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Cattle grazing found to have had no negative effect on soil organic carbon stocks at a site in the Northern Territory

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Abstract

Soil organic carbon (SOC) stocks were measured at three water points in the same paddock on the Barkly Tableland in 2013. The water points were selected based on age - the oldest was established in 1910, the second oldest in 2005 and the youngest in 2010. The study aimed to determine what levels of SOC were typical for the cracking black soils (vertosols) in the paddock and whether there were any relationships between SOC stock, age of the water point and distance from water. The results confirmed previous work that showed that SOC is naturally quite low in the vertosols of the Barkly. There were very few statistically significant differences found between SOC stocks and age of the water point or distance from water. A notable exception was significantly higher SOC stocks at 100 m from the oldest bore, which could be due to the long-term accumulation of cattle dung and/or high turnover of short-lived plants. Soils from long-term ungrazed enclosures at the bores did not have significantly more SOC than adjacent heavily grazed areas suggesting that up to 100 years of grazing has had no discernible negative impact on SOC stocks at the study site. If typical, the results suggest that the economic potential for increasing SOC and earning carbon credits from the management of land condition on black soils in the Barkly region is low.

Introduction

Current Australian government climate policy includes incentives for landholders to sequester SOC. However, supporting documentation for the current approved methodology for SOC measurement states that soil carbon projects are unlikely to be viable in most areas of the Australian rangelands due to the expense of sampling and slow rates of sequestration (Commonwealth of Australia 2014). Despite this, there are producers showing interest in soil carbon and the potential to diversify their income by participating in the emerging carbon market. The NT DPIF conducted an opportunistic study in 2013 to answer the following questions:

- What SOC levels are typical on black soils (vertosols) in the Barkly region?
- Do SOC levels change with long-term grazing duration (age of water point)?
- Do SOC levels change with grazing intensity (distance from water)?
- Is there potential for increasing SOC levels and participating in the carbon economy?

Methods

The NT DPIF has been monitoring the pastures in East Ranken paddock at Alexandria station as part of a demonstration of sustainable stocking rates and pasture spelling (Walsh 2011). East Ranken paddock is 700 km², comprised of Mitchell grass pastures (Barkly land system), and is considered well-watered by the standards of the region (95% watered on a 5 km watered-area basis). Average annual stocking rates are managed within recommended sustainable levels (Walsh 2011) and the land condition is typically good (B to A condition, Chilcott *et al*. 2005) beyond the immediate vicinity of water points.

Land condition indicators and pasture productivity have been measured on transects radiating out from three bores of different ages every year since 2010. The oldest of these bores was established in 1910, the second oldest in 2005 and the youngest in 2010. In July 2013 we sampled SOC at three distances from each bore and inside long-ungrazed enclosures at the two older bores. Soil sampling locations were allocated prior to arriving at the paddock (0 m, 100 m, 1500 m and 3500 m from water were planned). However, on arrival, the actual distance from water had to be adjusted to ensure the sampling locations fell on black soils rather than the red gravelly rises typically found throughout Barkly land system. Samples were thus collected from three distance bands (100-500 m, 1400-1500 m and 3000-3500 m).

Soil samples were taken from four 1 m^2 quadrats, 10 m apart, at each distance from water. At the ungrazed enclosures, three quadrats were sampled taking care to avoid areas disturbed during construction of the bore. Sampling conditions were very difficult due to the dryness and hardness of the soil. To overcome this, we wet the ground by dripping water from 20 L drums overnight onto the sampling quadrats.

Within each quadrat, soils were collected from 0-10 cm, 10-20 cm and 20-30 cm depths using a 5 cm diameter hand auger. Between three and five samples were bulked at each depth in each quadrat in order to fill a snap lock plastic sandwich bag. This resulted in samples of between 700 and 1200 g (field weight) for each depth in each quadrat. A bulk density pit was dug (usually at Quadrat 1) and usually three (occasionally more) samples were taken at different depths up to 33 cm using 5 cm brass bulk density rings (resulting in 209.16 cm^3 of soil material per sample). All quadrat and bulk density samples were weighed using a digital balance prior to samples being transported in insulated containers to the laboratory.

The quadrat samples were air dried for four days in an air-conditioned laboratory at 22^{O}C by opening the top of the zip lock bags. Damper samples were put into alloy containers for drying (190 x 140 x 50 mm). After drying, samples were then re-sealed in their plastic bags and weighed. About 400 g of soil was sub-sampled from each bag, crushed by hand using a metal roller, then sieved through a <2 mm sieve. The sieved sample was further sub-sampled by collecting 100 g of soil and placing it in a snap lock plastic bag, removing as much air as possible. These were sent to CSIRO Analytical Laboratories in South Australia for soil carbon analysis.

The 43 bulk density samples were placed in alloy containers and dried in a drying oven at 105^{O}C for three days then weighed and dried for a further 24 h to confirm a stable dry weight was reached. The dry samples were then dissolved in water and passed through a <2 mm sieve to collect all gravel and stone. The gravel and stone was dried, the weight recorded and deducted from the original sample weight giving a dry weight of soil in each sample.

