Brazil / São Paulo

JECAM/GEOGLAM Science Meeting

Guerric LE MAIRE
Stéphane DUPUY

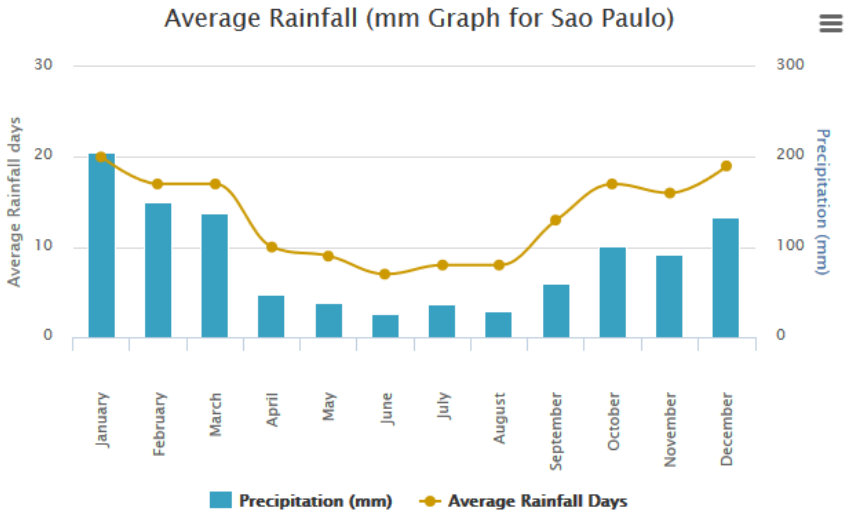
JECAM
Joint Experiment for Crop Assessment and Monitoring

GEO GROUP ON EARTH OBSERVATIONS

Site Description

- Brazil, São Paulo state
- Topography: Mostly flat
- Soils: deep Ferralsols, ~20% Clay (in centroid area)
- Drainage class/irrigation: Moderately to well drained
- Crop calendar:
  - Eucalyptus: 6 years rotations
  - sugarcane 5 years, permanent pastures, citrus, etc.
  - corn-soja rotations
- Field size: ~40 ha
- Climate and weather:

Humid Tropical (Aw Koppen)



JECAM
Joint Experiment for Crop Ass

http://www.worldweatheronline.com

sugarcane

Pasture, very young Eucalyptus plantation, old Eucalyptus plantation

Orange tree orchards

Soybean and Eucalyptus plantation

Young Eucalyptus

Project Objectives

- **Crop identification and Crop Area Estimation for all crops, natural and planted forests in the area.**

Land use change analysis: Eucalyptus and Sugarcane area increase: When ? Where ? What previous land use ?

On Eucalyptus plantations :

- Plantation Condition/Stress
- Biomass estimates
- Yield Prediction and Forecasting

