Tocantins, Brazil

JECAM/GEOGLAM Science Meeting

Kiev 11-12 October, 2016

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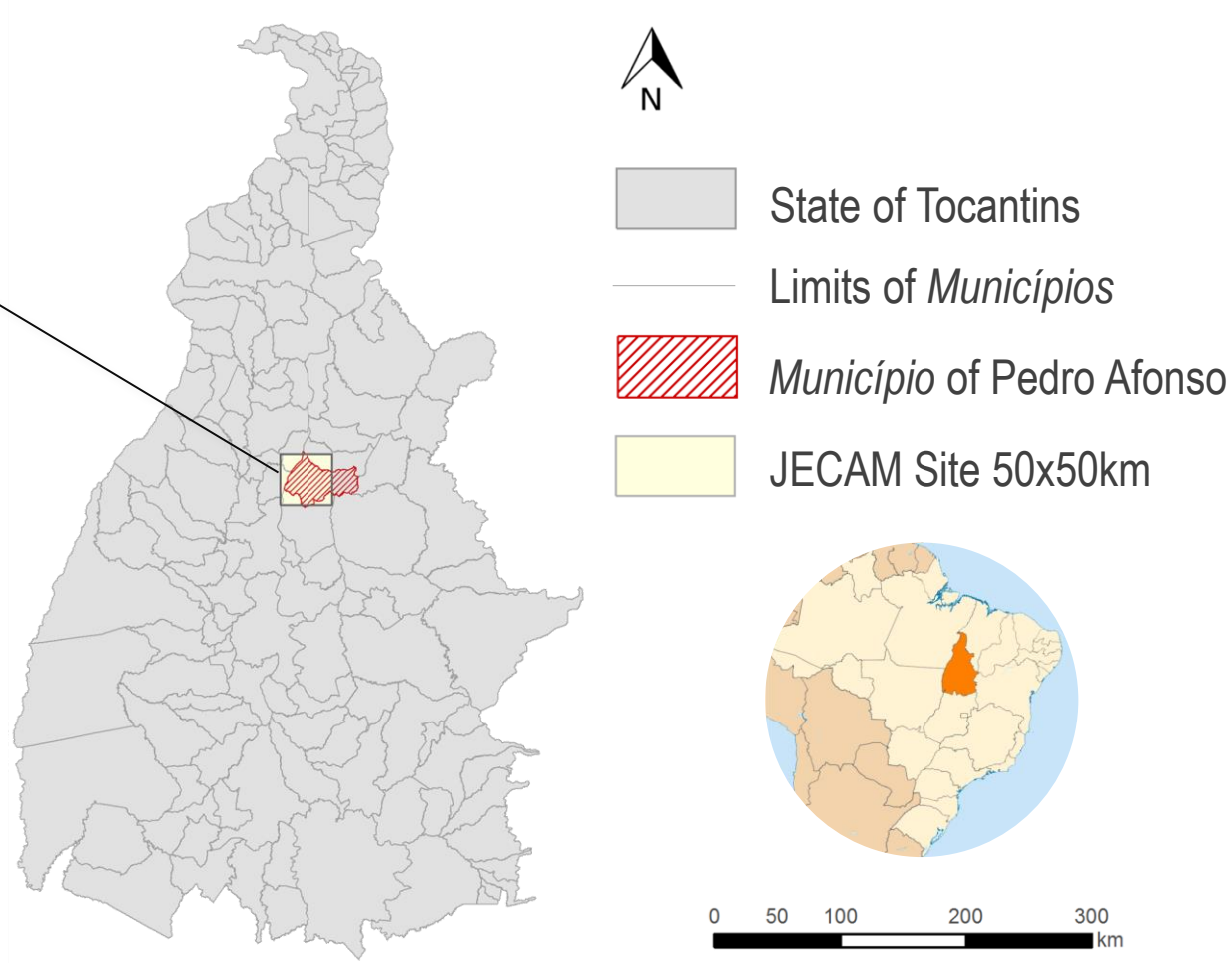
Site location



Site description

FIELD SIZE	Mostly large (~ 100 ha.)
CROP CALENDAR	Double cropping system: • Summer soybean crop - from Nov. to February (harvest in January/February) • Cereal crop - from March to May (harvest in April/June) Sugarcane crop: annual cycle (12 months) or longer (18 months)
AGRICULTURAL METHODS	Seeding, fertilization, pesticide application and harvest -> mechanical equipment Soil management -> dominance of zero-tillage systems
IRRIGATION	Center-pivot irrigation systems

Cover crop sorghum residues

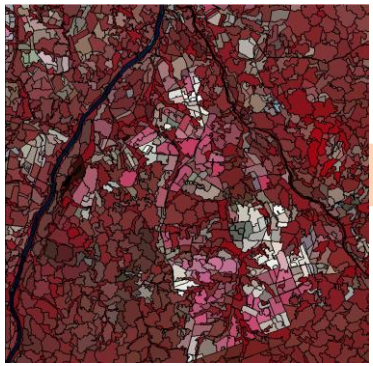
Center-pivot irrigation over sugarcane plantation

