Investigation of the carbon sequestration potential of soils and woodlands at university farms

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INTRODUCTION

Agricultural land management like tilling, planting and harvesting has important impacts on soil carbon. Understanding the determinants for the current amount of carbon storage as a function of different types of land management on farms (e.g. crop fields versus woodland) offers opportunities to manage farmland owned by institutions in a way that achieves carbon emission reduction targets. For example, Newcastle University aims to reduce 43% of its CO_2 emissions by 2020 against the 2005/6 baseline.

METHODS

Cockle Park Farm (CP, 307 ha) and Nafferton Farm (NF, 498 ha) are owned by Newcastle University, and were used to conduct a soil carbon survey. In total, 206 soil samples from crop fields and 96 soil samples from woodlands at three soil layer depths (0-30 cm; 30-60cm; 60-90cm) on two farms were collected. Total carbon and organic carbon from soil samples were measured, and the statistical differences between the different types of managed land, within the same farm, and between the two farms were analyzed.

RESULTS

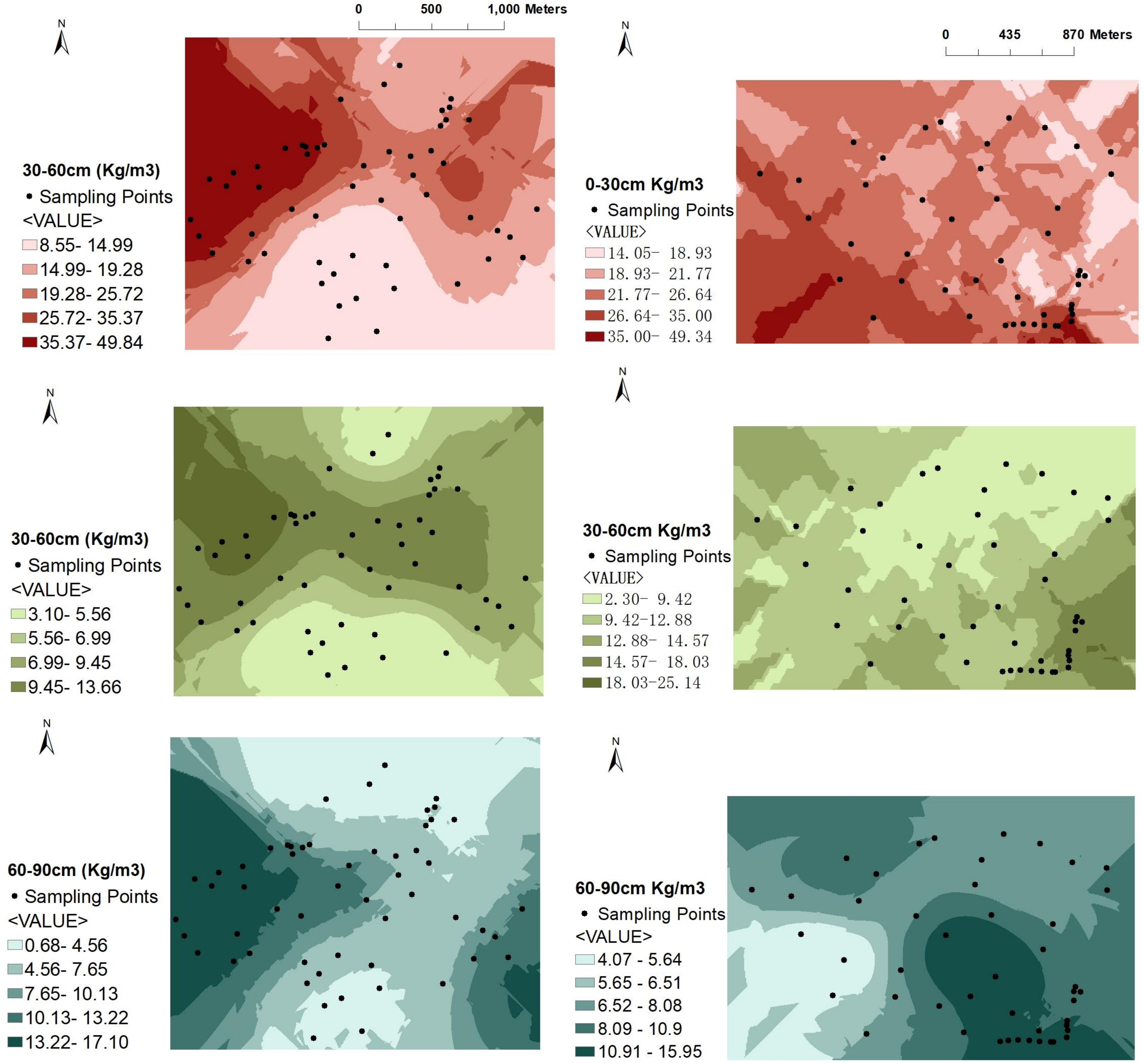

Figure 1. Maps showing the total carbon distribution on farmland Left side: Cockle Park farm; right side: Nafferton Farm. From top row to bottom: 0-30cm, 30-60cm, 60-90cm depth.

1. The carbon content in woodland soil (NF:18.26±10.62 kg/m³; CP: 16.15±10.58 kg/m³) was higher (p ≤ 0 01) than that in crop field soil (NF:14.00±8.80 kg/m³; CP:11.99±7.00 kg/m³) for the top 90 cm soil layer on both farms.

