SPATIO-TEMPORAL DYNAMICS OF SOIL CARBON STOCKS AND NITROUS OXIDE EMISSIONS UNDER SUGARCANE IN BRAZIL – CONVERGENCE BETWEEN SPECIFIC MODELS FOR TIME AND SPACE

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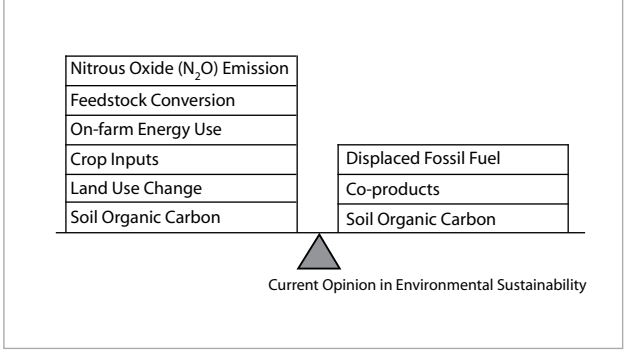

Figure 1. Greenhouse Gas (GHG) balance for bioenergy production systems. Soil nitrous oxide (N_2O emissions) and land use change are important, but uncertain, components that often determine if a particular system is a net GHG source or sink. Soil organic carbon appears on both the left (sources) and right (sinks) because, depending on previous land use and current management, soils used for feedstock production can lose or sequester carbon. Del Grosso et al. 2014

Both land use change and crop management changes under sugarcane are intensively occurring on a large scale in Brazil. It is essential to estimate the impacts of those changes in greenhouse gas emissions and soil carbon stock changes, taking into account soil, climate land use and management aspects, in order to ensure the sustainability of those processes. The goal of this project is to develop research focusing on mathematical modeling and geoprocessing applied to the assessment of soil carbon stocks and soil nitrous oxide emissions under sugarcane production in Brazil. The use of modeling and geographic information systems will enable the evaluation of the environmental impact of land use changes and crop management associated with sugarcane production, contributing to the definition of public and sectoral policies aiming at sustainable sugarcane production (*Figure 1*). This environmental modeling system will allow the comparison of different practices such as no-till, minimum cultivation and conventional tillage; replacing burned harvest by mechanized unburned harvest with maintenance of different amounts of straw on the field; the application of nitrogen fertilizers, limestone and agroindustrial residues such as stillage and filter cake; and the expansion of sugarcane over pastures, annual and perennial crops and native vegetation. The main computer models capable of simulating soil carbon stocks and soil nitrous oxide emissions will be used: CENTURY, Daycent, APSIM and RothC. Furthermore, the GEFSOC (Global Environmental Facility – Soil Organic Carbon) system, integrating modeling and geoprocessing, will be used. GEFSOC will be used to spatially and temporally explicitly map soil carbon stocks under sugarcane in Brazil in two periods: recent past (2002-2012) and future scenario (2012-2022), taking into account changes in land use and agricultural practices. Environmental modeling is an emerging research area in Brazil, and will enable scientific collaboration between research groups both in the country and abroad.

SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

Results so far have been focused on a case study in Piracicaba, an important sugarcane growing region in Brazil. A database has been compiled including input data for the process-based models used in this project. Climate data on long-term averages for precipitation and temperature were retrieved from a global gridded database. Soils data were obtained from a global product covering physical, chemical and biological parameters organized in a gridded database in a high spatial resolution. The land use dynamics was assessed through the use of remote sensing. The main land uses in the studied region were classified and mapped (*Figure 2*) in order to build a land use history to be used in the model runs. The climate, soil and land use data was organized in a gridded dataset with a common resolution, in order to allow geoprocessing operations be performed. A large number of unique combinations was generated, and the storage, processing and visualization operations is computationally demanding. These operations are being performed in virtual machines located in a cloud service, using the Microsoft Azure platform through a research grant. The Century model was applied in sugarcane experiments in São Paulo State including a) fertilizer management – rates and nitrogen fertilizer types; b) application of filter cake and vinasse; c) soil tillage comparing no till, minimum tillage and conventional tillage; d) use of green manure in the reform period of sugarcane. The model was also applied to simulate conditions prior to sugarcane production, such as cerrado vegetation and pastures. The next steps will include running the process-based models in each unique combination of climate, soil and land use history for the studied area, and mapping the results expressed as soil carbon stock changes. Once the model simulations are performed for this region, the same methodology will be applied in other important sugarcane growing regions in São Paulo state.

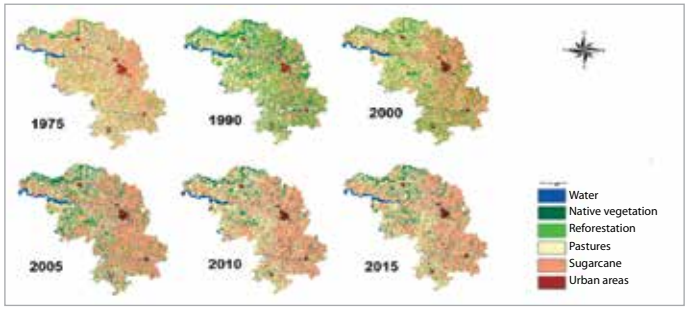

Figure 2. Temporal dynamics of land use in the Piracicaba region

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