Soil C Saturation: Determining Rates and Limits of Carbon Sequestration.

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Objective:

To address the limitations of current methods (i.e. analytical and modeling approaches) of assessing C sequestration potential by developing a better understanding of the biophysiochemical limitations to C sequestration in soils and incorporating this into a model.

Global hypothesis:

In aerobic soils, there is a level at which soil C becomes saturated and the rate and limit of C sequestration in soils is directly influenced by the inherent C saturation level.

Saturation level is determined by the behavior of four different C pools: 1) a chemically protected C pool, 2) a silt- and clay-protected C pool 3) a microaggregate-protected C pool, and 4) an unprotected C pool.

Saturation level varies across ecosystems as a function of soil properties (e.g. texture), input characteristics (e.g. amount and quality of residue), climate (e.g. temperature and precipitation), and disturbance (e.g. tillage).

Field sampling and laboratory analyses are combined to ensure that results can be incorporated into a process-based, predictive model.

Field sampling:

* contrasting gradients of production and decomposition.
* local textural and disturbance gradients are sampled within each climatic region to examine limitations to physical protection and management effects on protected and unprotected soil C.

Laboratory analysis:

* analysis of soils collected at sites with contrasting texture, climate, and base saturation.
* incubations to isolate driving variables such as litter quality and quantity, soil texture, and base saturation influences on the four soil C pools.

Modeling:

* incorporate the saturation concept into models.

* Constructed a labeling chamber/ collected soils for incubation

* Wrote a review article titled:"Stabilization mechanisms of protected versus unprotected soil organic matter: Implications for C saturation of soils." Accepted in Plant and Soil.

* Sampled NT-CT long term experiment in Sidney, NE and are testing and further developing fractionation procedure.

* Incorporated into the Century soil organic matter model a silt- and clay-associated C pool with a stabilization capacity is related to the silt plus clay content of the soil. C is stabilized through adsorption/desorption dynamics, and stabilization rates are related to the remaining stabilization capacity (i.e., silt and clay content). When tested against data from long-term agroecosystem research sites, the model was capable of accurately (usually w/in ±5%) predicting total soil C content, silt- and clay-associated C, and saturation deficit (amount of protective capacity remaining) for a wide range of sites each with a number of different management (tillage, fertilization, rotation) treatments.

Significance and benefits:

* Determine whether or not well-defined saturation limits to soil C sequestration exist.

* Establishment of true C saturation limits
  - enables more accurate predictions of C sequestration rates
  - determine the extent to which soils can be C sinks in the advent of future technologies designed to boost C input.
  - is relevant both for the development and application of virtually all technologies and/or programs designed to increase terrestrial carbon sequestration.
  - affect the efficacy of any technologies designed to boost C input rates or reduce decomposition rates.

* The influence of the biophysical properties controlling saturation limits will determine how rates of C sequestration change over time, which is crucial information for assessing projects and policies.