PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Carbon Sequestration

4/2008

CARBON SEQUESTRATION IN RECLAIMED MINE SOILS OF OHIO

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Background

Prior to 1972, surface coal mining in Ohio was performed by removing the soil and rock above the coal deposit (known as overburden) during mining operations. Because specific reclamation guidelines did not exist at the time, the overburden was not replaced and the mined site was simply planted to grass or trees, without performing grading or reclamation. After 1972, the Ohio Mineland Reclamation Act mandated that mined sites be graded to restore their original topography and reclaimed with topsoil application. In 1977, a Federal law was enacted, titled the Surface Mining Reclamation and Control Act (SMRCA), to regulate the effects of coal mining throughout the United States.

Description

This research project involved the assessment of the soil organic carbon (SOC) sequestration potential of reclaimed mined soils (RMS) at six sites in various counties in Ohio. The experimental sites were chosen at locations where mining occurred both prior to (without topsoil under grass or forest) and after the SMRCA regulation, which made application of topsoil mandatory for reclamation.

In revegetated reclaimed mine soil, the carbon sequestration from recent carbon inputs proceeds from the soil surface to deeper soil layers. Thus, in order to follow this process in a chronological sequence, approximately 50 soil samples were collected from depths of 1–15 centimeters and 15–30 centimeters and analyzed to determine SOC pool, total soil nitrogen pool, and the physical, chemical, and hydrologic properties. The sites received six different reclamation treatments to determine the spatial and temporal variations of SOC and the rate of sequestration in forest and pasture. The mechanisms of SOC sequestration and the potential of using biosolids for reclamation were assessed.

The data gathered were used to test the following hypotheses: (1) The potential of SOC sequestration in RMS depends on biomass productivity, root development in subsoil, and changes in mine soil properties resulting from the weathering of overburden material. (2) The increase in SOC over time is related to improvements in soil quality. (3) The capacity of RMS to sequester SOC is a function of the type and duration of land use. (4) The rate of SOC sequestration is related to changes

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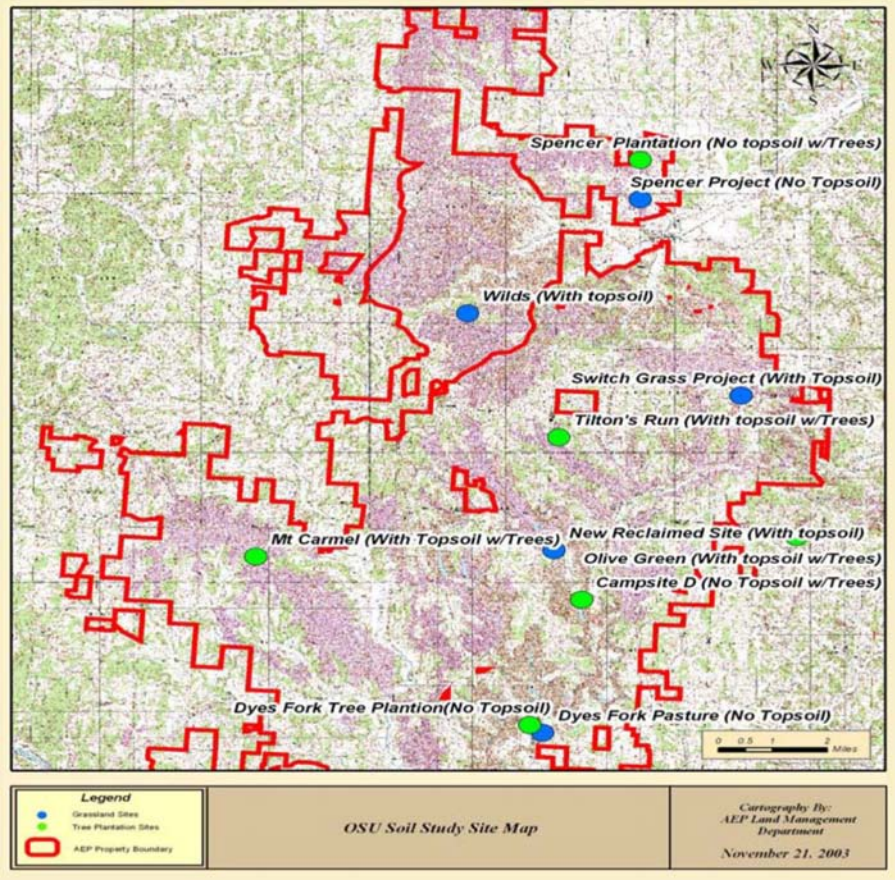
in soil structure. (5) Carbon aggregation is influenced by the interaction between SOC, the silt and clay concentration, and the mineralogical composition. (6) The rate of SOC sequestration increases linearly with the rate of biosolids application and is proportional to the total amount and rate of release of mineralizable nitrogen. (7) The rate of aggregation depends upon the mineralizable carbon and nitrogen in the biosolids. (8) The SOC sequestration potential is related to its mechanical (porosity, strength) and hydrologic (hydraulic conductivity, infiltration rate, available water capacity) properties.

