Soil and Water Resources

Fred P. Miller, Soil and Water Resource Specialist

Soil Erosion: Can Mother Nature Replace It Fast Enough?

A recent study by the Soil Conservation Service confirmed that water is washing away soils on the Nation's cropland at an average rate of 9 tons per acre per year. This rate is nearly twice the rate considered "acceptable" by soil conservationists. The Middle Atlantic region averaged losses of 14 tons per acre per year from its cropland acreage, according to this study.

Soil losses from U.S. croplands totaled 2.8 billion tons in 1975. Nearly 42 percent of the 355 million acres of cropland harvested in 1975 were not receiving adequate treatment for soil erosion.

How much soil does 10 tons represent? A foot of Maryland topsoil over an acre (43,560 ft^2) weighs about 1800 tons (dry). Thus, an acre-inch of this dry soil weighs 150 tons. This is equivalent to 83 pounds per cubic foot or 1.12 tons per cubic yard. Soils with high organic matter content and low bulk density will weigh less and soils with high sand concentrations or high densities will weigh more. But these figures provide us with at least some general references.

Losing soil at the rate of 10 tons per acre per year would take 15 years to remove one inch of soil from an acre.

Is this loss rate alarmingly high? The annual geologic or natural erosion rate on sloping soils in Maryland under native forested conditions can be guesstimated at rates in the neighborhood of 0.5 ton to 1 per acre. Therefore, an erosion rate of 10 tons per acre per year represents a soil loss that is roughly 10 to 20 times the natural soil loss rate.

Sediment measurements in Maryland streams draining forested areas are in the range of 10 to 25 tons per $mile^2$ while streams draining predominantly agricultural watersheds yield sediment deliveries of 200 to 500 tons per $mile^2$. It must be emphasized that these figures represent only the sediment actually reaching the stream and that scoured from the stream bed itself. Most of the soil eroded from a field is trapped in flood-plains and areas remote from the stream. Thus, only a small fraction (ca. 6-15 percent) of the soil eroded or moved from a point on the landscape actually gets delivered to a stream.

From soil survey data, Maryland has lost an average of 3 inches of topsoil since the forests were cleared. For the nearly level and flat areas of the State, the erosion rate has been relatively low or negligible. But for the steeper and more rolling landscapes, topsoil losses have exceeded this average. Maryland's Piedmont landscapes have commonly lost 50 percent or more of the original topsoil (9-14 inches thick) with as much as 6 or more inches having been removed.

How long will it take to replace this soil? How long does it take to form an inch of soil? If we are losing 10 tons of soil per acre per year, can Mother Nature keep up with this rate of soil loss?

Rocks and earthern materials differ in their susceptibility to weathering. The intensity of the weathering process differs from place to place. Because of these variations, soil scientists think in terms of horizon and soil profile development rather than in terms of inches of soil formed per century. An area of barren granite exposed in the tropical climate of Puerto Rico will develop a soil profile much faster than the same rock material exposed to the less intense climate of Maryland. A highly metamorphosed mica schist, typical of Maryland's Piedmont, exposed to the same climatic variations may form soil profiles much faster than the resistant granite exposed to the same weathering intensities.

Soils developed from hard resistant bedrock in low rainfall areas may have taken several thousand years to form just a few inches of topsoil. Where porous or fractured material susceptible to weathering occurs in a warm, humid climate, soil profiles up to several feet thick

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can form in a thousand years. Therefore, depending upon the weathering intensity (climate) and parent material (bedrock or unconsolidated materials), soils can form at rates of as much as one inch in several decades to as little as one inch in 1000 years or longer.

Radiocarbon dates of buried organic matter in silty soils typical of those in Maryland's Coastal Plain and Eastern Shore, indicate that these soils have taken about 10,000 years to reach their present profile development. These soils are about 3 feet thick. Therefore, soil development has occurred in these soils at a rate of one inch in less than 300 years. No doubt the upper horizons and topsoil form at a more rapid rate than the subsoil horizons, indicating a rate of formation that is not uniform with time. But, in the interest of illustrating a point, this rate of soil formation yields about 150 tons of soil in less than 300 years, or about 2 tons per acre per year. Thus, an erosion rate of 10 tons per acre per year is removing soil about 5 times as fast as it can be replaced under its natural environment.

For soils on Maryland's Piedmont formed in more resistant rocks, the rate of soil formation is even slower. Some of these soils have probably taken as much as hundreds of thousands of years to reach their present profile development. These soils are very prone to erosion loss. Annual soil losses at rates of 10 tons per acre exceed their replacement rate manyfold. Even the "acceptable" soil loss tolerances of 3 tons per acre per year are most likely far in excess of the soil formation capabilities of the environmental conditions for many of Maryland's Piedmont soils.

The dilemma facing us today is that a 10 ton per acre soil loss is not an alarmingly high amount of soil loss when such a rate represents "only" 0.07 inches of soil lost per year. It is hard to get excited about losing such a thin layer of soil. We can continue to lose these amounts of soil and not suffer too much in yields. We are, at least partially, substituting energy-intensive resources (e.g. fertilizers) for the lost topsoil to sustain high yields. And we can continue to do so for many years.

But we are mining our soils at current loss rates. The piper will have to be paid. It is being paid now with increased energy inputs to sustain yields and environmental degradation caused by the sediment losses. But, perhaps worst of all, the insidious process of erosion is happening before our eyes at a slow enough rate to seduce us into complacency but at rates that are many times faster than what it takes Mother Nature to form new soil to replace what was lost. Eventually this policy will catch up with us. Future generations will look back at our efforts as stewards of the soil resource. The recent SCS study suggests that they will be disappointed in what history tells them.

From men, man learns to speak,
from the gods to keep silent.