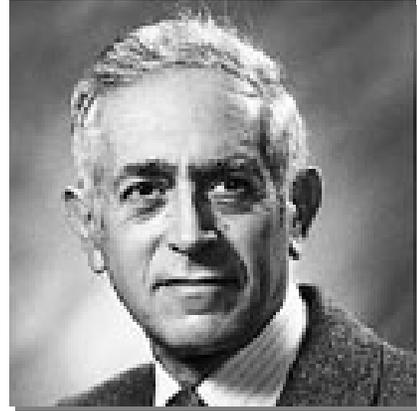


## GUEST ESSAY

### Land Degradation and Environmental Resources

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At a time when the world's human population is rapidly expanding and its need for more land to produce food, fiber, and fuelwood is also escalating, valuable land is being degraded through erosion and other means at an alarming rate. Soil degradation is of great concern because soil reformation is extremely slow. Globally it takes an average of 500 years (with a range of 220 to 1,000 years) to renew 2.5 centimeters (1 inch) of soil in tropical and temperate areas—a renewal rate of about 1 metric ton of topsoil per hectare of land per year. Worldwide annual erosion rates for agricultural land are about 20–100 times this average.

Erosion rates vary in different regions because of topography, rainfall, wind intensity, and the type of agricultural practices used. In China, for example, the average annual soil loss is reported to be about 40 metric tons per hectare (18 tons per acre), whereas the U.S. average is 18 metric tons per hectare (8 tons per acre). In states such as Iowa and Missouri, however, annual soil erosion averages more than 35 metric tons per hectare (16 tons per acre).

Worldwide, about 10 million hectares (25 million acres) of land—an area about the size of the state of Virginia—are abandoned for crop production each year because of high erosion rates plus waterlogging, salinization, and other forms of soil degradation. In addition, according to the UN Environment Programme, crop production becomes uneconomical on about 20 million hectares (49 million acres) each year because soil quality has been severely degraded.

Soil erosion also occurs in forestlands, but it is not as severe as that in the more exposed soil of agricultural land. Soil erosion in managed forests is a primary concern because the soil reformation rate in forests is about two to three times slower than that in agricultural land. To compound this erosion problem, at least 24 million hectares (59 million acres) of forest are being cleared each year throughout the world; most of this land is used to grow food and graze cattle.

The effects of agriculture and forestry are interrelated in other ways. Deforestation reduces fuelwood supplies and forces the poor in developing countries to substitute crop residue and manure for fuelwood. When these plant and animal wastes are burned instead of being returned to the land as ground cover and organic fertilizer, erosion is intensified and productivity of the land is decreased. These factors, in turn, increase pressure to convert more forestland into agricultural land, further intensifying soil erosion.

One reason that soil erosion is not a high priority among many governments and farmers is that it usually occurs so slowly that its cumulative effects may take decades to become apparent. For example, the removal of 1 millimeter (1/25 inch) of soil is so small that it goes undetected. But over a 25-year period the loss would be 25 millimeters (1 inch), which would take about 500 years to replace by natural processes.

Besides reduced soil depth, soil erosion leads to lower crop productivity because of losses of water, organic matter, and soil nutrients. A 50% reduction of soil organic matter on a plot of land has been found to reduce corn yields as much as 25%.

When soil erodes, vital plant nutrients such as nitrogen, phosphorus, potassium, and calcium are also lost. With U.S. annual cropland erosion rates of about 18 metric tons per hectare (8 tons per acre), an estimated \$18 billion of plant nutrients is lost annually. Using fertilizers to replace these nutrients substantially adds to the cost of crop production.

Some analysts who are unaware of the numerous and complex effects of soil erosion have falsely concluded that the damages are minor. For example, they report that soil loss causes an annual reduction in crop productivity of only 0.1–0.5% in the United States. However, we must consider all the ecological effects caused by erosion, including reductions in soil depth, availability of water for crops, and soil organic matter and nutrients. When this is done, agronomists and ecologists report a 15–30% reduction in crop productivity, leading to increased use of costly fertilizer.

Because fertilizers are not a substitute for fertile soil, they can be applied only up to certain levels before crop yields begin to decline.

Reduced agricultural productivity is only one of the effects of soil erosion. In the United States, water runoff is responsible for transporting about 3 billion metric tons (3.3 billion tons) of sediment (about 60% from agricultural land) each year to waterways in the lower 48 states. Off-site damages to U.S. water storage capacity, wildlife, and navigable waterways from these sediments cost an estimated \$6 billion each year. About one-fourth of new water storage capacity in U.S. reservoirs is built solely to compensate for sediment buildup in older reservoirs.

When soil sediments that include pesticides and other agricultural chemicals are carried into streams, lakes, and reservoirs, fish production is adversely affected. These contaminated sediments interfere with fish spawning, increase predation on fish, and destroy fisheries in estuarine and coastal areas.

Increased erosion and water runoff on mountain slopes flood agricultural land in the valleys below, further decreasing agricultural productivity. Eroded land also does not hold water very well, again decreasing crop productivity. This effect is magnified in the 80 countries (with nearly 40% of the world's population) that experience frequent droughts.

Thus, soil erosion is one of the world's critical problems, and if not slowed, it will seriously reduce agricultural and forestry production and degrade the quality of aquatic ecosystems. Solutions that are not particularly difficult are often not implemented because erosion occurs so gradually that we fail to acknowledge its cumulative effects until damage is irreversible. Many farmers have also been conditioned to believe that losses in soil fertility can be remedied by applying more fertilizer or by using more fossil-fuel energy.

The principal way to control soil erosion and its accompanying runoff of sediment is to maintain adequate vegetative coverage on soils by a variety of well-known methods. These methods are also cost-effective, especially when off-site costs of erosion are included. Scientists, policy makers, and agriculturists need to work together to implement soil and water conservation practices before world soils lose most of their productivity.