Contribution of textural information from Terrasar-X images for forest mapping

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Context

Since 2007, **radar sensors** like Radarsat-2 or Terrasar-X offer **high spatial resolution** acquisition (about 1m), well suited to the patchwork parcels of European landscape. Beyond giving **complementary information to optical data**, radar data are insensitive to cloud cover. Such resolution allows to access to **textural information** which was not possible with previous existing sensors such as ERS, ASAR with almost 25m of spatial resolutions. This work focuses on evaluating the potential of textural analysis of high spatial resolution radar images for forest mapping.

To complete studies that have already shown the interest of textural analysis for **forest mapping** [1], three textural analysis methods are compared : two methods based on frequency textural analysis : namely **wavelet transform** and **Fourier transform**, the third method is based on the characterization of the of the gray level co-occurrence matrix (denoted GLCM) by retrieving **Haralick** descriptors from it. The derived attributes of each method are evaluated by analyzing their performance from **Random Forest classification**.

Study Site and Data

Brasil

Sao Nicolau Fazenda

Image characteristics :	
Wave length	λ=3cm (X-band)
Polarization	HH
Footprint	5x7km
Spatial resolution	1m
Pixel Size	0.5

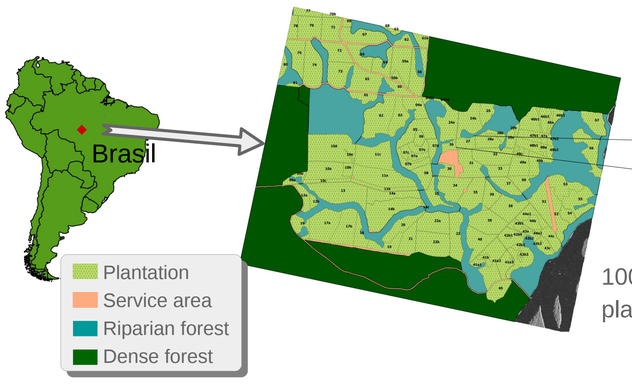
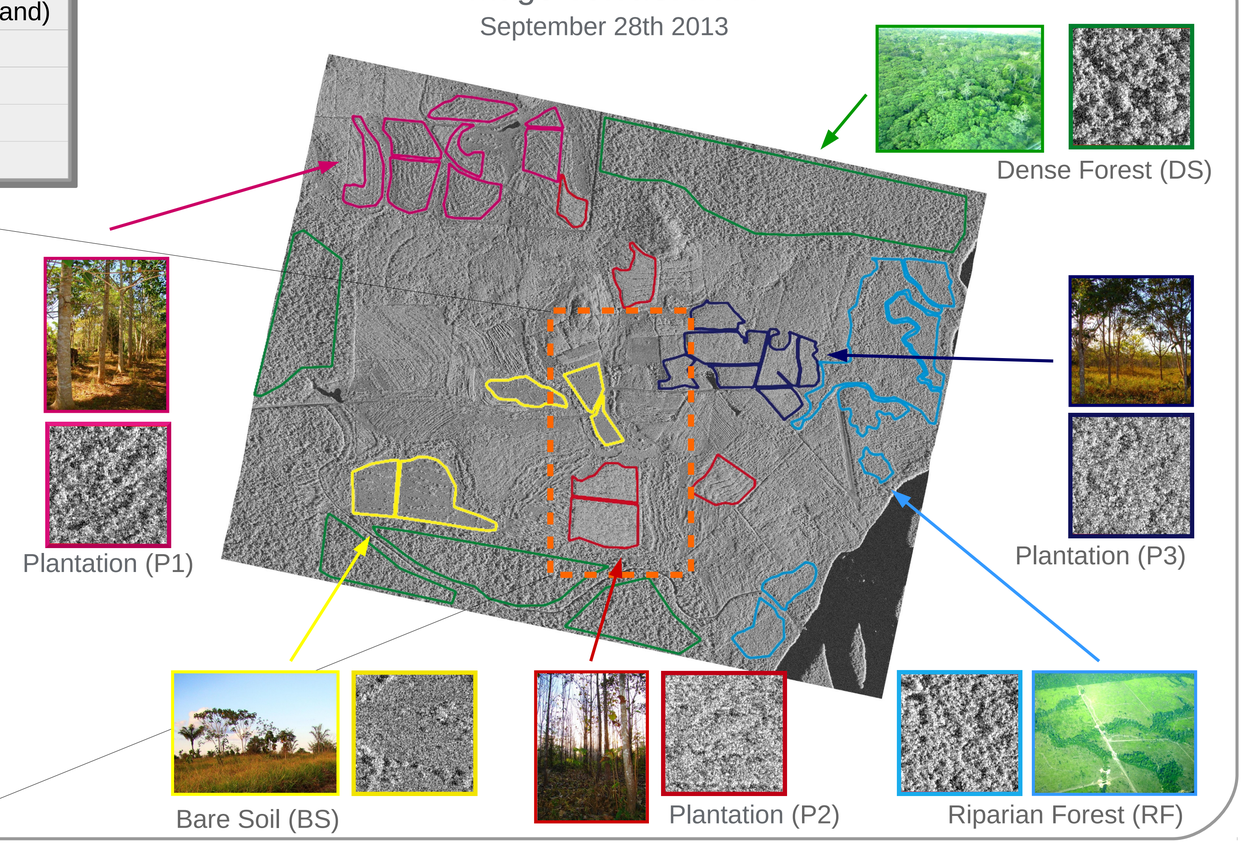


