Quantifying Soil Organic Carbon Fractions under Land Use Types in Nachusa Grasslands

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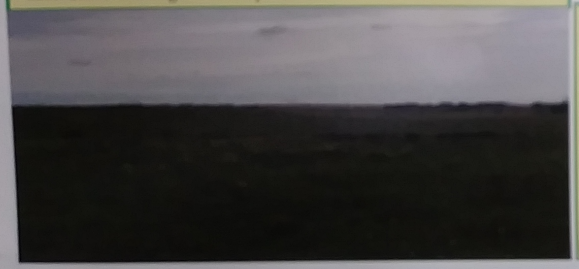
Introduction

Soil organic carbon (SOC) is an important indicator for describing soil quality, health and environmental sustainability, but is sensitive to land use types. Numerous studies have been conducted to evaluate the impacts of land use changes on total SOC stocks. Because SOC is composed of plant, animal and microbial residues in various stages of decomposition with different physicochemical properties, it has been suggested that alterations in the different SOC fractions are more effective in indicating changes in land use than total SOC stocks. In general, macro-aggregates of SOC constitute recently deposited residues that reflect active SOC stocks. Conversely, micro-aggregates of SOC is composed of microbial-processed and passive SOC stocks. However, how soil aggregation regulates SOC storage and distribution is still not fully understood.

Nachusa Grasslands is one of the largest and most biologically diverse grasslands in Illinois and contains various types of plant communities (prairie, savanna, wetland, and woodland) with different management and restoration practices (such as grazing, fire and seeding). In the past years, a number of research successfully carried out in this area. However, no information on SOC fractions in land use types and management practice exists in this preserve.

The purpose of this project is to examine the impacts of land use change on aggregate characteristics of SOC fractions in Nachusa Grasslands. The specific objectives are: (1) to quantify the total amount and vertical distribution of macro-aggregate and micro-aggregate of SOC stocks, (2) to evaluate the relationships between total SOC and each SOC fraction, (3) to reveal soil property parameters, especially soil microbial communities controlling SOC fraction pools, and (4) to analyze the effects of land use with management regiments on characteristics of SOC fractions. The results from this project will provide scientific references for further understanding of SOC composition in different plant ecosystems and also provide guidance for sustainable management of prairies.



Summary

Land use change affects composition of soil organ carbon (SOC) in terrestrial ecosystems. In this study, we investigated the quantity and distribution of SOC in four aggregate classes (>1000, 250-1000, 53-250, and < 53 μm) under four land use types (prairie, savanna, wetland, and woodland) in Nachusa Grasslands, northwestern Illinois. Wetting-sieving method was used to obtain soil aggregate categories. Carbon and nitrogen contents were analyzed using Walkley Black Wet Digestion Method. The results from this project would provide us a better understanding of how land use changes and relative management practices affact SOC sequestration and soil fertility.

Expected outcomes

- Quantifying amount and distribution of SOC fractions under typical selected land use types in Nachusa, and associated with relevant management practices.
- Developing relationships between soil properties and SOC fractions in the selected prairie, savanna, wetland, and woodland types.
- Examining the dynamic properties of SOC fractions distribution in different restorative aged prairies.
- Evaluating the relationships between leaf C and N contents and SOC fractions, and between soil microbial community compositions and SOC fractions..

Methods

Four land use types (prairie, savanna, wetland, and woodland) were selected in Nachusa. Four plots (each 5m × 5m in size) were set up for each of the four land use types.

In each plot, species composition and abundances of plants were recorded. Then five leaves per species were collected from the three most abundant plant species in each plot. Soil samples were collected using a hand auger (5.5 cm in diameter). Within each plot, three replicate soil samples were taken from soil depths of 0–10, 10–20 and 20–30 cm), respectively. These soil samples were for SOC fraction analysis. The soil bulk density were measured by steel ring method. Another 150 g soil subsamples were taken from each of the three depth intervals for measurements of soil texture, bulk density, soil water content and phospholipid fatty acid (PLFA). All soil samples were brought to the Governors State University (GSU) laboratory for analysis.

In the lab, soil samples for SOC fraction analysis were air dried at ambient conditions and passed through a 2-mm sieve. These soil samples were divided into four particle size fractions: large macro-aggregates (> 1000 μm), moderate macro-aggregates (250–1000 μm), small macro-aggregates (53–250 μm) and micro-aggregates (<53 μm), using wetting-sieving method. The extracted soil fractions were ground, dried in an oven for 48 h at 60° C, and analyzed for carbon and nitrogen contents using Walkley Black Wet Digestion Method. Soil samples for bulk density and water content measurement were dried at 105 °C for 48 h. Soil samples for PFLA analysis were freeze-dried until analyzed.

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