Total carbon stocks (t/ha) were calculated for each quadrat for 0-10 cm, 10-20 cm, 20-30 cm and 0-30 cm depths by multiplying the laboratory-determined carbon % by the bulk density (minus stone and gravel) measured at each sampling location. ANOVA and Tukey HSD tests were used to identify significant differences in Statistica.

Results

SOC was found to be relatively low in the productive vertosols in East Ranken (typically <0.5%). SOC was highest in the top 10 cm of soil and declined with depth at all sampling locations. When converted to SOC stock, average stocks were typically in the order of 4-6 t/ha in the top 10 cm and 9-17 t/ha in the top 30 cm. To put this into context, CSIRO estimates that across Australia, the amount of SOC in the top 30 cm of soil ranges between <5 and >200 t/ha (http://www.csiro.au/Organisation-Structure/Flagships/Sustainable-Agriculture-Flagship/Australian-Soil-Carbon-Map.aspx).

There were few statistically significant differences in average total SOC stocks between the different age bores and distances from water (Fig 1.). The highest average SOC stock (23.8 t/ha) was found at 100 m from the oldest bore. The lowest average SOC stock (9.2 t/ha) was found at 300 m from the youngest bore.

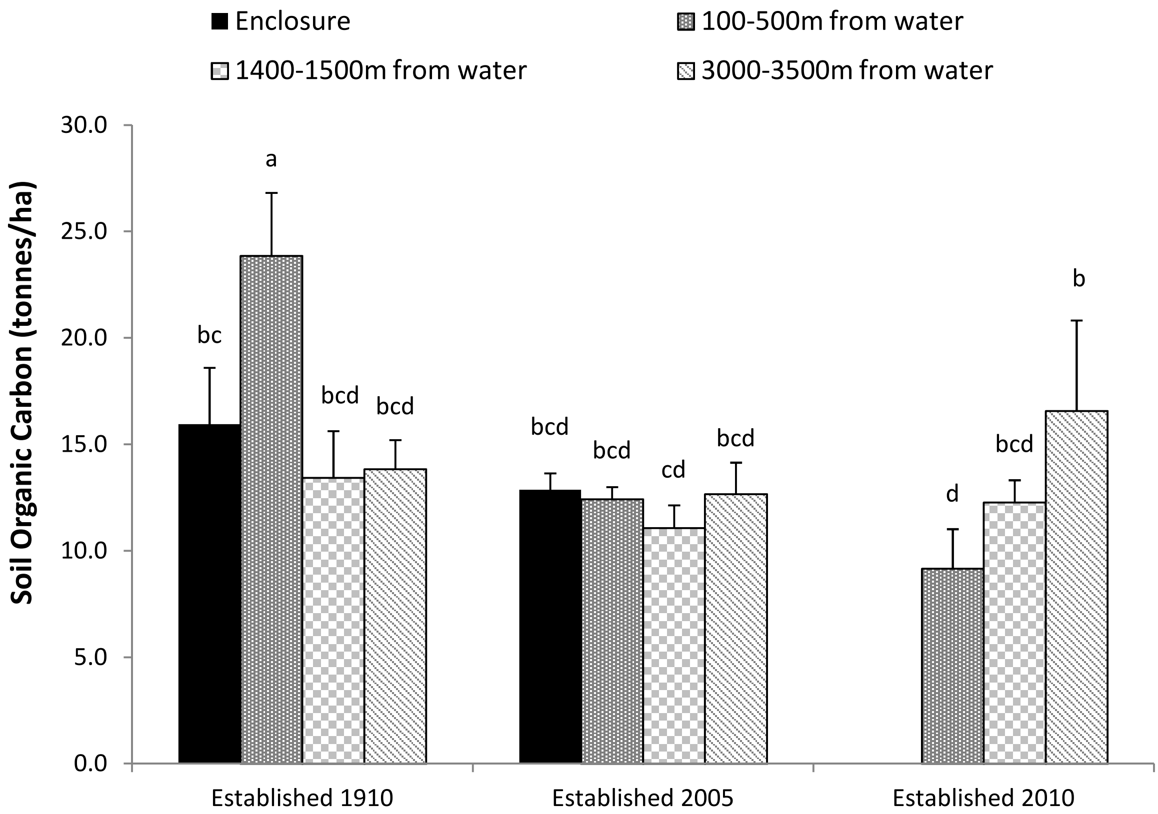

Fig 1. Total SOC stocks (0-30 cm) for three water points in East Ranken paddock, Alexandria station. Error bars are the 95% confidence interval. Means with different letters are significantly different to each other.

Discussion and Conclusion

The relatively low SOC levels (typically <0.5%) found in the study are consistent with other data collected from vertosols across the Barkly (DLRM, unpublished). No consistent relationships were found between average SOC stocks and age of bore (grazing duration) or distance from water (grazing intensity). The highest SOC stocks were found at 100 m from the oldest bore, possibly due to the disturbance, accumulation of dung and/or high turnover of annual plants. Soils from the long-ungrazed enclosures near the bores did not have significantly more SOC than the adjacent heavily grazed areas, suggesting that up to 100 years of grazing has had no discernable negative impact on soil carbon levels. If typical, these results suggest that the potential for increasing soil carbon and generating carbon credits via the management of land condition will be low on black soils on the Barkly.

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