Image **TerraSAR-X**
September 28th 2013



Because of the **high variability of texture** inside a **mono-species plot**, the definition of the classes to be used for the classification is based on both the **textural information** and **thematic information**. The textural information is based on the photo interpretation of the TerraSAR-X intensity image. **6 classes** have been defined.

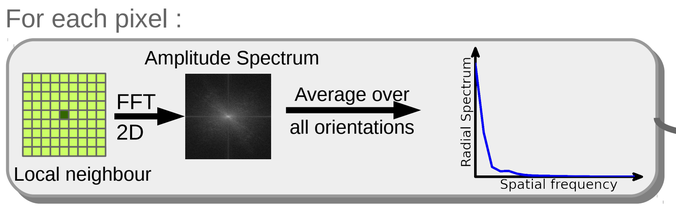
In situ data are provided by ONF International, Terrasar-X image was acquired in the frame of "Planet Action" project..

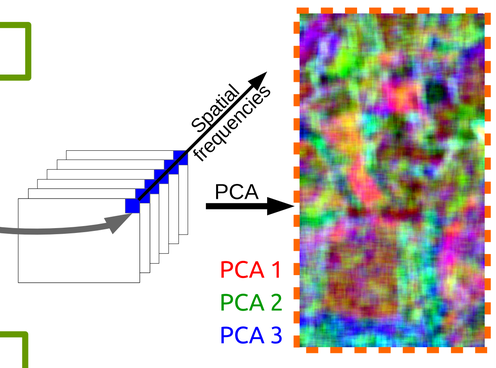
Methods

Three textural analysis methods have been compared : Fourier transform, wavelet transform and Haralick textural attributes.