Earth Observation (EO) Data Received/Used

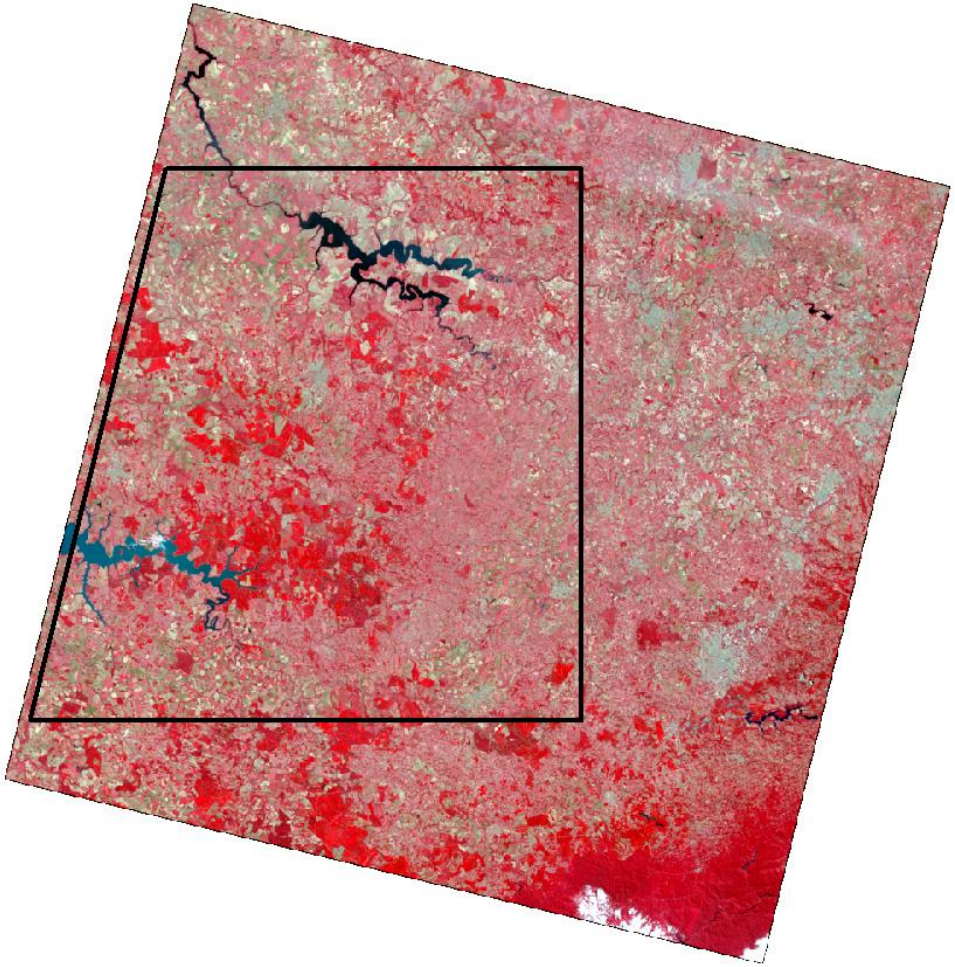
Landsat 5

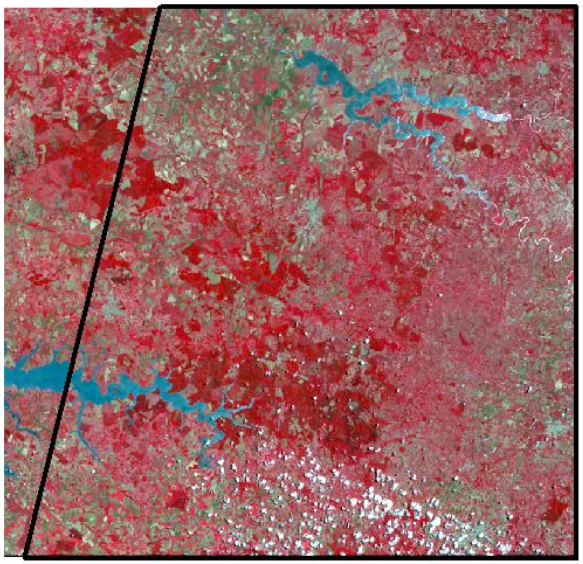
- Number of scenes: 5
- Dates: 08/09/2013; 11/11/2013; 30/01/2014;11/09/2014;29/10/2014
- 30 m MS + 15 m PAN
- Processing level: TOA reflectance
- Cloud mask

Earth Observation (EO) Data Received/Used

Deimos

- Number of scenes: 3
- Dates: 13/11/2013;05/04/2014;19/07/2014
- 20 m MS
- Processing level: TOA reflectance
- Cloud mask