Soybean growing over maize residues

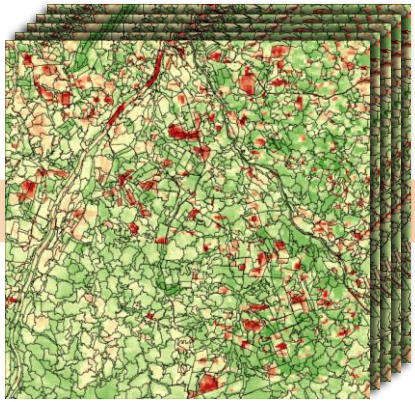
Methods & Results

Annual cropland
- Single cropping system
- Double cropping system

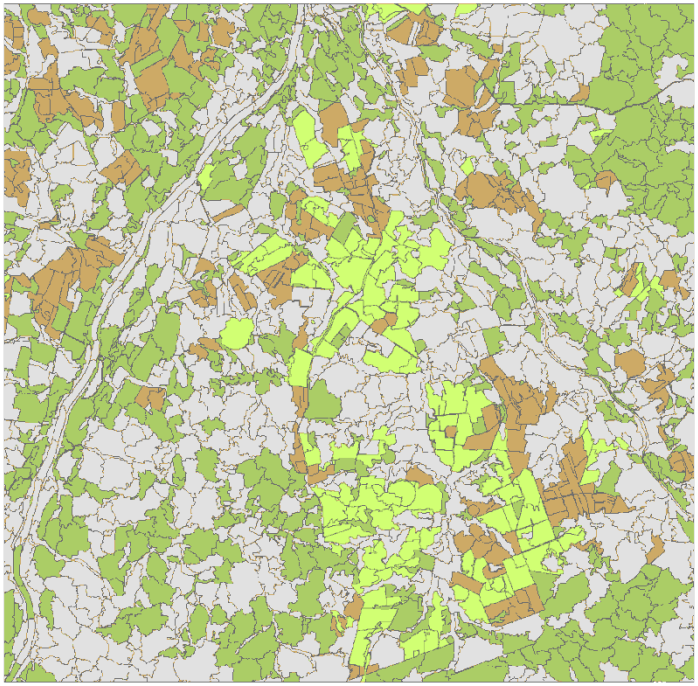
- Grassland & meadows
- Other LULC classes



High Spatial Res.
Segmentation



NDVI Time Series
Classification



OBIA + Unsupervised Classification

Tocantins (Brazil)

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CIRAD - TETIS Research Unit

1 Site description & Project objectives

STUDY SITE

LOCATION	Pedro Afonso municipality and surroundings (Fig. 2), Center-North Region of Brazil Lat.: 8.59°S / Long.: 48.10°O
TOPOGRAPHY	Areas with mild relief, slightly-undulating with soft slopes (170-392m)
SOILS	Dominance of Yellowish-Red Oxisols and Entisols
IRRIGATION	Center-pivot irrigation systems
CROP CALENDAR	Double cropping system: • Summer soybean crop - from Nov. to February (harvest in January/February) • Cereal crop - from March to May (harvest in April/June) Sugarcane crop: annual cycle (12 months) or longer (18 months)
FIELD SIZE	Mostly large (> 100 ha.)
CLIMATIC ZONE	Megathermal wet (Thornthwaite-Mather (1955)
AGRICULTURAL METHODS	Seeding, fertilization, pesticide application and harvest → mechanical equipment Soil management → dominance of zero-tillage systems

Cover crop sorghum residues

Center-pivot irrigation over sugarcane plantation

Soybean growing over maize residues

Fig. 1 Pictures of representative agricultural practices in the JECAM site

Fig. 2 50x50 km JECAM site's location in the Tocantins State

OBJECTIVES Cropland mask ; Crop type identification ; Cropping patterns

2 Data (2014-2015 growing season)

SATELLITE DATA

Mission/Sensor	Supplier	Product	Optical/SAR	Number of scenes	Dates	Spatial res.
Landsat 8/OLI	NASA / USGS	OLI L1T	Optical (Bands X5)	1	07/07/2015	30m
Terra/MODIS	NASA	MOD13Q1 L3	Optical (Band NDVI)	25 (1 scene = 16-day composite)	Oct. 2014 to Oct. 2015	250m

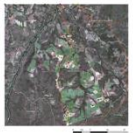


Fig. 3 GPS waypoints on land use for the 2014-2015 growing season (background: Landsat 8 image)

LEGEND

Annual cropland
- Multiple cropping systems
- Single cropping systems

Other Land Cover Classes
- Build-up surface
- Water bodies
- Fallow
- Forest
- Shrub land
- Grassland and meadows

Municipal boundaries

Main roads

Landsat 8 OLI in Color-infrared

MODIS NDVI 16-days composites time series

GROUND DATA

Land use observations : 192 GPS waypoints with land use attributes according to the JECAM nomenclature (Fig. 3).

Ground data was collected during a field campaign in October-November 2015 and includes the majority of crop fields in the JECAM site for full representability of the different cropping systems.

