TEN STRESSES ON THE PLANET

Loss of Topsoil

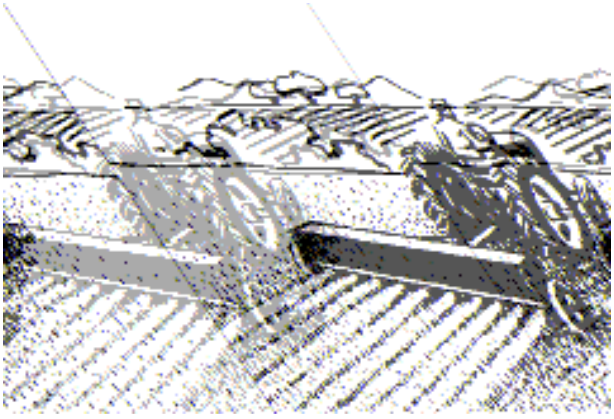
The thin layer of topsoil covering the planet's land surface is, as Lester Brown says, the foundation of civilization. As soil formed on Earth from the weathering of rock and accumulation of organic material, it provided a medium in which plants could grow. Plants, in turn, protect the soil from erosion.[1] In a natural state, the rate of soil formation is relatively equivalent to the rate of soil erosion, the gradual movement of soil to the sea. However, human activities causing soil erosion, degradation, and contamination are threatening this balance. Hope lies in new farming techniques and grassroots efforts that help restore the balance.

TOPSOIL EROSION

The rate of soil erosion now vastly exceeds soil formation. Soil is washed away ten times faster than it is replenished in the US and 40 times faster in China and India.[2] In some areas of the Great Plains, agricultural topsoil has decreased in thickness from 12 inches to less than four inches.[3] As a result of erosion in the last 40 years, 30 percent of the world's arable land has become unproductive.[4] Just as it takes hundreds of years for a clear-cut forest to return to an old growth state, an inch of topsoil can take 500 years to form, and at least six inches are needed for crop production.[5]

Where land is dry and bare, soil is easily eroded by winds. Americans are familiar with the 1930s' Dust Bowl of the Great Plains, which took place after years of over plowing followed by successive droughts. The same phenomenon occurred in the Soviet Union in the 1960s and is now frequent in northern Africa and China. In 2001, the western US was blanketed with dust from a huge storm in China and Mongolia.

SOIL DEGRADATION



Approximately 65 percent of the earth's soils are degraded to some extent.[6] The primary causes are overgrazing, removal of vegetation, and agricultural practices.[7] When land is overgrazed or deforested or when crops are harvested, there is often not enough plant litter remaining to protect and nourish the soil. Soil organisms die, resulting in a loss of fertility. Sparse cover allows raindrops to erode the surface, loosening the soil's structure, freeing up fine clay particles, and transporting them downhill.[8] Repeated mechanical tilling changes the structure of the soil so it erodes more easily, and compaction by heavy farm equipment reduces water infiltration and increases runoff. Nutrients are also lost when farmers fail to allow fallow periods or to replenish the soil.

Desertification, the gradual process of soil productivity loss and thinning of vegetative cover, is a problem on 30 percent of Earth's land.[9] It is most extensive in Africa, central Asia, and

northeastern Brazil. But the phenomenon has also occurred in the semi-arid Western US, primarily from cattle grazing in the late 1800s.[10] More than 22,000 square miles of arable land on Earth turn into desert each year.[11]

Over time, irrigation of land can cause water logging or salinization—a buildup of salt in the soil. In poorly drained soil, the excess water sometimes pushes the water table up near plant roots. Air spaces become filled with water, and plant roots suffocate. Water used for irrigation contains small amounts of salt, which are left behind when water evaporates from the ground surface. In arid areas, salt can accumulate, inhibiting the ability of plants to absorb water. Salt problems are especially severe throughout Asia and in California, where human use of the Colorado River has approximately doubled its salinity.[12] According to a UN Food and Agricultural Organization estimate, salt buildup has severely damaged about 13 percent of the world's irrigated farmland.[13] Drip irrigation could help prevent this phenomenon, but poor countries have not been able to afford it.

Soil Contamination and the Importance of Soil Organisms in Ecosystems

Excessive application of chemicals by farmers or spills and leaks of petroleum products and toxic substances by other users kill soil organisms. Soil is a complex living food web, where a variety of organisms interact to process organic matter, recycle nutrients, and nurture plants. According to soil scientist Elaine Ingham at Oregon State University, just one gram of healthy agricultural soil contains around 100 yards of threadlike fungal material, 100 million bacteria, tens of thousands of one-celled organisms called protozoa, and up to 2000 tiny worms called nematodes. Growth of plants depends upon the presence of these microorganisms, which interact to retain nutrients and make nitrogen available. Higher up the food chain are the springtails and mites that prey on fungi. Larger still are the earthworms, ants, termites, millipedes, and beetles that fragment the organic debris, aerate the soil, and form channels for infiltration of water.[14]

Ingham explains, "Once you start killing off these organisms, you've reduced the capacity of that ecosystem to resist disease. So you apply more pesticides, and you kill off more of these organisms, which just makes it easier for the pathogen to come back each year." The effect is that soil viability can be lost in as little as 40 to 50 years. Fertilizers move right through the soil because fewer organisms are left to retain them. The solution is to rebuild populations of the microorganisms.[15]

Lack of knowledge about the intricacies of soil ecosystems was highlighted by the failure of Biosphere 2. This manmade "ecosystem," built in Arizona, was to house eight human beings along with 4,000 species of plants and animals for two years. The technological wonder began to experience problems soon after the experiment began in 1991. By 1993, oxygen concentrations had fallen precipitously within the enclosed atmosphere. Morning glory vines, introduced to absorb excess carbon dioxide, overran other plants. Nineteen of 25 vertebrate species died off, as did all pollinators, dooming many plants to seedlessness. The majority of insects were lost, leaving ants, cockroaches, and katydids as the dominant species. Scientists still don't understand the causes of ecosystem failure, but one guess is the imbalance of introduced soil. A high level of organic matter caused microbial populations to take off and consume the available atmospheric oxygen.[16]

WHAT IS BEING DONE?

A number of farming practices are currently being implemented in the developed world to limit soil degradation, including using drip irrigation, planting cover crops at the end of the growing season, applying manure or other organic material to the soil, rotating crops, practicing contour cultivation, and using no-till methods. The practice of organic agriculture, which eschews pesticides and synthetic fertilizers and optimizes long-term soil fertility, is becoming more prevalent to meet consumer demand. In parts of the developing world, grassroots community action is being taken. In one region of Burkina Faso, Africa, basins are dug during the dry season and filled with compost or manure to reclaim degraded land and restore soil fertility. Sorghum yields there have increased by 400 percent.[17]

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