12-6-2016

Mapping the Impact of Intensive Rotational Grazing on Soil Fertility Over Time on Greenbrier Farms in Pickens County, South Carolina

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Emily Kirby, Introduction to Geographic Information Systems (GIS), Fall 2016

Introduction

Exorbitant population increases and negligent approaches to natural resource management and land use has prompted a global transformation into a predominantly anthropogenic era. Continued indifference to transitioning towards more sustainable lifestyles at a global scale will result in further irreversible alterations to the terrestrial biome. Additionally, the importance of rangelands and pastures is becoming more evident as agricultural systems now cover approximately 40% of the world's ice-free land surface (Ramankutty et al., 2008). The need for cost effective sustainable food production and agricultural practices becomes increasingly imperative in supporting booming populations.

Recent studies suggest that the potential detrimental impacts that unsuitable grazing intensities can have on valuable soil properties and fertility could be alleviated by thoughtful and effective management strategies (Wang et al., 2014). Wang et al. 2014 found that over a 4 year period of controlled grazing treatments, soil organic carbon and soil organic nitrogen content was greater with high intensity grazing and lower with low intensity grazing. Furthermore, research suggests that conservation tillage and sustainable land use and management will have the most benefit on soil quality in regions with low organic matter (Franzluebbers, 2010).

Intensive rotational grazing (IRG) is a management technique that involves a more intentional management approach which includes increased paddock numbers, shorter grazing periods, larger livestock presence per acre, and longer periods of rest on pastures (**Figure 1**). Potential advantages of this management technique include improved forage quality, greater yield, decreased erosion, stable production during adverse growing condition, and improved soil fertility (Undersander et al., 2002). This study collects and analyzes data to understand the impact of rotational grazing on soil fertility as measured by SOC (soil organic carbon) and SON (soil organic nitrogen) on Greenbrier Farms in Easley, South Carolina. This study analyzes the transition from open grazing to five years of intensive rotational to observe the change in SOC and SON levels. The existing evidence on the intensive rotational grazing process is merely anecdotal and lacks sufficient data, but suggests that improved SOC and SON ratios should be expected. The purpose of this study is to provide some of the first, comprehensive scientific data regarding the impact that intensive rotational grazing has on soil fertility as measured by SOC and SON ratios and map the observed changes to visually portray the findings. Mapping the changes in SOC and SON ratios overtime will provide an opportunity to analyze the trends in data and how they correspond to their location. The implications of scientifically supporting intensive rotational grazing as a method of improving soil fertility on pasture land has the potential to promote sustainable agriculture as a feasible practice, both environmentally and economically, which is becoming increasingly valuable considering the observed and projected global population growth.