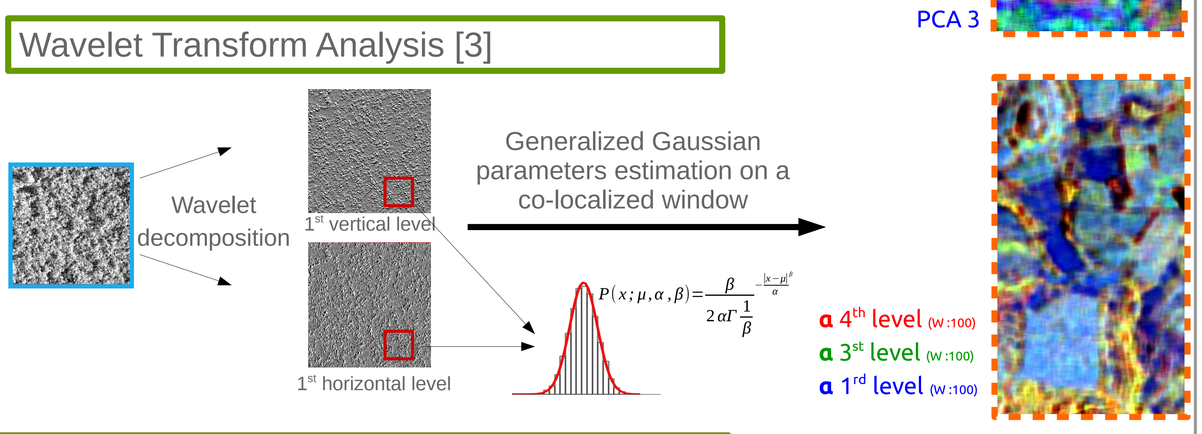
Fourier Transform Analysis (FOTO [2])

For each pixel :

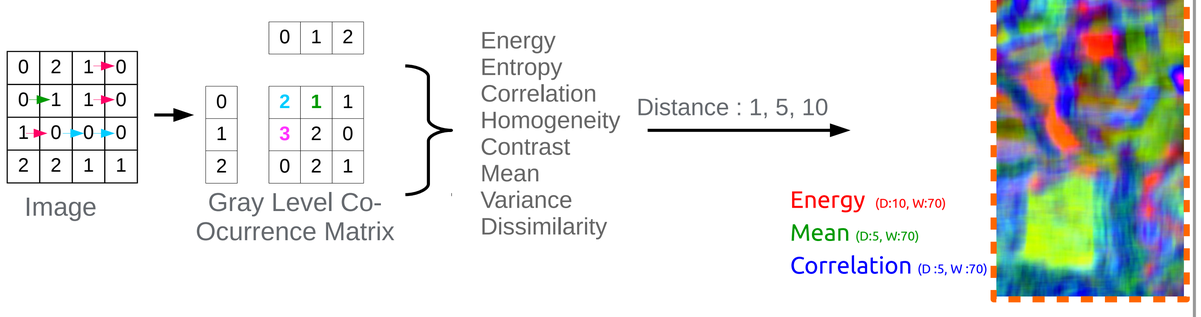




Wavelet Transform Analysis [3]



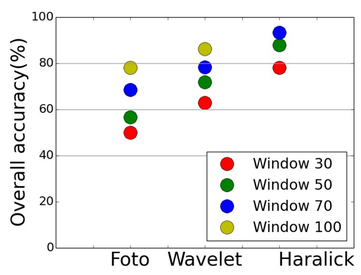
Haralick Analysis [4]



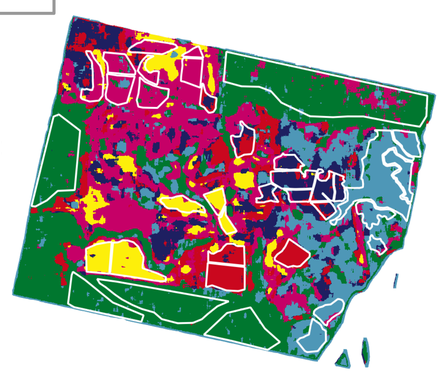
The 3 methods are compared using the overall accuracy of a supervised classification (Random Forest).

