USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

Rangeland Soil Health

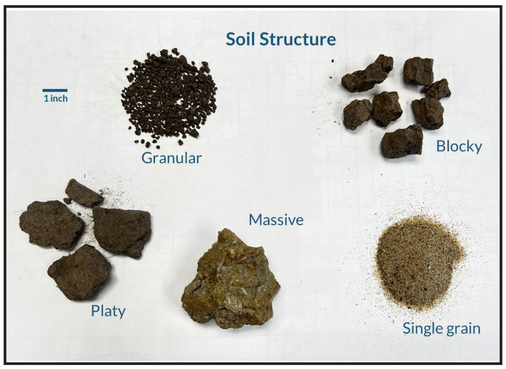
Aggregate Stability

What are soil aggregates?

Soil aggregates are groups of soil particles that are bound to each other more strongly than to adjacent particles. Organic matter "glues" produced when soil biota break down dead roots and litter hold the particles together. For example, mycorrhizal fungi produce glomalin, a sugar-protein substance that can help bind soil particles together. The threadlike strands of fungi can also join particles into aggregates. Microscopic aggregates are the building blocks of larger aggregates. The larger aggregates and the arrangement of them, along with chemical attraction between particles, determine soil structure. The structure of the surface layer commonly is granular or blocky, but a degraded surface layer can be crusted, platy, or structureless. Pores, which are important for the movement of air, water, and plant nutrients, occur within and between aggregates. Pores also provide "roads" for soil organism movement and improve water infiltration through the soil.

What is aggregate stability?

Aggregate stability refers to the ability of aggregates to resist degradation. Additions of organic matter to the soil enhance the stability of aggregates. Raindrops, flowing water, and windblown sand grains can break apart soil aggregates, exposing organic matter to decomposition and loss. Physical disturbances, such as vehicle traffic and trampling, can break down soil structure. Soils can resist degradation differently when wet or dry. For example, dense, cloddy soils can be very stable when dry but unstable when wet.



Why is aggregate stability important?

Stable aggregates are critical to erosion resistance, water availability, and root growth. Soils with stable aggregates at the surface are more resistant to water erosion than other soils, both because soil particles are less likely to be detached and because the rate of water infiltration tends to be higher on well aggregated soils. Unstable aggregates disperse during rainstorms, then form a hard physical crust when the soil dries. Physical crusts restrict seedling emergence because they have few pores for air and water entry into the soil. The crusts result in more runoff, more erosion, and less available water.

Aggregated soils hold more water than other soils and provide pores for root growth. Large, stable aggregates can resist degradation and removal by wind better than small, weak ones.

Aggregate stability is a good indicator of the content of organic matter, biological activity, and nutrient cycling in the soil. The amount of organic matter increases after the decomposition of plant residue and dead roots begins. Stable aggregates result from this process because soil biota produce material that binds particles together. "New" organic matter stabilizes the larger aggregates, while the smaller aggregates are more likely to be bound by "old" organic matter. New organic matter holds and can release more nutrients.

Changes in aggregate stability may serve as early indicators of recovery or degradation of soils and, more generally, of ecosystems. Perennial plants can often persist long after the soil and plant community have become too degraded to support plant regeneration, while recovery is often occurring long before desirable plants become reestablished.

How is aggregate stability measured?

Aggregate stability can be measured in a few different ways. The easiest way is the 'simple field method', as explained below. The first step of measuring aggregate stability is collecting samples.

Where to sample. Rangeland aggregate stability is commonly measured on soil samples removed from the top one-fourth to one-half inch of the soil. This part of the soil is most likely to be removed by wind or water erosion. Deeper samples can also be analyzed. Samples should be collected both from beneath plants and from spaces between plants. Several samples should be collected from each area.

Simple field method (no drying or weighing required). This method can be applied in the field with relatively simple tools. Remove at least nine soil fragments or 'peds' from the soil surface. These fragments should be one-fourth to one-third inch in diameter (about the size of a pencil eraser). Place each in a separate sieve constructed from ¾ inch PVC and window screen. Place each air-dry fragment in distilled water one inch deep. After five minutes, gently sieve each fragment five times, pulling the sieve completely out of the water with each cycle. Soils with low stability will appear to "melt" as soon as they are placed in the water, while soils with high stability will remain intact even after sieving.

Another easy method is the bottle cap test. This is done similarly to the simple field method above. Placing a soil fragment or 'ped' in a water bottle cap full of water. After 30 seconds, swirl the water in the bottle cap for 5 seconds. If the soil stays intact, you have good aggregate stability, but if the soil breaks apart during agitation or within the first 30 seconds, you may have low stability.

What affects aggregate stability?

The stability of aggregates is affected by soil properties that change relatively little and by properties that change in response to changes in vegetation and management. As a result, measurements of the aggregate stability of a given soil should be compared only with measurements for the same or similar soils with similar textures.

Soil properties. Soil properties that change relatively little include texture and type of clay. Expansion and contraction of clay particles as they become moist and then dry can shift and crack the soil mass and create or break apart aggregates. Calcium in the soil generally promotes aggregation, whereas sodium promotes dispersion. The quantity of calcium and sodium is specific to each type of soil.

Vegetation. Management affects the plant community. Changes in the composition, distribution, and productivity of plant species affect aggregation related soil properties, including aggregate stability, the amount and type of organic matter in the soil, and the composition and size of the soil biotic community. The amount of plant cover and the size of bare patches also are important. The centers of large bare spaces receive few inputs of organic matter and are susceptible to degradation.

Grazing. Disturbance of the soil surface by grazing animals has both beneficial and detrimental effects on aggregate stability. It breaks the soil apart, exposing the organic matter "glues" to degradation and loss by erosion; however, it also can incorporate litter and standing dead vegetation into the soil, increasing the content of organic matter in the soil. Heavy grazing that significantly reduces plant production disrupts the formation of aggregates by reducing the inputs of organic matter. Grazing is more likely to increase aggregate stability in areas where an unusually large amount of standing dead material is on the soil surface and the risk of erosion is not increased by removal of plant material and disturbance of the soil surface.

Management strategies

Improving the productivity of rangeland through good range management normally increases aggregate stability. Include practices that:

- Maintain the optimum amount of live vegetation and plant residue to maintain organic matter content, soil structure, and control erosion.
- Decrease the number and size of bare areas.
- Minimize soil surface disturbances, especially in arid areas.

For more information. Check the following: https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/soil/soil-science/ or sd.nrcs.usda.gov.