Brazil / São Paulo

JECAM/GEOGLAM Science Meeting

Guerric LE MAIRE
Stéphane DUPUY
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)

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
• 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
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

<table>
<thead>
<tr>
<th>Land use</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana</td>
<td>3</td>
</tr>
<tr>
<td>Built-up</td>
<td>53</td>
</tr>
<tr>
<td>Coffee plantation</td>
<td>14</td>
</tr>
<tr>
<td>Corn</td>
<td>30</td>
</tr>
<tr>
<td>Eucalypts plantation</td>
<td>160</td>
</tr>
<tr>
<td>Fallow</td>
<td>7</td>
</tr>
<tr>
<td>Forest</td>
<td>36</td>
</tr>
<tr>
<td>Orange tree plantation</td>
<td>63</td>
</tr>
<tr>
<td>Other</td>
<td>30</td>
</tr>
<tr>
<td>Pasture</td>
<td>127</td>
</tr>
<tr>
<td>Pines plantation</td>
<td>47</td>
</tr>
<tr>
<td>Rocks</td>
<td>11</td>
</tr>
<tr>
<td>Soybean</td>
<td>91</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>154</td>
</tr>
<tr>
<td>Water</td>
<td>21</td>
</tr>
</tbody>
</table>

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.

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


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 8E 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.
<table>
<thead>
<tr>
<th>Class</th>
<th>area (ha)</th>
<th>% of the total area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasture</td>
<td>513 740.70</td>
<td>31.79%</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>365 820.20</td>
<td>22.64%</td>
</tr>
<tr>
<td>Eucalyptus</td>
<td>180 609.11</td>
<td>11.18%</td>
</tr>
<tr>
<td>Natural forest</td>
<td>175 723.77</td>
<td>10.88%</td>
</tr>
<tr>
<td>Soybeans</td>
<td>95 522.29</td>
<td>5.91%</td>
</tr>
<tr>
<td>Orange tree</td>
<td>86 593.38</td>
<td>5.36%</td>
</tr>
<tr>
<td>Coffee</td>
<td>81 163.27</td>
<td>5.02%</td>
</tr>
<tr>
<td>Water bodies</td>
<td>48 899.04</td>
<td>3.03%</td>
</tr>
<tr>
<td>Build-up surface</td>
<td>39 656.73</td>
<td>2.45%</td>
</tr>
<tr>
<td>Pines</td>
<td>22 603.40</td>
<td>1.40%</td>
</tr>
<tr>
<td>Rocks</td>
<td>2 200.99</td>
<td>0.14%</td>
</tr>
<tr>
<td>Maize</td>
<td>2 025.74</td>
<td>0.13%</td>
</tr>
<tr>
<td>Other</td>
<td>1 137.54</td>
<td>0.07%</td>
</tr>
<tr>
<td>Banana</td>
<td>130.4</td>
<td>0.01%</td>
</tr>
<tr>
<td>Young fallow</td>
<td>89.85</td>
<td>0.01%</td>
</tr>
</tbody>
</table>
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