Comparison between carbon stock measurements methods in eucalyptus stems

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Introduction

The levels of greenhouse gases (GHG) have been significantly increased since the Industrial Revolution. However, only after 1980 was that the changes in the levels of GHG were scientifically evident. This finding led to the establishment in 1988, the Intergovernmental Panel on Climate Change (IPCC).

In 1997, during the Conference of the Parties (COP) held in Japan, the Kyoto Protocol was established in order to reduce the emission of GHGs mainly by industrialized countries. Among the mechanisms cited for compensation of GHG emissions there is the Clean Development Mechanism (CDM).

Developing countries, e.g. Brazil, started the implementation of the CDM to generate carbon credits to be traded with developed countries, since they have committed to reduce GHG emissions. Through calculating the GHG that had their volumes avoided and/or removed from the atmosphere emissions, carbon credits are generated. Each carbon credit is equal to a stored GHG ton and/or that have not been released into the atmosphere and they may be negotiated between developed and developing countries.

The forest carbon sequestration is one way of CDM in which trees remove carbon dioxide from the atmosphere and accumulate in the woody matter. By presenting strong forestry vocation, Brazil has great potential for the implementation of CDM projects, and on a global market and increasingly competitive, the possibility of adding value to planted forests by the Forest Carbon Sequestration reinforces the need for projects on forest management and forest measurement.

Thus, this study aimed to compare two carbon stock assessment methodologies in eucalyptus trees.

Material and Methods

The experiment was carried out in Ribas do Rio Pardo, Mato Grosso do Sul State, Brazil, on a farm located between the GPS coordinates 20°26’09” and 20°27’31”S and 53°56’13” and 53°57’43”W. The soil of the experimental area is classified as Typic Quartzarenic Orthic (Santos et al., 2013). The weather pattern of the area is classified, according to Koppen (1948), as a transition between CFA and humid Aw.

The experimental data, as well as tree fragments were obtained from forests of clonal eucalyptus H77 (*Eucalyptus urophylla* x *Eucalyptus grandis*), aged between 12, 24 and 36 months. The determination of wood density was held at Plant Physiology and Analytical Chemistry Laboratories of Anhanguera-Uniderp University/Campo Grande (Brazil).

After the characterization of forest stands were selected 12 trees of each age (12, 24 and 36 months), totaling 36 samples, representing all ages of the evaluated population. It was measured the height of the stem and the stem diameter without bark at breast height (diameter at breast height – DBH - 1.30 meters above ground).

Just after the measurements, the selected trees were cut for collect a 10 cm disc of stem at the DBH, for determining the density of the wood, according to the methodology proposed by Vital (1984) and the amount of carbon stored in the stem, according to the methodology proposed by Tedesco et al. (1995) and by Walkley-Black method with external heat, described by Allison (1965).

To estimate the carbon stored in the stem, it was considered that 50% of the total biomass consists of carbon (Soares et al., 2005).

Results and Conclusions

The amount of carbon in the stem determined by destructive and non-destructive methods according to the age of the trees are shown in Table 1. The availability of papers about wood density as a function of tree age and spatial arrangement are scarce in the literature, so we used the same average wood density for the carbon stock calculations for both methods.

Table 1. Carbon stock (t ha^{-1}) in the eucalyptus tree stem, determined by destructive and non-destructive methods, depending on the age of the trees.

Tree	12 months		24 months		36 months	
	Destructive Method	Non-destructive Method	Destructive Method	Non-destructive Method	Destructive Method	Non-destructive Method
1	0,4049	0,4122	0,4119*	0,4676*	0,9148	0,9252
2	0,2957	0,2898	0,5599	0,4991	1,0849	1,0973
3	0,2793	0,2562	0,4156	0,4286	1,0248	0,9919
4	0,3636*	0,3152*	0,6112	0,6065	1,1526	1,1366
5	0,3852	0,3377	0,6317	0,6430	1,0956	1,0872
6	0,3222	0,3100	0,1507*	0,5944*	0,9902	1,0015
7	0,3369	0,3343	0,5352	0,5149	1,2367*	1,1684*
8	0,3262	0,3216	0,4476	0,4442	0,9556	0,9919
9	0,3267	0,2922	0,3670	0,3860	0,8433	0,8163
10	0,2869*	0,3281*	0,3813	0,3646	0,9308*	0,8847*
11	0,3368	0,3182	0,5917	0,5624	1,2729	1,2552
12	0,3280	0,3235	0,5339	0,5168	1,0773	1,0427

*The two data that present the biggest differences between the determination by destructive and non-destructive methods for each age were eliminated.

The regression analysis shows high correlation - upper than 99% (Figure 1) – between two methods for determining the carbon stock in the stems of eucalyptus trees for all ages studied. These results corroborate Reis et al. (1994) that found high correlation between destructive and nondestructive methods for determining carbon in tree stems. Therefore, the nondestructive method can be used to estimate the carbon stock in the stems of eucalyptus trees with a high degree of confidence and with the advantages of higher efficiency and lower cost.

In Figures 2, 3 and 4 are shown separately, the regression equations and correlation between destructive and nondestructive methods for each age studied.

We conclude that the two methods compared to the determination of carbon eucalyptus stems have high correlation. The determination of the amount of carbon stored in the stems of eucalyptus plants by non-destructive method has high reliability.

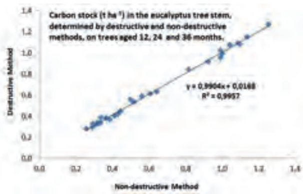

Figure 1. Correlation between carbon stock determined by destructive and non-destructive methods on eucalyptus trees aged 12, 24 and 36 months.

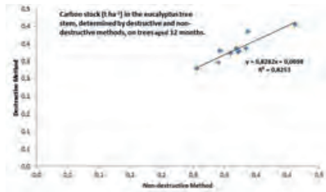

Figure 2. Correlation between carbon stock determined by destructive and non-destructive methods on eucalyptus trees aged 12 months.

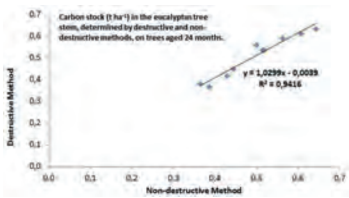

Figure 3. Correlation between carbon stock determined by destructive and non-destructive methods on eucalyptus trees aged 24 months.

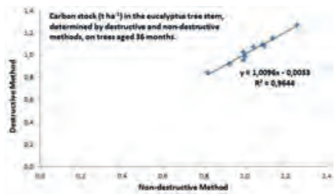

Figure 4. Correlation between carbon stock determined by destructive and non-destructive methods on eucalyptus trees aged 36 months.

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