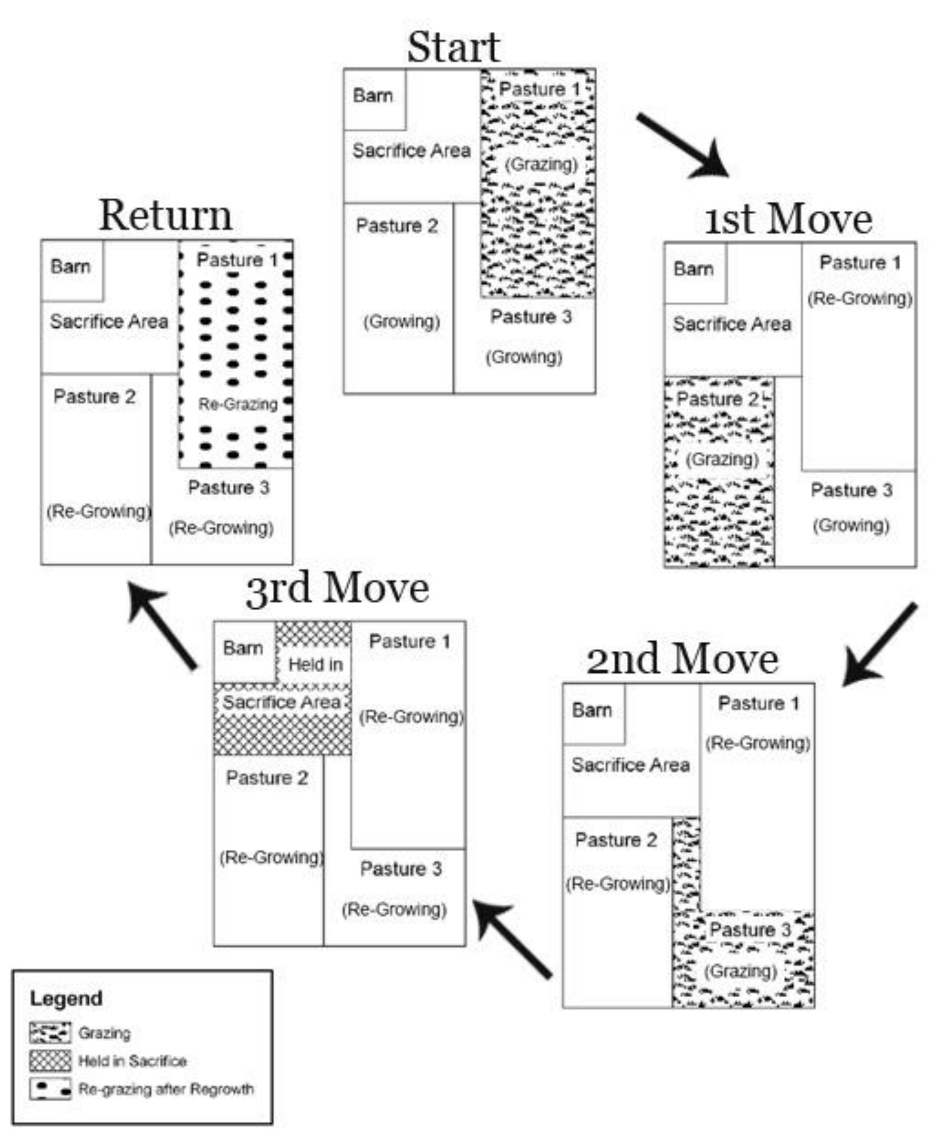

Figure 1: General outline of the Intensive Rotational Grazing technique
Source: MyHorseUniversity

Figure 2. Students taking soil cores on the study site: Greenbrier Farms in Easley, South Carolina in 2016