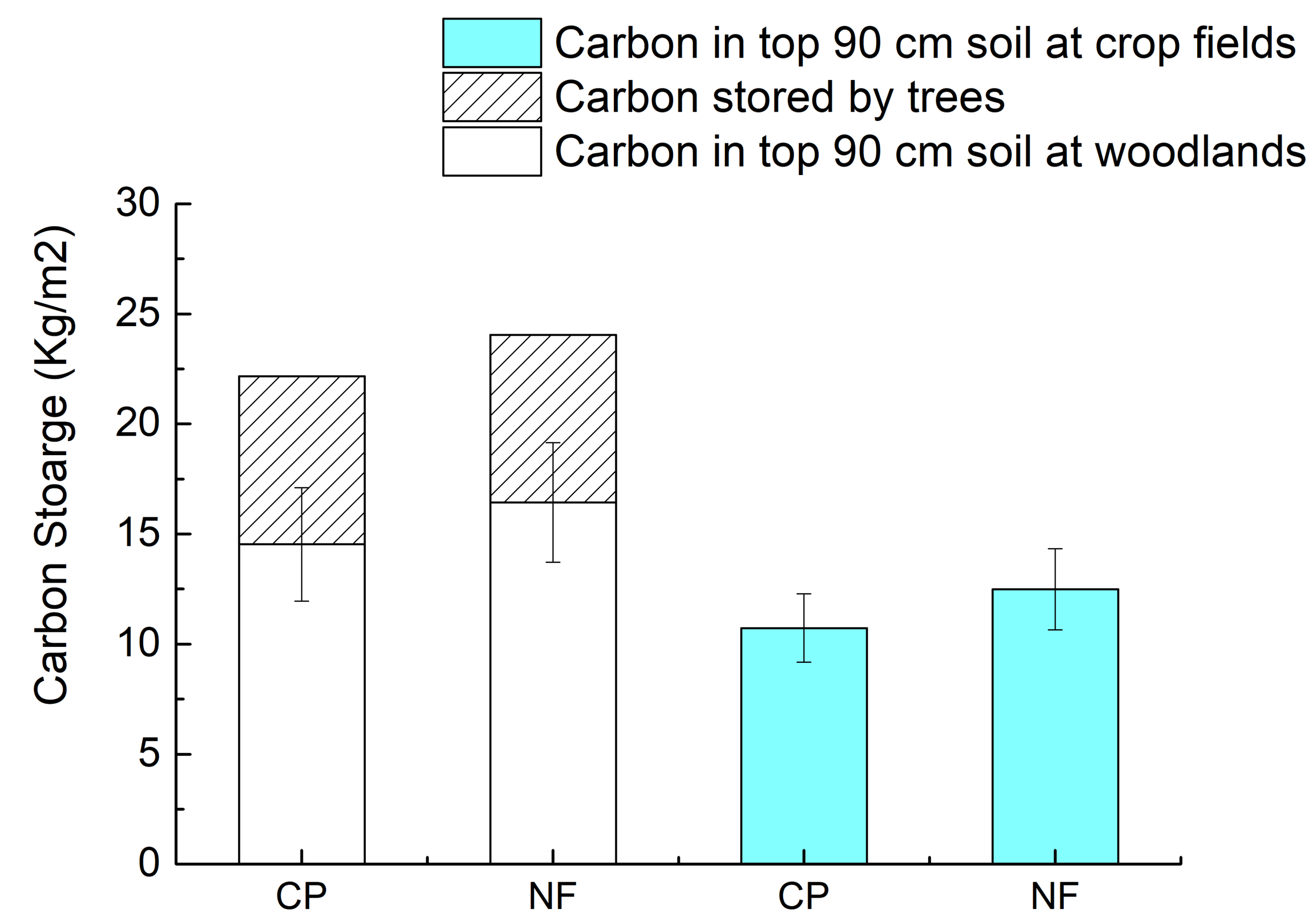

Figure 2. The carbon storage capacity (kg/m², mean ± SD) of woodlands and crop fields at the two farms; Cockle Park Farm (CP), and Nafferton Farm(NF).

2. Soil carbon between different crop fields within one farm, and between the crop fields from the two farms were not significantly different. Carbon content significantly differed ($p<0.05$) as a function of soil depth on the two farms.

3. Carbon stored in the topsoil from broadleaved woodland (NF: 28.39±11.44 kg/m³; CP: 23.75±7.71 kg/m³) was lower than that in coniferous woodland (NF: 30.37±12.28 kg/m³; CP: 29.49±12.68 kg/m³) on both farms.

4. Old growth stands stored more carbon than young growth stands on CP.

3. Geostatistical interpolation demonstrated that the Gaussian model is the most appropriate model for predicting carbon distribution among most groups of data. If classifying the C stock into five categories on the prediction maps, the values indicate that total C stock with the largest percentage over the whole surface soils is 19.64-21.07 kg/m³ (31.14%) in CP, and 21.97-23.5 kg/m³ (31.31%) in NF, respectively.

4. The addition of further sampling points for the soil plots with younger growth woodland would improve the understanding in terms of the variability of soil carbon caused by different ages of trees in woodlands.

CONCLUSIONS/DISCUSSIONS

1. Carbon stock significantly varies with soil depth and land uses, with most of the carbon present in the upper soil organic horizons, but no statistically significant difference was found regarding crop cultivation. Soil carbon stored in various soil depth layers at woodlands is remarkably higher than that in crop fields at both farms.
2. Developing a new woodland is a feasible method for achieving carbon emissions reduction targets in a short time on a regional-scale. If converting the overall crop fields at the farms into new woodlands, 2,200 tons C would be captured annually over a period of 40 years, which accounts for 27% of the estimated annual carbon emissions from Newcastle University (8,181 tons).