Primary Project Goal

The primary project goal was to assess the degree to which soil carbon sequestration in RMS can offset fossil fuel emissions, provide additional income to land owners through trading carbon credits, and strengthen the terrestrial carbon sequestration database to assist policy makers on land use modifications to mitigate climate change.



This map shows the locations of experimental sites.

Objectives

- Assess the sink capacity of RMS of various ages to sequester SOC.
- Determine the rate of SOC sequestration and the spatial (vertical and horizontal) and temporal variations of SOC.
- Develop and validate a model for SOC sequestration rates.
- Identify the mechanisms of SOC sequestration in RMS.
- Assess the potential of different methods of soil reclamation to alter SOC sequestration rate, soil development, and soil mechanical and water transmission properties.
- Determine the relation between SOC sequestration rate and soil quality in relation to soil structure and hydrologic properties.

Benefits

Soils represent a huge potential sink for sequestering carbon, and carbon trading could provide an incentive for landowners to modify land management practices to increase carbon sequestration in soils. However, for this to be possible, techniques have to be developed to quantify carbon uptake by soils and the best treatments need to be determined to promote carbon accumulation by soils and their associated vegetation. This project addressed both of these issues, and has increased the understanding of the potential of both grassland and reforested minelands to sequester carbon.

Mine Land Without Topsoil Reclaimed to Forest in 1957.

PERFORMANCE PERIOD

09/22/2003 to 12/31/2007

COST

Total Project Value
$706,105

DOE/Non-DOE Share
$563,491 / $142,614

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Accomplishments

- Test sites, characterized by distinct age chronosequences of reclaimed mine soil, were selected. The criteria for selection was soil: (i) reclaimed prior to the 1972 Ohio Mineland Reclamation Act or the 1977 SMRCA and under continuous grass and forest and without topsoil application, and (ii) reclaimed after the 1972 Ohio Mineland Reclamation Act (which made application of topsoil mandatory for reclamation) and under continuous grass and forest and with topsoil application.
- Soil samples were collected from 0–15 cm and 15–30 cm depths and analyzed to determine SOC concentration, total soil nitrogen concentration, pH, and electrical conductivity for each sampling location.
- Results from soil sampling showed that SOC and total nitrogen (TN) concentrations increased with increase in time after reclamation in all three aggregates size fractions for both depths at the forest and grass sites, and that the effect of erosion on SOC and TN concentration was negligible.
- The higher SOC and TN concentrations in older sites demonstrated the sequestration potential of younger sites.
- The forested sites selected for sampling have higher SOC and TN than grassland sites of the same age.

Mine Land Reclaimed to Switchgrass in 1987.

Planned Activities

This project is now inactive and NETL is awaiting the final report.