U.N. World Food Programme lifelines.<sup>38</sup>

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 percent of its wheat.<sup>39</sup>

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.<sup>40</sup>

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.