Example Landsat image 08/09/2013

Example Deimos image 13/11/2013

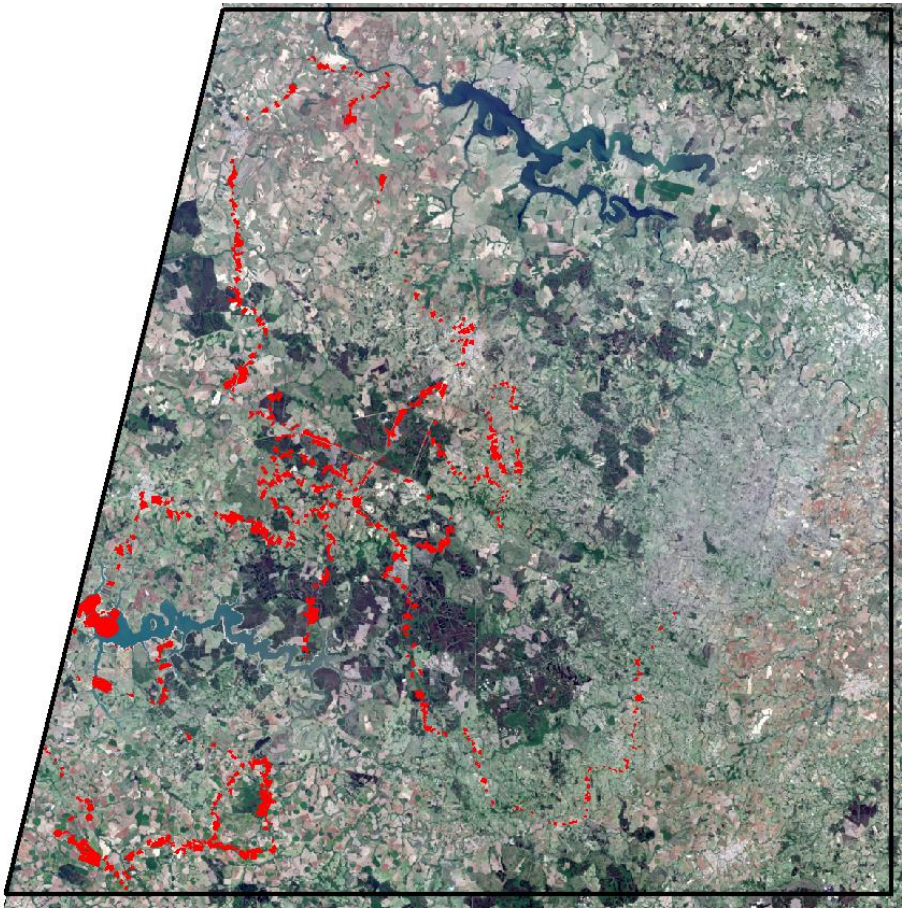
JECAM
Joint Experiment for Crop Assessment and Monitoring

GEO GROUP ON EARTH OBSERVATIONS

In situ Data

- **May 2012:** 422 ground points recorded in May 2012 with a GPS. 33% of these points were Eucalyptus plantations and the other belonged to 21 other land cover types
- **December 2014** : 847 GPS point recorded in the field, following the JECAM protocol and updated nomenclature. Along roads, across JECAM area. GPS points converted to polygons based on the images.
- **Year 2015** : field survey 3 months for 260 *crop* points (southern area)

In situ Data



2014 measurement polygons in red

Land use	
Banana	3
Built-up	53
Coffee plantation	14
Corn	30
Eucalypts plantation	160
Fallow	7
Forest	36
Orange tree plantation	63
Other	30
Pasture	127
Pines plantation	47
Rocks	11
Soybean	91
Sugarcane	154
Water	21

Total : 847

In situ Data

- Many measurements are conducted on a large Eucalyptus stand of ~200 ha that was planted in 2009 (Eucflux project) on a flux-tower instrumented site.

Evapotranspiration	Leaf temperature	Canopy reflectance spectra
Carbon net ecosystem exchange	Soil respiration	Leaf, trunk, litter reflectance spectra
LAI, fAPAR	Litterfall	Canopy structural properties (leaf angles, leaf distrib)
Carbon Biomass in trunk and roots	Soil carbon content	Tree sizes and location
Soil water content 0 -10 m	Root profiles, root turnover	…
Water table depth	Nutrient biomass and fluxes	
Meteorological data (weather station)	Transmitted radiation	
Soil temperature	NDVI and PRI sensors	

Collaboration

- SIGMA European Collaborative Project (FP7-ENV-2013 SIGMA — Stimulating Innovation for Global Monitoring of Agriculture and its Impact on the Environment in support of GEOGLAM — project no. 603719)
- SIGMA - JECAM experiment on medium to large field size agrosystems: test and compare classification methods for cropland area estimations based on MODIS data, and applied in different contrasted JECAM sites. Paper submited (Waldner et al.)

