# Spatialization of soil carbon stock in a rural landscape – a study case in the Southest of Brazil

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**Abstract** Agriculture is one of the main responsible for the increase of $CO_2$ atmospheric in Brazil. However, the adoption of conservation farming practices is an alternative to mitigate climate change. Geoprocessing tools can assist in land use mapping process and associate different landscape parameters in an integrated spatial analysis. To carry out this study, the C stock was calculated and spatialized using the software Arcis® 10.2. A gradual C stock values categorization is presented according to land use cover map. It was observed that Annual e Perennial crops land use classes presented the lowest values of C stock. That showed the fragility of agrosystems concerning C stocks, but in the other hand, the great opportunity and importance of to improve agricultural management practices seeking decrease the impact of food production into the global C cycle.

## Introduction

Human activity has been influenced significantly the Earth's climate (IPCC, 2013). Since the industrial revolution, with the increased use of fossil fuels, it is possible to observe significant increase of carbon level in the atmosphere - almost twice higher than last geological era (Machado, 2005). Land use change (LUC) has been one of the main responsible for this increase, and the agricultural activity plays an important role in this process (IPCC, 2007), markedly in Brazil.

Erosion, deforestation and plowing, often present in conventional farming practices, can be considered one of the reasons of carbon emissions into the atmosphere (Reicosky, 1997; Fearnside, 2001; Lal et al., 2004). On the other hand, conservation practices of agriculture can influence the C emissions and, thereby, increase the potential for prediction of ecosystem services (ES) by rural landscapes. ES are natural processes that ensure the survival of the species on the planet and, with their contributions, satisfy human needs (De Groot et al., 2002; MEA, 2005). These services are related to the benefits derived from natural processes, such as air purification and climate regulation (MEA, 2005).

Geoprocessing tools are very useful for spatial analysis and data and information visualization. With it, it is possible to map different landscape properties and identify favorable areas for ES provision. For instance, it is possible to use GIS to map soil parameters and associated it with land use/land cover classes. It represents an opportunity to recognize the landscape weaknesses and potentiality and contribute with more appropriate decisions for landscape management.

In this study GIS tools were used to integrate soil C stock parameter with land use/land cover map, since evaluation of C stock in the soil can be a good indicator to identify how each landscape unit is responding about its land use. It represents a powerful information for decision-making (Machado, 2005), that can be used to effective public policies related to climate change (Guo and Grifford, 2002; Ribeiro, 2008). In Brazil, there is a specific National Plan for Agriculture and Livestock sector, knowing as *Plano ABC*. This plan aims to reduce GHG emissions from agriculture and livestock activities and contribute, indirectly, to reduce emissions from deforestation. The program would support actions in recovering degraded pasture areas and integrated production systems (agro-pasture, silvopasture, agro-forestry or agro-silvopasture systems), or definition of permanent preservation areas in rural landscapes and to identify related public policy land use and agricultural management appropriate to the soil (Ludenã et.al., 2011).

Hence, the aim of this study is to present the potentiality of GIS tools to spatialize soil C stock, an indicator of agricultural management practices status, to subsidize decision-making in rural landscapes.

## Materials and methods

The studied area is a watershed, with around 500 ha, located in the mountainous area of Rio de Janeiro State, Southeast of Brazil. In this area, 43 soil samples, in a depth of 0.05m, were collected and analyzed for total organic C (dry combustion). The carbon content and soil density analysis were proceeded. From these parameters, the C stock was calculated, using the formula $C = (COT \times Ds \times 0.05) / 10$, which corresponds to: stock of organic carbon; organic carbon content; bulk density; and thickness of the sampled layer, respectively (Veldkamp, 1994). In each collected point, a geographic coordinate was assigned. Arcis® 10.2 software was used to analyze spatially and integrated the C stock information with land use/land cover watershed map, from 2010 (Tavora, 2014). The values of C stock were associate to all the eight classes of land use/land cover map.

## Results and Discussion

The average of C stock was calculated for each land use class (Table 1).

Pasture and bare soil were the classes with the highest C stock value, probably because the grass root system in the pasture and because the bare soils represents the class after annual crop harvest, with the subsequent deposition of crop biomass in the soil surface.

When this results are spacialized (Figure 1), it is not possible to observe a behavior tendency of the C stock in the landscape.

**Table 1:** C stock in the land use/cover of Pito Aceso Watershed.*

| Class | Average soil C stock (Mg ha $^{-1}$) |
|---|---|
| Pasture Level 2 | 41.08 |
| Bare Soil | 34.36 |
| Pasture Level 1 | 27.17 |
| Forest (Initial) | 26.32 |
| Forest (Advanced) | 24.63 |
| Perennial crops | 23.41 |
| Annual crops | 20.21 |

*Pasture Level 1 is represented by smooth pastures without the presence of shrubs, Pastures Level 2 is represented by pastures with the presence of small shrubs. Bare soils represent soil after harvest of annual crops.

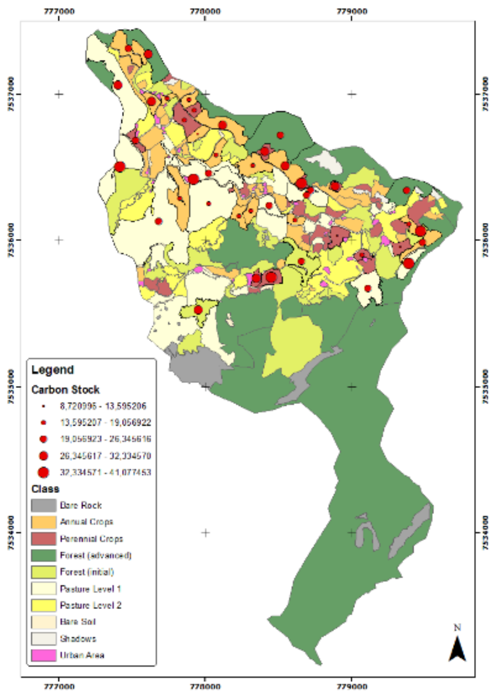


**Fig. 1** Land use/land cover map of Pito Aceso Watershed and soil C stock values.

The presented analysis permitted to identify that the management practices in the area have potential to be improved, since agricultural land use classes were those with the lowest soil C stock. It would represent an advance for the local rural community, since the use of better agricultural management practices represent a possibility of being contemplated by existing public policies, as *Plano ABC*, contributing with ES provision and climate change mitigation. However, the results allow to affirm that the association between a unique soil indicator - soil C stock – and land use/land cover is not sufficient to demonstrated the landscape status. For an integrated analysis, it is necessary to add others soil parameters, associated with landscape metrics.

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