Rangeland Soil Quality

National Park Service
U.S. Department of the Interior

Inventory & Monitoring Program
Soil Resources Inventory

Water Erosion

Water erosion is the detachment and removal of soil material by water. The process may be natural or accelerated by human activity. The rate of erosion may be very slow to very rapid, depending on the soil, the local landscape, and weather conditions. Water erosion wears away the earth's surface. Sheet erosion is the more- or- less uniform removal of soil from the surface.. Rill and gully erosion occurs when concentrated runoff cuts conspicuous channels into the soil. Deposition of the sediment removed by erosion is likely in any area where the velocity of running water is reduced—behind plants, litter, and rocks; in places where slope is reduced; or in streams, lakes, and reservoirs.

Why is erosion a concern?

Loss of topsoil changes the capacity of the soil to function and restricts its ability to sustain future uses. Erosion removes or redistributes topsoil, the layer of soil with the greatest amount of organic matter, biological activity, and nutrients. The ability of a plant community to recover after topsoil is lost is restricted. Erosion breaks down soil structure, exposing organic matter within soil aggregates to decomposition and loss. Degraded soil structure reduces the rate of water infiltration. Erosion of nutrient- rich topsoil can cause a shift to less desirable plants, such as from grass to shrub species. In this process, soil organic matter and nutrients eroded from one area contribute to resource accumulation in another, such as the area around shrubs. Erosion of shallow soils can decrease the thickness of the root zone and the amount of air, water, and nutrients available to plants. The sediment removed by erosion can bury plants and roads; accumulate in streams, rivers, and reservoirs; and degrade water quality.

What causes water erosion?

Erosion is caused by the impact of raindrops on bare soil and by the power of running water on the soil surface. Natural erosion rates depend on inherent soil properties, slope, and climate, which together determine the ability of the site to support vegetation. Accelerated erosion occurs when the plant cover is depleted, the spaces between plants becomes larger, and soil structure is degraded by excessive disturbance or reduced inputs of organic matter. Compaction increases runoff and the risk of accelerated erosion. Runoff concentrated by poorly designed or maintained roads or trails can cause accelerated erosion on the adjacent slopes and in roadbeds. Many vegetation and soil properties affect the risk of erosion. Each specific soil has its own natural erosion rate. A sandy or clayey texture generally is less erodible than loam or silt loam. Sandy soils that formed in material weathered from decomposed granitic rock, however, are highly erodible. Soils with rock fragments or biological crusts on the surface are protected from the impact of raindrops. Stable soil aggregates bound together by organic matter resist erosion, enhance infiltration, and result in less runoff. The amount of runoff and the power of water to erode and transport soil are greater on long, steep slopes. Bare soil between plants is most susceptible to erosion.

What are some indicators of erosion?

Erosion and the risk of erosion are difficult to measure directly. Other soil properties that affect erosion and can change with management, including soil surface stability, aggregate stability, infiltration, compaction, and content of organic matter, can be measured. Measuring these properties can shed light on the susceptibility of a site to erosion. Comparing visual observations along with quantitative measurements to the conditions indicated in the ecological site description or a reference area helps to provide information about soil surface stability, sedimentation, and soil loss.

The visual indicators used to identify past erosion include:

- bare soil;
- pedestaled plants or rocks;
- exposed roots;
- terracettes (benches of soil deposited behind obstacles);
- an increase in the number and connectivity of waterflow patterns between plants;
- soil deposition at slope changes;
- changes in thickness of topsoil;
- exposure of subsoil at the surface;
- rills, headcutting, and/or downcutting in gullies;
- sediment in streams, lakes, and reservoirs; and
- reduced plant growth.

When measured every few years, the following indicators can be used to predict where accelerated erosion is likely to occur in the future:

- an increase in the amount of bare ground or in the size or connectivity of bare patches,
- reduced soil aggregate and soil surface stability, and
- reduced water infiltration.

Management strategies that minimize water erosion

The risk of erosion and the potential for recovery after erosion must be considered in any management plan. The risk of erosion is increased by a fire frequency or intensity that is either greater or less than is expected for the site; by disturbances, such as heavy grazing; and by the establishment of weeds. Areas with fertile topsoil are most likely to recover after a disturbance. In areas where much of the topsoil is lost, the site may no longer be able to support the historic vegetation.

Management strategies include:

- Maintain or increase the cover of plants or litter on the soil through the application of good rangeland management practices.
- Reduce soil surface disturbances, especially in arid areas.
- Increase the rate of water infiltration and improve soil aggregate stability by improving or maintaining the quality of the plant community.
- Minimize grazing and traffic when the soil is wet and thus prevent the reduced infiltration caused by compaction and physical crusting.
- Build water bars and direct waterflow from roads, trails, or vehicle tracks across the slope or into existing drainageways.
- Maintain road surfaces and drainageways.

For More Information

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More information can also be found on the Soils website at: www2.nature.nps.gov/geology/soils

The National Park Service, Soil Inventory and Monitoring Program is partnering with the USDA-Natural Resources Conservation Service, and the USDA Agricultural Research Service, Jornada Experimental Range, to develop a series of assessment and monitoring protocols to assist NPS Vital Signs Monitoring Networks in understanding and evaluating the important role soils play within ecosystems.