Results

- A land cover map done for December 2014
- Method: Random forest of the 2013-2014 images (8 images)
- 240 variables were computed for each polygon: we used all the bands reflectances of all images, and computed several vegetation indices.
- The Random Forest algorithm was then used under R. The model was calibrated on 70% of the field data, and afterward applied on the entire image, giving the final landcover map.
- The result is very good for sugarcane, eucalyptus, pines, forests, pastures and water bodies. Classification error is high for coffee plantations, maize and orange tree orchards.

Results

- A Brazil map of Eucalyptus plantations from MODIS

le Maire, G., Dupuy, S., Nouvellon, Y., Loos, R.A., & Hakamada, R. (2014). Mapping short-rotation plantations at regional scale using MODIS time series: Case of eucalypt plantations in Brazil. Remote Sensing of Environment, 152, 136-149

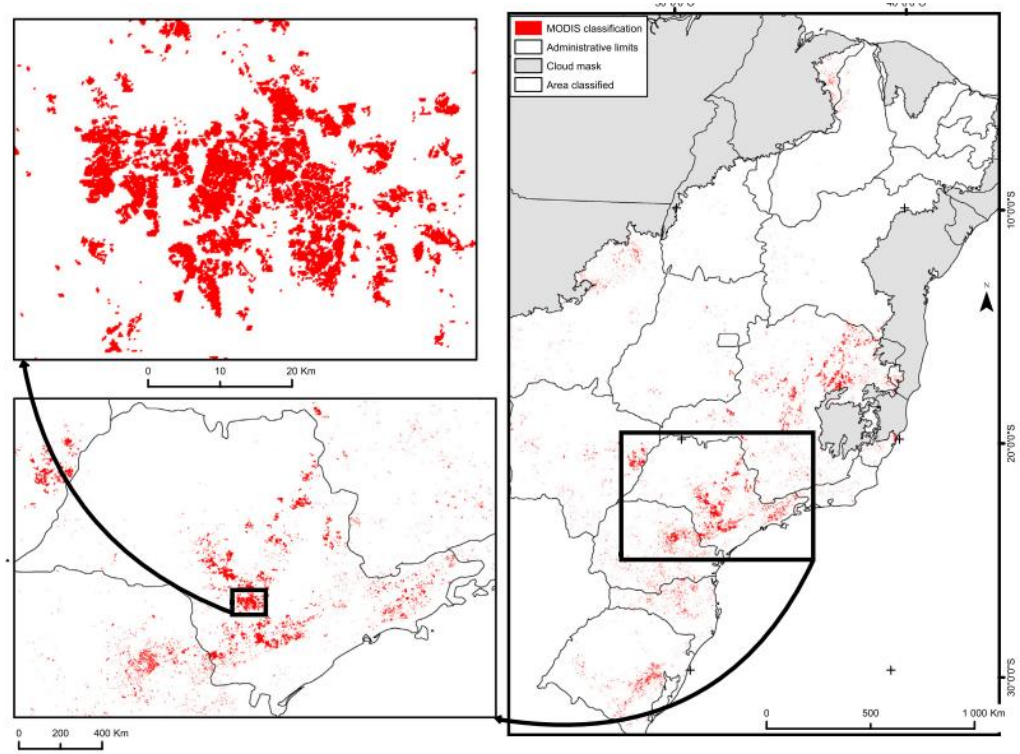


Fig. 8. Map of fast-growing Eucalyptus plantations in 2009 over a large part of Brazil obtained in this study using MODIS 250 m NDVI time series classified with the *BE* matching function. Left images are two successive zooms on a particular area in the state of São Paulo.

Results

- To what extent have the project objectives been met?

We have obtained an Eucalyptus map of the area, which has been validated. Other land uses were classified, but not validated

- Can this approach be called ‘best practice’?

