Carbon Footprints
in the Soil

USU research examines forest ecosystems—from the ground up.
Dirt holds the key to the carbon balance in forests, as well as all ecosystems. Carbon is stored in the soil and naturally goes through a cycle in which it eventually returns to the atmosphere. But what happens when the levels of carbon in the atmosphere change, such as in the event of global warming? Can more carbon be stored in the soil? This is what Helga Van Miegroet, a researcher in the USU College of Natural Resources, is trying to find out.

Carbon is a basic element of every ecosystem, and each ecosystem has the ability to store a certain amount of carbon in plants and soils. Van Miegroet has been studying the carbon cycle in conifer and aspen forests to determine their ability to retain carbon in the soil beneath the forest floor. “We have found that the soil beneath aspen forests can retain more carbon than the soil beneath conifers,” said Van Miegroet. “This leads us to ask new questions such as, ‘Is all carbon in soil equally stable, or can some be released into the atmosphere more readily than others?’ We also begin to wonder if there are different types of carbon; if the carbon in aspen forests is different from the carbon in conifers.” All of these questions are part of Van Miegroet’s research to determine how the health of forests affects the carbon cycle in the Intermountain West.

Surprisingly, some of the most important change that happens in a forest is performed by the lowliest element of all—dirt.

“In nature, vegetation has a tendency to creep, and some colonies will encroach upon other groups of vegetation and even cause them to die out,” said Van Miegroet. She has found that in Intermountain West forests, conifers are encroaching on aspen forests and slightly diminishing the square mileage that aspens cover. “Even the slightest change in these forests can have a major impact on the ecosystem as a whole.”
Since aspens store more carbon in the soil than conifers do, Van Miegroet is looking to find out if higher levels of carbon are being released into the atmosphere when aspen trees disappear. This could have a potential impact on carbon dioxide levels in the atmosphere. If a large number of aspen forests were to be lost, the levels of carbon dioxide in the atmosphere could rise significantly.

Van Miegroet is analyzing the effect of conifer encroachment on aspens to determine if and how it could affect CO₂ levels in the Intermountain West. Currently, she and her team are taking soil samples at the T. W. Daniel Experimental Forest and Deseret Land and Livestock Ranch, both located in northern Utah. These samples are being tested for their quality and retention of soil organic carbon, which is expressed in terms of chemistry, decomposability, and the amount of water-soluble organic carbon. So far, Van Miegroet and her team have found that vegetation type does affect carbon retention capacity, and could potentially affect future climate projections. As they studied these soil samples from conifers or trees bearing cones and evergreen leaves, aspen, and various forb and shrub sites, they looked at soil respiration, or loss of soil organic carbon, and found that the soils in these systems may vary in sensitivity to climate change. This means that depending on how climate change affects the respiration of soil carbon, levels of carbon in the atmosphere could potentially increase or soil could be a major store for carbon, which could help lower atmospheric carbon levels.

Research conducted in Europe on conifer forests has already shown that climate change is having a big impact on these forests and the surrounding soil. As the climate gets warmer, the tree line in the alpine ecosystems of Europe's mountains is beginning to rise. The conifer forests are creeping higher in elevation, and since conifer forests hold less carbon in the soil than grassland and dwarf shrub soils, the question is raised whether more carbon is being released into the atmosphere as the conifers creep upslope. Van Miegroet is collaborating with European researchers on this topic to determine whether the same thing might be happening in the Intermountain West as conifers encroach on aspen forests.

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Helga Van Miegroet
Wildland Resources

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Dirt: The Foundation of Our National Parks

National parks are home to some of the most awe-inspiring landscapes in the world: sweeping ranges with gaping gorges, soaring peaks, lush forests, and colorful red rock. Though each national park is unique in its own beauty, they all have one element in common—dirt. The soil in Rocky Mountain, Glacier, and Teton National Parks largely determines the biodiversity of the ecosystems found there. The National Park Service works to maintain the natural beauty that inspired early explorers and thousands of others since then. In order to do this, the ecosystems, which include the soil, must be monitored.

Much of the terrain in Rocky Mountain, Glacier, and Teton National Parks is above the tree line and is considered alpine tundra. These alpine ecosystems have very short growing seasons, and even small alterations in the chemical makeup of the soil can cause drastic changes.

Increases in nitrogen in the soil, which can be caused by intensified air pollution coupled with changes in temperature and precipitation, alter carbon and nitrogen cycles and lead to changes in biodiversity; one plant species takes over another, and certain species die off.

For the last ten years, Helga Van Miegroet, professor in USU’s wildland resources department, and her colleagues have been monitoring carbon and nitrogen levels in the aforementioned national parks to monitor changes occurring in the soil. Their research will help resource management teams monitor these changes and be prepared for their consequences. It’s hard to imagine that dirt can have such a major impact on unique landscapes, but the livelihood of national parks depends on it.