Implications of a Disconnect in the Carbon Cycle for Forest Soil Carbon Sequestration

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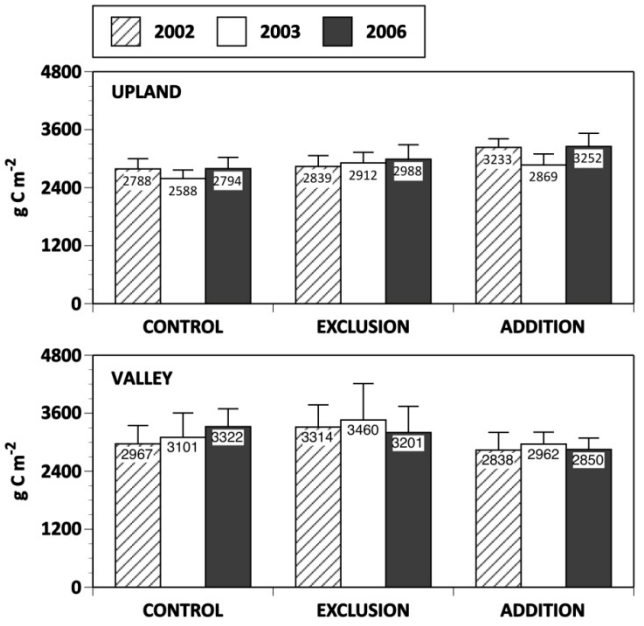
- Management of soil carbon through enhanced aboveground litter production has been suggested as a means of storing carbon in forest soils.
- We tested the effect of increased leaf litter additions or exclusions over 4.5 years on forest soil carbon stocks in an experiment on the Oak Ridge Reservation in Tennessee.
- Aboveground litter addition (3x ambient) or litter exclusion did not effect mineral soil carbon stocks at any depth to 30 cm.
- Compartment models of soil carbon cycles may require modification to reflect limited transfer of forest floor carbon to mineral soil stocks (i.e., a disconnect in soil carbon dynamics).
- Processes that directly increase belowground carbon inputs such as bioturbation or enhanced root production will be needed to increase carbon sequestration in forest soils.



Mean carbon stocks in mineral soil (30 cm deep) under control, litter exclusion, and litter addition study plots in an upland and a valley. Litter additions did not significantly increase soil carbon.

Reference: Garten CT Jr. (2008) A disconnect between O horizon and mineral soil carbon – Implications for soil carbon sequestration. *Acta Oecologia.* doi:10.1016/j.actao.2008.10.004 (in press).

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When nutrient availability is not limiting, elevated atmospheric carbon dioxide concentrations can increase both above- and belowground forest biomass production. Increased root and leaf litter production in forests could have important implications for strategies to promote soil carbon sequestration and partially mitigate future projected increases in atmospheric carbon dioxide. Some researchers have suggested that forest soils can be effectively managed for carbon sequestration through practices that increase aboveground litter production. We tested the short-term (4.5 years) effect of increased litter additions on forest soil carbon in a litter manipulation experiment on the Oak Ridge Reservation. Short-term litter exclusion or addition (three times ambient) had no detectable effect on carbon stock in the mineral soil, measured to a depth of 10 cm or 30 cm, or the partitioning of carbon in the mineral soil between two different storage pools (particulate and mineral-associated organic matter). Field data, in combination with compartment modeling of forest soil carbon dynamics, were consistent with little carbon transfer between the O horizon (forest floor litter) and the mineral soil. There were statistically significant differences between a valley and upland location in the turnover rate of the O horizon carbon stock (2.4 and 6.5 years, respectively), but most of the O horizon soil carbon stock was lost to the atmosphere in decomposition and was not incorporated into mineral soil carbon pools. The disconnect between O horizon and mineral soil carbon dynamics was attributed, in part, to the absence of significant bioturbation at both sites. Environmental factors that directly increase inputs to belowground soil carbon, via roots, or reduce decomposition rates of organic matter are more likely to benefit efforts to increase carbon sequestration in forests where carbon dynamics in the O horizon are uncoupled from the mineral soil.

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