The approach consisted in the use of 4 images of 2 consecutive years, to be able to classify the Eucalyptus clear-cuts. For other land use, this approach may not be valid, and some adaptations will be necessary. Field data collection protocol to change to meet JECAM requirement

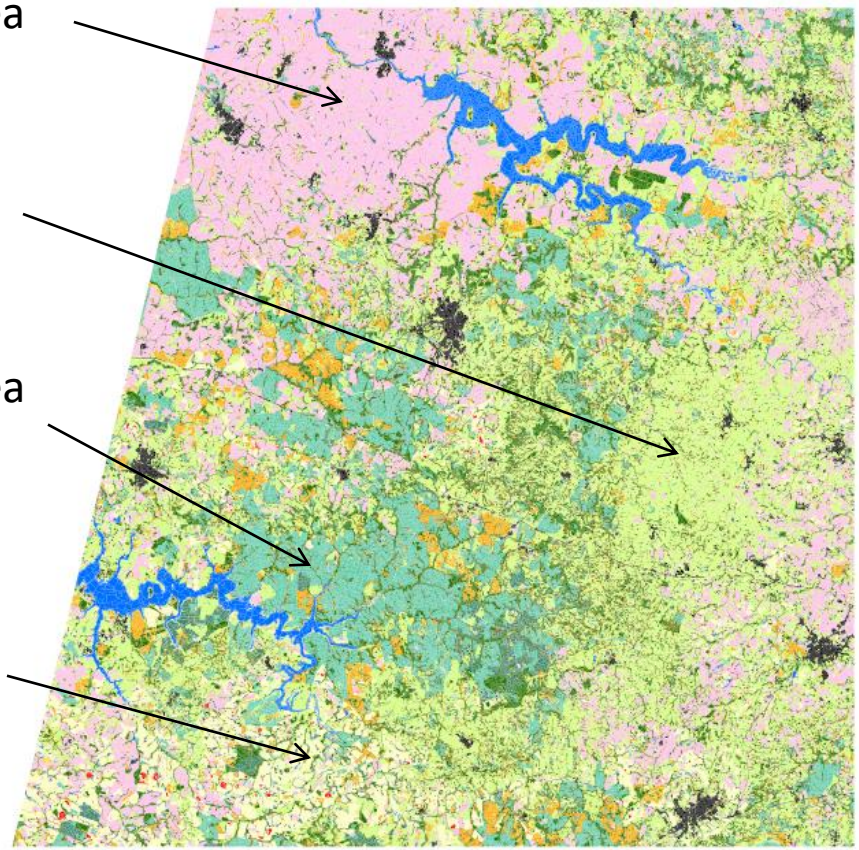
Brazil - Sao Paulo Jecam Site

Sugarcane area

Pasture area

Eucalyptus area

Crop area



Class	area (ha)	% of the total area
	1 615 916.42	
Pasture	513 740.70	31.79%
Sugarcane	365 820.20	22.64%
Eucalyptus	180 609.11	11.18%
Natural forest	175 723.77	10.88%
Soybeans	95 522.29	5.91%
Orange tree	86 593.38	5.36%
Coffee	81 163.27	5.02%
Water bodies	48 899.04	3.03%
Build-up surface	39 656.73	2.45%
Pines	22 603.40	1.40%
Rocks	2 200.99	0.14%
Maize	2 025.74	0.13%
Other	1 137.54	0.07%
Banana	130.4	0.01%
Young fallow	89.85	0.01%

0 10 20 Km

N

Banana
Build-up surface
Coffee
Eucalyptus
Maize
Natural forest
Orange tree
Other
Pasture
Pinnus
Rocs
Soya beans
Sugar cane
Water bodies
Young fallow

JECAM
Joint Experiment for Crop Assessment and Monitoring

GEO GROUP ON EARTH OBSERVATIONS

Research Plans for Next Growing Season

- Focus on the "crop class", especially corn – soybean, by including the field surveys done along the year (every 3 months). Main difficulty : there is not a common crop calendar in the region

- Use of a Spot image to derive texture information for helping classify the orange orchards (SPOT6 planned in 2015/2016)

- Do another complete survey in December 2015 or January 2016, and continue the 3 months field surveys if possible