The impact of Soil and Relief on the performance of afforested pastures in South East Brazil

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Background

Projects involving the reforestation or afforestation of abandoned or degraded land are a practical biological approach to restore regional ecological functions and to sequester atmospheric carbon to help mitigate the global imbalance of atmospheric carbon associated with climate change. Large gaps remain, however, in understanding the dynamics of afforested tree communities. In this non-experimental, small-scale study, the effect topographical relief has on the growth performance of planted trees has been assessed. Above ground dry biomass accumulation was estimated to evaluate afforested tree communities performance, established on abandoned pasture at the Reserva Ecológica de Guapíçu (REGUA), in the Serra dos Órgãos region of Rio de Janeiro, Brazil (Fig.1).

Methods

Eighteen 10x10m plots were established 2012 in afforested areas planted during the rainy season of 2007-2008. All trees with DBH≥1cm were tagged and censused following the guidelines for studying tropical forest census plots suggested by Condit (1998). To estimate AGBdry, the allometric model for young secondary forests developed by Tiepolo et al. (2002) was used. Root biomass has been estimated applying a root-to-shoot ratio of 0.24 of above ground biomass. To convert biomass to carbon, AGBdry was multiplied by 0.47 as suggested by the FAO-IUFRO (Magnussen & Reed 2004). Disturbed soil samples were taken 0 to 30cm below surface and analyzed for a basic set of chemical (C, N, P, CEC, pH) and physical (grain size distribution, bulk density) soil properties. Soil analysis was performed by EMBRAPA Solos according to Brazilian standard procedures.

Results

AGBdry of the tree community on the plane** afforestations measured 80.08±15.0 Mg ha⁻¹, whereas the afforested tree community on the slope*** measured less then half of this (37.23±12.6 Mg ha⁻¹). Combining soil sampling results for soil organic carbon and carbon contents of above- and below ground biomass, the total carbon pool for plane and sloped areas shows almost the same pattern (Tab.1).

Tab. 1. Carbon pool estimates for afforestation plots in plane and slope position

<table>
<thead>
<tr>
<th>Carbon pool</th>
<th>Plane (Mg C ha⁻¹)</th>
<th>Slope (Mg C ha⁻¹)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGBdry</td>
<td>37.64 ± 7.1</td>
<td>17.50 ± 5.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Root</td>
<td>9.03 ± 1.7</td>
<td>4.2 ± 1.4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Biomass</td>
<td>46.67 ± 8.7</td>
<td>21.70 ± 7.3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Soil (Organic Carbon, 30cm)</td>
<td>46.32 ± 9.1</td>
<td>40.94 ± 2.6</td>
<td>n.s.</td>
</tr>
<tr>
<td>Total</td>
<td>92.99 ± 10.5</td>
<td>62.64 ± 12.2</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

A CCA ordination of plot AGBdry shows a significant influence of soil and relief explaining the variation of the afforestations biomass and carbon accumulation (Fig.2).

Fig. 1. Study site at REGUA with afforested hill slope (S) in the background and plane area (P), both previously used as pasture.

References


The study revealed large discrepancies in AGB and respective organic carbon accumulation depending on topography and related soil conditions. Hence, these differences in tree growth performance should be considered to prevent misleading carbon sink estimates when developing regional REDD+ strategies promoted by afforestations.