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Soil carbon sequestration potential of Queensland under land use change and future climate scenarios

Stephen Leo [a], Massimiliano De Antoni Migliorati [a], Marco Carozzi [b]

[a] Queensland Government Department of the Environment, Tourism, Science and Innovation, Brisbane, Australia, [b] French National Research Institute for Agriculture, Food and Environment, Paris, France
Email: stephen.leo@detsi.qld.gov.au

Abstract: Climate change presents a significant challenge that affects countries globally, especially their primary producers. Carbon (C) farming has emerged as a pivotal sector in Australia's strategies to mitigate this threat by allowing landholders to generate income through tradeable Carbon Credits and enabling investors to offset their C footprint through funding C farming projects. Before implementing C farming projects, it is essential for stakeholders and policymakers to identify where C sequestration has greater potential. It is well known that C sequestration potential can vary greatly due to a multitude of factors including land management, soil and climate. Uncertainty also exists around whether current C sequestration strategies will remain effective under future climatic conditions.

This project aims to develop a high-resolution, free digital support system displaying the C sequestration potential across the entire state of Queensland in Australia, under current and future climate change scenarios. This study will develop a spatial modelling framework that integrates the DayCent-CABBI biogeochemical model and a range of spatial datasets including soil, weather, vegetation and land use information. The DayCent model is parameterised using a combination of field trial data, regional data and other publicly available datasets. The calibrated model will be subsequently extrapolated across Queensland according to region-specific crops and management conditions. The potential of sequestering C in the soil and woody vegetation components will be assessed by simulating four land use change scenarios: converting land from i) cropland to grassland, ii) cropland to forest, iii) grassland to cropping, and iv) grassland to forest. Continuing the business-as-usual land use will also be assessed. Each land use change scenario is simulated for a duration of either 25 or 100 years under current and future climatic conditions.

Initial calibration of the DayCent model has focused primarily on native (forests, woodlands, grasslands), grazing and cropping systems (sugarcane, cotton, grains), yielding promising results when evaluated against observed total soil organic C, soil organic C fractions, crop yields, above-ground biomass, nitrogen uptake and residue retention. This project uses Queensland as a case study to set up a modelling framework, which will provide a regularly updatable and transparent state-of-the-art platform to support science-based decision making in C farming projects. Importantly, the framework is designed to add other features, such as the ability to simulate the impact of different crop management practices, and the full suite of greenhouse gas emissions (CO_2, CH_4, N_2O) across land uses and climatic scenarios.

Keywords: *Climate change, soil carbon, DayCent, land use change, future climate*