Result

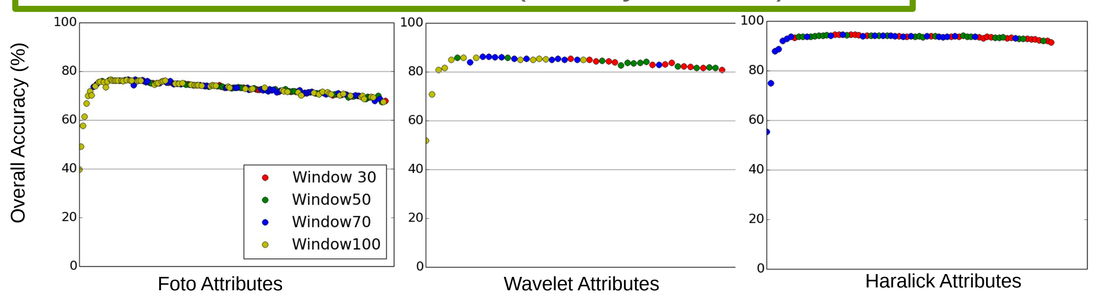
Scale analysis sensitivity



Best classififcation results :
- Foto (OA : 86%).
- Wavelet (OA : 78%).
- Haralick (OA : 94%).



Incremental attributes selection (Greedy Forward)



The incremental attributes selection shows a strong dominance of the large scale analysis.
Foto : predominance of spatial frequencies from 0 to 400 cycle.km^{-1}.
Wavelet : scale parameter (α) and form parameter (β) are very important compare to the position parameter (mean, μ). All wavelet decomposition level are used.
Haralick : Distance 1, 5 and 10 are use full, with a small predominance of D=5.

Attribute fusion

	DF	RF	Pl 1	Pl 2	Pl 3	BS
DF	86	8	6	0	0	0
RF	14	80	4	1	1	0
Pl 1	10	9	68	8	4	1
Pl 2	2	2	9	70	14	3
Pl 3	1	6	7	15	68	3
BS	2	0	4	6	5	83

Fusion Foto (OA:78%)

	DF	RF	Pl 1	Pl 2	Pl 3	BS
DF	82	7	11	0	0	0
RF	7	84	5	2	2	0
Pl 1	12	3	79	1	3	2
Pl 2	0	0	5	70	24	1
Pl 3	0	4	9	22	64	1
BS	0	0	3	1	1	95

Fusion Wavelet(OA:86%)

	DF	RF	Pl 1	Pl 2	Pl 3	BS
DF	85	8	7	0	0	0
RF	10	82	5	0	3	0
Pl 1	7	4	83	1	3	2
Pl 2	0	1	2	83	13	1
Pl 3	1	4	6	18	70	1
BS	0	0	2	1	1	96

Wavelet and Foto attributes fusion (OA : 88%)

Conclusion

- The larger the **local neighborhood** is, the most **robust textural analysis** will be. This size have to be related to the plot size of the study site and computation times.
- **Haralick attributes method** is **more efficient** in this case : overall accuracy = 94 %.
- **Wavelet transform method** allows to **preserve sharp contour** of the plot, it can be useful with smaller plots.
- **Attributes fusion** can **improve classification results**, especially with **Foto method**, some classes can reach a producer accuracy 13 % greater than without attributes fusion.

Perspectives

- Further studies will be made over **different study sites** with an approach more related to the **plot scale analysis**.
- Foto method may be improved by **characterizing radial spectra** by comupting attributs to characterize their form.
- Thoses attributes will be compared to **bio-physical variables** (tree height, plantation density ...)

References

[1] H. Benelcadi, P.-L. Frison, C. Lardeux, G. Mercier, and J.-P. Rudant, "Using texture from high resolution Terrasar-x images for tropical forest mapping," in Geoscience and Remote Sensing Symposium. IEEE, 2014, pp.2328–2331.

[2] C. Proisy, P. Couteron, and F. Fromard, "Predicting and mapping mangrove biomass from canopy grain analysis using fourier-based textural ordination of ikonos images", Remote Sensing of Environment, vol. 109, no. 3, pp. 379–392, 2007.

[3] G. Mercier and M. Lennon, "On the characterization of hyperspectral texture", in Geoscience and Remote Sensing Symposium, 2002. IGARSS'02. IEEE, 2002, vol. 5, pp. 2584–2586.

[4] R.M. Haralick, K. Shanmugam, and I. Dinstein, "Textural features for image classification," Systems, Man and Cybernetics, IEEE Transactions on, , no. 6, pp. 610–621, 1973.