3 Methodology

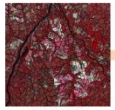
OBIA + K-MEANS UNSUPERVISED CLASSIFICATION

An **unsupervised object-based classification** approach was used for land use mapping of the Tocantins JECAM site.

An unsupervised clustering method was favored, since it can be established as a simple, **generic approach** which can be carried out every year with no need of in situ data for training.

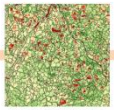
K-means algorithm (MacQueen, 1967), was chosen among other unsupervised clustering methods for its simplicity whilst being well adapted to many domains, in particular landcover classification

1 HSR SEGMENTATION



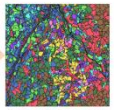
Landsat 8 July 2015
Multiresolution segmentation
eCognition Developer
Spectral bands: B, G, R, NIR, MIR
Scale parameter = 110
Shape = 0.8
Compactness = 1

2 MEDIAN NDVI PER OBJECT (25 composite images)



MODIS NDVI (MOD13Q1) time-series
Median NDVI value per object per composite image

3 K-MEANS CLASSIFICATION



Classification of the median values with K-means algorithm (k = 10 clusters)

4 CLASSIFICATION AGGREGATION

The resultant 10 clusters have been aggregated to produce 4 different significant classes :

- *Single cropping systems*
- *Double cropping systems*
- *Grassland and meadows*
- *Other Land Use/Land Cover (LULC) classes*

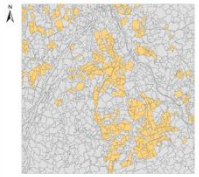
The *Single cropping system* class represents the surface covered by **sugarcane** and the *Double cropping system class* represents the surface covered by the **double cycle soybean-cereal system**. Both of these classes combined represent the totality of the *Annual cropland* for the JECAM site.

The *Grassland and meadows* class includes **rangelands and planted pastures**, which are particularly diverse within the JECAM Site (Fig. 4)

Fig. 4 As an example, four different types of grassland included in the Grassland and meadows class. A wide diversity of rangelands and pastures can be found in the JECAM site including degraded, overgrazed, colonized by native shrub species and different species (mainly Andropogon and Brachiaria).

4 Results

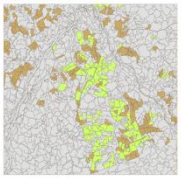
ANNUAL CROPLAND



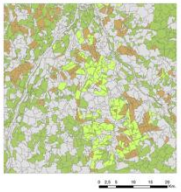
LEGEND

- Annual cropland
- Grassland & meadows
- Other LULC classes
- Single cropping system
- Double cropping system

CROPPING PATTERN



AGRICULTURAL LAND



	No. of aggregated classes	OVERAL ACCURACY	KAPPA INDEX
Annual cropland	2	94,8 %	0,89
Cropping pattern	3	90,6 %	0,83
Agricultural land	4	84,4 %	0,78

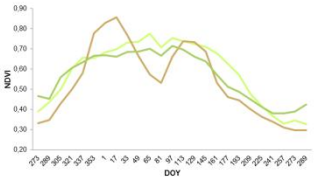


Fig. 5 Mean NDVI temporal signatures for single cropping and double cropping systems and grassland areas

5 Discussion & Conclusions

These first results show that through the use of OBIA and an unsupervised classification it was possible to establish at a field level a cropping pattern map with the two cropping systems present in the site, as well as an agricultural land map including the grassland areas.

The Brazilian Government's **Low Carbon Agriculture (ABC) Plan** to promote low carbon agriculture attaches great importance to the monitoring of grassland areas, their recovery from degradation being a key national concern and a global issue in a global climate change context.

In this regard, an annual spatial localization and quantification of these areas is therefore essential and was included in the classification in collaboration with the **Geo-ABC Project.**

ADVANTAGES

- Simple method, low computational time
- High classification accuracy
- Few, free data sets required
- No training data needed

DRAWBACKS

- Visual labellisation of clusters, needs photo-interpretation ability
- Many areas are burned during the direst months, which alters the temporal signature of natural vegetation and crops
- The diverse nature of rangelands and planted pastures generates classification errors
  In particular :
  - Some sugarcane fields are mixed up with highly productive planted pasture fields
  - Degraded pasture fields are mixed up with natural Cerrado shrubland areas

6 Ongoing work & Prospect

ONGOING WORK

- New unsupervised classification methods including the Dynamic Time Warping (DTW) algorithm are being tested to obtain a crop type classification.
  The aim is to obtain a crop type map for the second cycle crop of the *Double cropping system* class, which will be eventually subdivided in three different classes:
  Soybean – Maize
  Soybean – Sorghum
  Soybean – Millet
- 200 GPS Waypoints have been collected during a field campaign in August 2016 which are used for validation of the 2016 classifications.

PROSPECT

- Further work on the classification of degraded pastures and burned areas would be particularly interesting for this JECAM Site.

JECAM
Joint Experiment for Crop Assessment and Monitoring

SIGMA

CAPES

GEO GROUP ON EARTH OBSERVATIONS