Estimation of tropical forest biomass using image texture of radar images

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Question:
quantifying global carbon fluxes?

forest biomass retrieving
SAR acquisitions with the airborne ONERA SETHI system

fully polarimetric images at X, L, P band

From Dubois-Fernandez et al., 2010
Paracou: 15 measured experimental plots

6 control plots
3 sets of 3 plot each with various thinning levels

Biomass ranges from 266.7 to 466 t.ha$^{-1}$
100x100 pixels windows are selected in the SAR image

2 sets of texture features are calculated for each window:

- features characterizing the backscattering distribution (variance, skewness, kurtosis, entropy)

- features based on the grey level co-occurrence matrix or GLCM (variance, energy, contrast, entropy…) (Haralick, 1973) (pairs of horizontal joined pixels, 32 levels)
Texture features vs plot biomass regressions

- from $\sigma^\circ$ distribution
- from GLCM
Texture features vs plot biomass regressions

- from $\sigma^\circ$ distribution
- from GLCM
Texture features:

1) from $\sigma^o$ distribution
   kurtosis $R^2=0.28$

2) From GLCM
   contrast $R^2=0.20$

Correlation is poor: dispersion is large with respect to biomass range

Structural characteristics of plots

Estimation of tropical forest biomass using image texture of radar images. Champion I. et al. 
32nd EARSel Symposium, Mykonos island, Greece, 21-25 May 2012.
Plots are settled in a hilly landscape

Topographical classes for the 6 control plots P1, P6, P11, P13, P14, P15

Bottomlands

Hillsides

Hilltops

*From F. Morneau, 2007*
Edaphic constraints influence floristic composition and stand structure.

Plots were characterized by their trunk dbh class distributions:

- **Block 1**: small P1, intermediate P2, big: P3, P8
- **Block 2**: intermediate and big P6, P7, P10, P12
- **Block 3**: small P4, P5, P9, P11

As far as the global structures of the stands are concerned, the grouping resulted in more contrasted situations: block 1 (P1 to P3 and P8), the most heterogeneous, groups very different plots characterized either by a lot of small trees (P1), a lot of trees in intermediate classes (P2) or a lot of big trees (P3 and P8). Block 2 (P6, P7, P10 and P12) groups plots differing according to the weight of intermediate and large diameter classes. Block 3 (P4, P5, P9 and P11) is the most homogeneous, grouping mainly plots where small diameter classes are highly represented.

From Gourlet-Fleury et al., 2004
Edaphic constraints influences canopy structure of plots

Plots are characterized by their trunk dbh distribution

Block 1 small P1, intermediate P2, big: P3, P8

Block 2 intermediate and big P6, P7, P10, P12

Block 3 small P4, P5, P9, P11

S small, I intermediate, B big, IB intermediate and big

S1, I2, B3, S5, IB6, IB7, B8, S9, IB10, S11, IB12 and unknown 13, 14, 15

Texture features (GLCM):

- entropy vs variance

S small,
I intermediate,
IG, intermediate and big,
B big

No structural information
P13, P14, P15
Texture features (GLCM): entropy vs variance

B big
IB, intermediate and big,

differ from

S small and I intermediate,
with P13, P14, P15

Apart P3…

Texture indicator: GLCM-based statistics with two structural classes

O : Big trees

+ : Small trees

Retrieving biomass accounting for structural classes

<table>
<thead>
<tr>
<th></th>
<th>Group &quot;big&quot;, NdF=4</th>
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<th>Group &quot;small&quot;, NdF=8</th>
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<tbody>
<tr>
<td></td>
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<td>Texture from the GLCM</td>
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**discrimination of structural classes?**

**variation with topography and soil?**