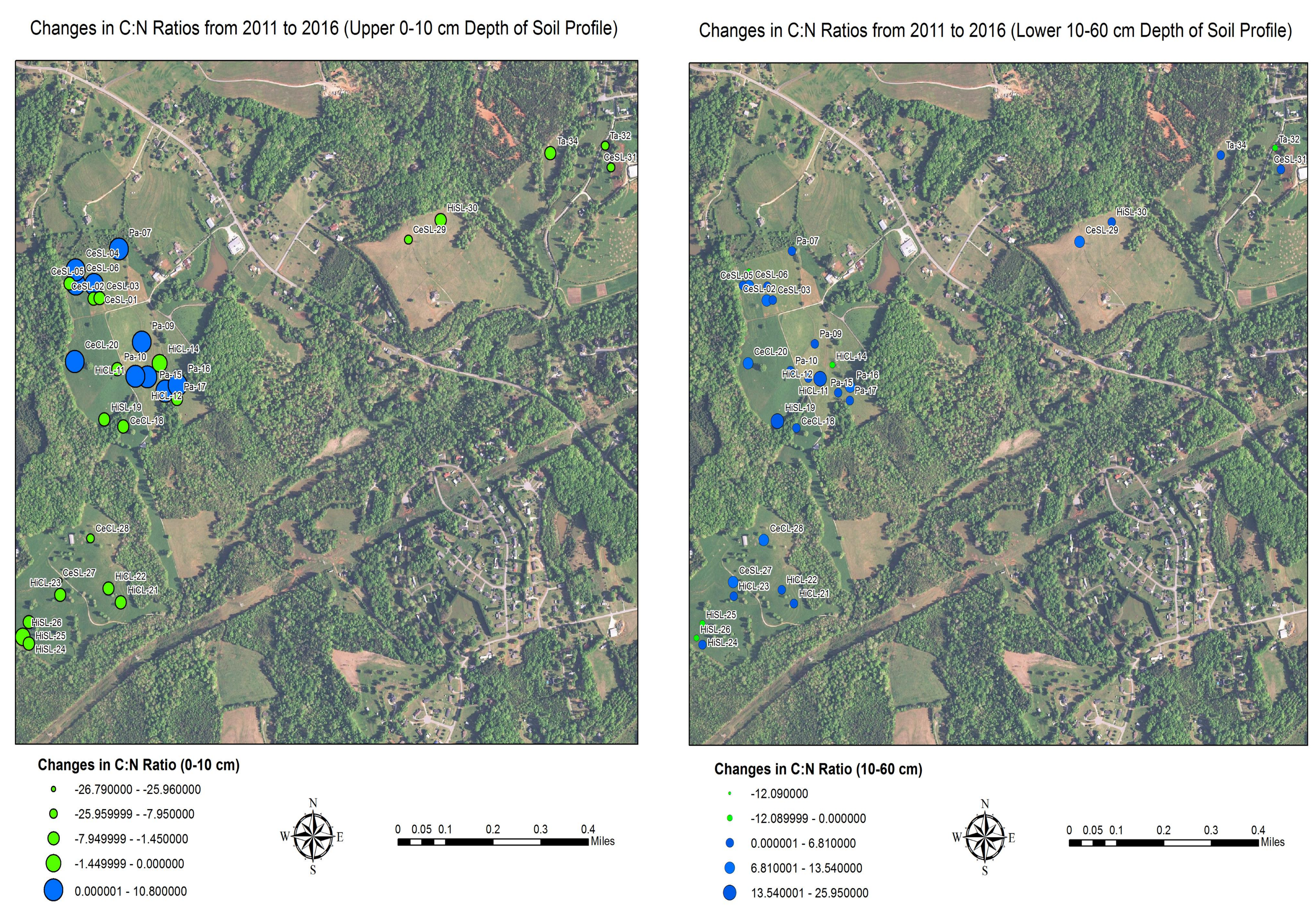

Figure 4. Comparing the average C:N Ratios for the upper 10 cm and the lower 10-60 cm of each sample location (soil core) at Greenbrier Farms

Results

This study found that the management practices of intensive rotational grazing have generally had a positive impact on SOC and SON overtime. The findings of this study will contribute to the baseline study done 5 years ago on the same farm to provide some of the first comprehensive data on the impact that intensive rotational grazing has on the soil organic carbon.

Carbon and Nitrogen values were measured in the LECO and that information was used to calculate the Carbon and Nitrogen content of soils in addition to the C:N molar ratio, which is used to identify and compare general soil fertility. Overall, both the average amount (mg) and percentage of Carbon and Nitrogen has increased since the 2011 study done before changing agricultural practices to intensive rotational grazing. The C:N molar ratios have decreased in the upper 10 cm of the soil from 2011 to 2016 (due to a substantial increase in nitrogen values) and increased in the remainder of the samples, which is to be expected for soils recovering from erosion (Piñeiro et al., 2010). Cecil Sandy Loam soil is the dominant soil series on Greenbrier Farms (representing 33.44%). The Cecil Sandy Loam soil cores exemplified the expected decrease in C:N ratio within the upper 10 cm and increase in C:N ratio from 10-65 cm (**Figure 3**). Some soil series, like Pacolet Sandy Loam, displayed a less dramatic effect of the decrease in C:N molar ratio within the upper 10 cm from 2011-2016. Hiwassee Sandy Loam, Hiwassee Clay Loam, and Tallapoosa Sandy Loam also showed initial decreases in C:N ratios (which extended past the typical upper 10 cm depth) followed by an increase in C:N ratios. The Cecil Clay Loam soil series was the only one to differ from the expected results. Overall, the observed trends in changes in C:N ratios are generally representative of improved soil fertility and soil quality.

The maps in **Figure 4.** show the average changes in C:N ratios from 2011 to 2016 for the upper 10 cm of the soil and the lower 10-60 cm of the soil at each sample location. Larger points indicate more positive numbers while blue represents values greater than 1 and green represents values less than one. Most of the samples within the upper 10 cm of the soil have negative C:N ratio values and most of the samples within the lower 10-60 cm of the soil have positive C:N ratio values. The map makes it easy to identify patterns of where the outliers are located. For example, most of the positive values within the map of the upper 10 cm depths are clumped nearby one another, suggesting that there might be less optimal soil conditions in that particular region. This information is helpful in altering IRG techniques at a local level to optimize the benefits and further strengthen to potential for sustainable agriculture.

