Rangeland Soil Quality—Aggregate Stability

What are soil aggregates?

Soil aggregates are groups of soil particles bound to each other more strongly than to adjacent particles. Chemical attraction between particles, coupled with glue-like substances from fungal hyphae and plant roots bind particles into aggregates. Microscopic aggregates are the building blocks of larger aggregates. Larger aggregates and their arrangement in the soil matrix determine soil structure. The structure of the soil surface layer in an undegraded soil is commonly granular, a roundish structure with relatively large macroaggregates comprised of smaller microaggregates. A degraded soil surface layer can be crusted, platy, or structureless.

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. Soils resist degradation differently when wet or dry. A dense cloddy soil may be very stable when dry but unstable when wet.

Raindrops, flowing water, windblown sand grains, and physical disturbances such as vehicle traffic and trampling can break apart soil aggregates, exposing organic matter to decomposition and loss

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 and contribute to more runoff, more erosion, and less available water due to a higher proportion of smaller pores for air and water entry. Well aggregated soils allow for higher water infiltration rates than poorly structured soils and provide pore space for root growth which is important for healthy plant production. Aggregate stability is a suitable surrogate indicator of soil organic matter content, biological activity, and nutrient cycling in the soil. Soil organic matter provides a source of energy for biological activities. When coupled with physical-chemical processes in the soil such as flocculation and swelling and shrinking of clay, stable soils aggregates are formed.

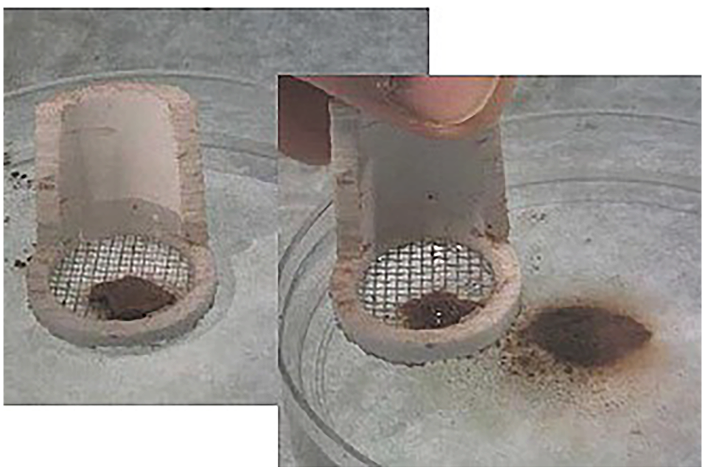
Changes in aggregate stability may serve as early indicators of recovery or degradation of soils and, more generally, ecosystems. Perennial plants can often persist long after the soil and plant community have become too degraded to support plant regeneration, while recovery is often occurring long before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

How is aggregate stability measured?

Where to sample – Aggregate stability in areas of rangeland is commonly measured on soil samples removed from the top ¼ to ½ inch of soil. This part of the soil is most likely to be impacted by wind or water erosion. Deeper samples can also be analyzed. Samples should be collected beneath plants and from spaces between plants. Several samples should be collected from each area.

Soil Stability Test–A simple field method (air dried but no weighing required) – This method can be applied in the field with relatively simple tools. Remove at least nine soils samples from the soil surface. These samples should be ¼ inch in diameter, 1/8 inch thick. Place each air-dry fragment in a ¾ inch PVC and window screen sieve (see following photo). Immerse each dry fragment in 1 inch of distilled water.

After 5 minutes, gently sieve each fragment five times, pulling the sieve completely out of the water with each cycle in a smooth oscillating motion. 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. Stability of a given soils is assigned a stability class rating on a scale of 1 to 6; class 1 having less than 50% and class 6 with greater than 75% structural integrity. For more information on conducting soil stability testing, see *Interpreting Indicators of Rangeland Health, Version 4, 2005, TR1734-6, BLM* http://www.blm.gov/nstc/library/pdf/1734-6rev05.pdf



What affects aggregate stability?

Aggregate stability is affected by soil properties that change relatively little, and by properties that change in response to modifications of vegetation and management. Therefore, management comparisons of aggregate stability should be done within the same soils type (ideal) or texture (acceptable).

Soil properties.–Inherent soil properties are relatively stable and 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 and can vary greatly at different soils depths.

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 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. Properly managed grazing can deposit litter and standing dead vegetation onto the soil surface, increasing soil surface organic matter content. Conversely, improper grazing removes protective plant litter cover exposing the soil surface to degradation and loss by erosion. Long-term improper grazing, which significantly reduces plant production, disrupts formation of aggregates by reducing the inputs of organic matter.

Management strategies.—Good rangeland management normally increases aggregate stability. This includes practices that:

- Maintain or improve native plant diversity, vigor and productivity;
- Maintain proper plant litter amounts, depth, distribution, and contact with soil surface (proper amounts of litter and bare ground will vary by ecological site); and
- Minimize excessive soil surface disturbance such as trails, livestock concentration areas, and off-road vehicular traffic.

For more For more information, check the following: http://soils.usda.gov/sqi and http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/soils/health/

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