Catchment action market based instruments – Soil Carbon Research Project

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Introduction

Soil organic carbon (SOC) is essential for improved soil health to increase water infiltration, reduce runoff and soil erosion, and buffer the soil against acidification, soil structure decline and loss of fertility. There is also hope that sequestering SOC can reduce atmospheric CO_2 levels. A body of evidence supports the significant effects land management can have on SOC levels (e.g. Chan *et al.* 2010; Luo *et al.* 2010), but there is substantial variability reported under similar management, and more information is required on how land management affects SOC levels in different soil types and under different climate regimes. This project aims to develop a matrix of SOC values for different land uses, soil types and climatic regions. Sampling began in March 2010.

Soils, regions and landuses

To sample the most relevant locations, a matrix was developed according to Murphy *et al.* (2010) of: three climatic regions of the Lachlan catchment (tablelands, slopes and plains); the major soil groupings (identified using available soils and geology information); and the primary land uses for each of these soil/region combinations.

Site selection and setup

Potential sites were identified from local contacts, and these were contacted randomly until enough sites were found. Properties were selected that fulfilled the sampling criteria (i.e. the correct soil type and land use with sufficient records), and paddocks were randomly selected for measurement. Within each paddock, a site was selected that represented the 'average' conditions within the paddock. At each site, a 25 m x 25 m quadrat was set up with a northerly orientation, using the procedures outlined by Mckenzie *et al.* (2000) and Bowman *et al.* (2009).

Soil classification, sampling and analysis

At each site two cores of up to 1 m deep were taken at the SW corner of the 25 m x 25 m quadrat that was divided into 100 equal cells. These cores were used to classify the soil and record the depth, texture, colour, pH and structure of each horizon. The primary method of collecting soil samples was with a utility mounted percussive soil corer in 10 randomly allocated cells within the quadrat area. At each cell, the corer collected a 75 mm diameter core that was cut into segments at 0–5, 5–10, 10–20, 20–30 and 30–40 cm. Minimum numbers of intact samples at each depth were required (10 each for 0–5 and 5–10 cm; 7 for 10–20 cm, 5 for 20–30 cm and 3 for 30–40 cm). When it was not possible to get solid coherent cores (due to poor moisture) with the hydraulic corer samples were taken by hand with rings. All samples were bagged, labelled and returned to the lab for drying and weighing.

Soil samples were air-dried and sieved to <2 mm to determine total organic C and N (LECO), soil C fractions (particulate organic C, humus and charcoal), pH, phosphorus, and particle size analysis. Moisture content was determined on a 10–50 g subsample prior to sieving to calculate bulk density.

Vegetation assessment

Prior to coring, pasture composition, total and litter herbage mass and ground cover were visually assessed at 5 points using a $0.1m^2$ quadrat around each sampling point using the BOTANAL procedure (Tothill *et al.* 1992).

Land use surveys

At the same time as sampling, a survey was done to collect historical management data for the sampled paddock. Intensive data were collected for the 10 years prior to sampling. For cropping paddocks this included the crop sown, yield, stubble management and tillage method. For pasture paddocks it included stock type, stocking rate, pasture type, proportion of the year the paddock was stocked, and any seasons the paddock was normally rested. For all paddocks, rainfall, fertiliser and use of soil conditioners were also recorded. Less intensive data were collected beyond 10 years, including past fertiliser history, date of land clearance and whether there were significant changes in paddock management (e.g. change of tillage or grazing method).

Developing of a Market Based Instrument (MBI)

A separate aspect of this project is designing a market based instrument to improve SOC sequestration by implementing better farming practices. There are challenges, as the MBI must be viable and attractive to landholders, as well as address issues such as: verifying SOC storage; demonstrating 'additionality' in comparison to business as usual; and providing long-term sequestration for a defined period. Confidence in the measurement and estimation of SOC levels is also critical for the development of a market based instrument for soil carbon.

A matrix of the expected SOC ranges for land use, soil type and climate zone combinations will be developed. Associated factors such as: soil geology; specific land management; and time under management system will also be taken into consideration. These values will be used as a baseline in the Lachlan catchment to assess whether different MBI's are viable and how they could be implemented together with landholders.

References

Bowman, G, Chapman, G, Murphy, B, Wilson, B, Jenkins, B, Koen, T, Gray, J, Morand, D, Atkinson, G, Murphy, C, Murrell, A & Milford, H (2009). Protocols for soil condition and land capability monitoring. (NSW Department of Environment, Climate Change and Water, Sydney).

Chan, KY, Oates, A, Li, GD, Conyers, MK, Prangnell, RJ, Liu, DL & Barchia, IM (2010) Soil carbon stocks under different pastures and pasture management in the higher rainfall areas of south-eastern Australia. *Australian Journal of Soil Research* 48, 7–15.

Luo, Z, Wang, E & Sun, OJ (2010) Soil carbon change and its responses to agricultural practices in Australian agro-ecosystems: A review and synthesis. *Geoderma* 155, 211–223.

Mckenzie, N, Ryan P, Fogarty, P & Wood, J (2000) Sampling, measurement and analytical protocols for carbon estimation in soil, litter and coarse woody debris. Australian Greenhouse Office, Technical Report No. 14.

Murphy, BW, Rawson, A & Wilson, B. (2010) Development of a soil carbon benchmark matrix for Central West NSW. 19th World Congress of Soil Science, Brisbane, August 2010 (*in press*).

Tothill JC, Hargraves, JNG & Jones, RM (1992) BOTANAL – a comprehensive sampling and computing procedure for estimating pasture yield and composition. I. Field sampling. CSIRO Australia, Division of Tropical Crops and Pastures, Tropical Agronomy Technical Memorandum No. 78.