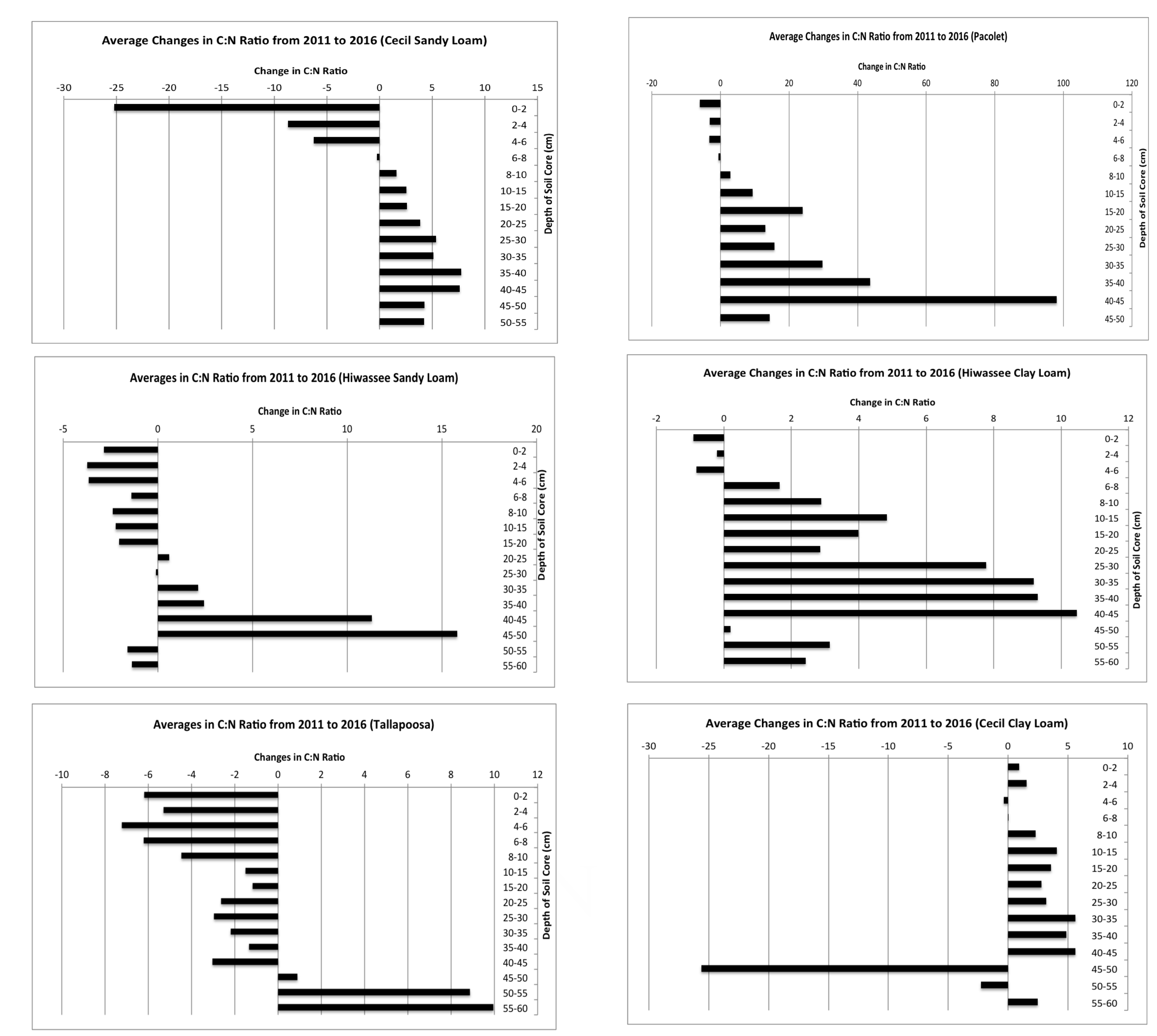

Figure 3. Average changes in C:N ratios from 2011 to 2016 in the Cecil Sandy Loam, Pacolet Sandy Loam, Hiwassee Sandy Loam, Hiwassee Clay Loam, Tallapoosa Sandy Loam and Cecil Clay Loam soil series present on Greenbrier Farms

Methods

Soil samples that were gathered prior to IRG in 2011 were compared with samples taken in the summer of 2016 to see the impact that IRG has had on the soil after 5 years. The two sets of samples were compared to identify the effect that land management had on soil fertility (as measured by soil organic carbon and soil organic nitrogen ratios). The study randomly resampled 33 of the 152 locations from the previous study by taking 60 cm soil cores and 20 cm soil profiles (**Figure 2**). After the samples were processed in the lab, they were put into the LECO TruMac Carbon/Nitrogen Determinator, which heats samples to 1350° C and provides carbon and nitrogen analysis. Those carbon and nitrogen values were then analyzed and compared to the results of the 2011 study. GIS software (ArcMap) was used to plot the longitude/latitude coordinates of each sample location and the corresponding data with the Display XY Data function.

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Data Sources

Data was retrieved from Geospatial Data Gateway, which provides raster and vectors generated from USDA data. This study specifically utilized Soil Survey Spatial and Tabular Data (SSURGO 2.2, SC 077 Pickens County, South Carolina), Digital Ortho County Mosaic of 7.5' quads by APFO, National Land Cover Dataset by State, and Cropland Data Layer by State. Data was analyzed with Microsoft Excel and ArcMap 10.4.1.

Acknowledgements

I would like to thank: Dr. Brannon Andersen for advising my research and providing assistance during the writing process, Lori Nelsen for her consistent help in the lab, Mike Winiski for overseeing and helping me with my project, and Phoebe Ferguson for her help in the field, lab, and computer lab with advice on obtaining GIS data. I would also like to thank Miles Hauser, Amanda Richey, and Emily Anderson for their help in the field collecting data.