Rangeland Soil Quality

National Park Service
U.S. Department of the Interior

Natural Resources Program Center
Geologic Resources Division

Hydrophobicity

Soils that repel water are considered hydrophobic. A thin layer of soil at or below the mineral soil surface can become hydrophobic after intense heating. The hydrophobic layer is the result of a waxy substance that is derived from plant material burned during a hot fire. The waxy substance penetrates into the soil as a gas and solidifies after it cools, forming a waxy coating around soil particles. The layer appears similar to nonhydrophobic layers. Plant leaves, twigs, branches, and needles form a layer of litter and duff on the forest floor and under chaparral and shrubs. During the interval between one fire and another, hydrophobic substances accumulate in this layer. During an intense fire, these substances move into the mineral soil. Some soil fungi excrete substances that make the litter and surface layer repel water.

Why is hydrophobicity important?

Fire- induced water repellency can affect soil and the watershed.

- Hydrophobic soils repel water, reducing the amount of water infiltration.
- Decreased infiltration into the soil results in damaging flows in stream channels.
- Erosion increases with greater amounts of runoff, and much of the fertile topsoil layer is lost.
- Increased runoff carries large amounts of sediment that can spread over lower lying areas, clog stream channels, and lower water quality.
- Depending on the intensity of the fire, hydrophobic layers can persist for a number of years, especially if they are relatively thick. A smaller amount of water will penetrate the soil and be available for plant growth.

What affects the development of hydrophobic layers?

Not all wildfires create a water- repellent layer. Four factors commonly influence the formation of this layer. These include:

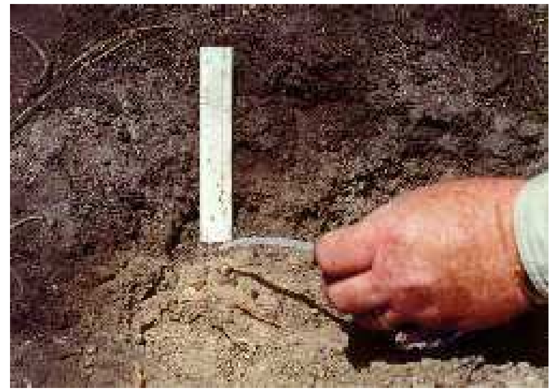
- A thick layer of plant litter prior to the fire
- High- intensity surface and crown fires
- Prolonged periods of intense heat
- Coarse textured soils

Very high temperatures are required to produce the gas that penetrates the soil and forms a hydrophobic layer. The gas is forced into the soil by the heat of the fire. Soils that have large pores, such as sandy soils, are more susceptible to the formation of hydro- phobic layers because they transmit heat more readily than heavy textured soils, such as clay. The coarse textured soils also have larger pores that allow deeper penetration of the gas.

The hydrophobic layer is generally ½ inch to 3 inches beneath the soil surface and is commonly as much as 1 inch thick. Some hydrophobic layers are a few inches thick. The continuity and thickness of the layer vary across the landscape. The more continuous the layer, the greater the reduction in infiltration.

How are these layers detected?

Scrape away the ash layer and expose the mineral soil surface. Place a drop of water on air- dry soil and wait 1 minute. If the water beads, the soil layer is hydrophobic. The upper few inches of the soil commonly are not hydrophobic. In these cases, it is necessary to scrape away a layer of soil ½ to 1 inch thick and repeat the test to find the upper boundary of the water- repellent layer. Once a water- repellent layer is found, continue to scrape additional layers of soil, repeating the water drop test on each layer until a non- hydrophobic layer is reached. This procedure will indicate the thickness of the hydrophobic layer.



Considerations for rehabilitation

The amount of vegetative cover, woody material, soil texture, soil crusting, surface rocks, and slope of the land should be considered in any rehabilitation work. The combination of these factors along with the extent and thickness of the hydrophobic layer determine the likelihood of increased runoff, overland flow, erosion, and sedimentation. Thicker layers will persist for more than a year and will continue to have an impact on infiltration as well as plant growth. Plant roots, soil micro- organisms, and soil fauna break down the hydrophobic layer. The reduction in water infiltration decreases the amount of water available for the plant growth and soil biological activity that break down the hydrophobic layer.

Treatment

- Place fallen logs across the slope to slow runoff water and intercept sediment.
- On level or gentle slopes, rake or hoe the upper few inches of the soil to break up the water-repellant layer and thus allow water to penetrate the soil for seed germination and root growth.
- On gentle and steep slopes, scatter straw mulch to protect the soil from erosion. Anchor the straw to hold it in place.
- Other practices that control erosion and reduce runoff include seeding, straw bale check dams, and silt fences.

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.