Antsirabe (Madagascar)
JECAM/GEOGLAM Science Meeting
Brussels, Belgium
16-17 November, 2015
Site Description

- **Location**: 60*60km in the Highlands (Lat.: 19.43° S / Long.: 47.04° E)
- **Topography**: hills / plains / shallows (1400-2000m)
- **Soils**: Clayey
- **Drainage class / irrigation**: Moderate / irrigation canals
- **Crop calendar**: October - April
- **Field size**: 0.03 ha
- **Climate and weather**: Subtropical humid (cloudy !)
- **Agricultural methods used**: Manual Tillage / Hoeing / Fertilization with manure more or less mixed with ashes (few NPK inputs due to availability and cost) / Irrigation on terraces or basins, rainfed crops on the hills
Site Description

Rainfed crops

Irrigated crops
Project Objectives

- **Crop identification and Crop Area Estimation**
  - Using existing missions providing decametric images (simulating Sentinel-2 data), VHSR imagery (PLEIADES) and other data (DEM, field database)
  - With OBIA and data mining (Random Forest)

- **Yield Prediction and Forecasting**
  - Analyzing time series to monitor crop phenology
  - Estimating yield of rice crop (main crop of the Region, and key information for food security systems)
Collaboration

- Koumbia (Burkina Faso – Cirad site)
  - Similar methods used (object based image analysis and Random Forest)
  - Comparisons in overall accuracies obtained for the classifications
  - Comparisons in metrics used (which are the most informative variables?)
- Champion user of S2-Agri project
- SIGMA project
Earth Observation (EO) Data Received/Used

1rst growing season (2012-13): SPOT4 Take5 experiment

- **SPOT5** (10m) from SEAS-OI receiving station
- **DEIMOS** (20m) from Deimos Imaging
- **LANDSAT 8** (15m) from USGS
- **PLEIADES** (0.5m) from CNES

**HSR Time series**

**VHSR coverage (pic of growing season)**

2nd: 7 days in average between 2 acquisition of the HSR time series

3rd: 13 days in average between 2 acquisition of the HSR time series
In situ Data

- **Land use and crop characterization 2014-2015**
  - 1020 GPS waypoints (with contour digitized on PLEIADES imagery)
  - Attributes: Land use (crop or non crop), toposequence, irrigation, associated crops (if any), photo

- **Rice yield 2014-2015**
  - 124 GPS waypoints (with contour digitized on PLEIADES imagery)
  - Attributes: Seeding and transplant dates, variety, fertilization (if any), toposequence, straw biomass, full grain weight, empty grain weight, photo
In situ Data

Land use and crop characterization

- NON CROP
- BEA
- CAB
- CAR
- CAS
- COR
- CRE
- FOD
- OAT
- ONI
- ORC
- OTHER_C
- PEA
- PN
- POT
- RIC_IRR
- RIC_RF
- SOY
- SWP
- TAR
- TOM

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In situ Data

Rice yield

- IRR (88 fields)
- RF (36 fields)
Methods — Crop identification and Crop Area Estimation

- **Preprocessing**
  - Orthorectification and TOA reflectance calculation for decametric time series (simulating Sentinel-2 data) and VHSR imagery (PLEIADES)
  - DEM processing (slope, watersystem extraction)
  - Digitizing fields contour (based on PLEIADES imagery and GPS waypoints)

- **Building a learning database**
  - 265 radiometric variables (mean and stdev spectral response in each band, indices, etc) from time series or PLEIADES imagery
  - 135 textural variables (mainly from PLEIADES imagery)
  - 5 static variables (slope, field size, etc)
Methods – Crop identification and Crop Area Estimation

- Random Forest
  - **Building a classifier** (based on learning database)
    # Hierarchical method:
    1. Crop/non crop classification
    2. « Crop group » and « crop class » classification within the cropland only
  - Analyzing the importance (**informative degree**) of the different variables
  - **Optimizing the classification** (by reducing the number of variables used)
Results – Crop identification and Crop Area Estimation

CROP/NON-CROP
Best OA = 93.8%

CROP GROUP
Best OA = 69.2%

CROP CLASS
Best OA = 58.9%

CROP SUB-CLASS
Results – Crop identification and Crop Area Estimation

- **Optimization**: how to map the whole area? (computer/volume limits)
Results – Crop identification and Crop Area Estimation

- **Optimization:** reduce the volume of variables used
  - 5/10 metrics for CROP/NON CROP (NDVI-SWIR-Panchromatic PLEIADES)
  - 45 metrics for CROP CLASS (SWIR-NDVI-Panchromatic PLEIADES)

Overall accuracies for crop class level according to number of variables used
Methods — Rice crop yield estimation

Surveyed fields
Methods – Rice crop yield estimation

**Smoothing:**
- Stavitsky-Golay. Eliminate noise linked to clouds, mixed pixels, different sensors, atmospheric effects

**Different thresholds:**
- Eliminate fields with incomplete temporal profil
- Eliminate fields with smoothed profil too far from raw profil

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Methods — Rice crop yield estimation

1: Max NDVI of the growing season
2 à 12: Integrals on different periods of the growing cycle
Results – Rice crop yield estimation

• The more the sorting is drastic, the more the correlations are good (but with less population!)

• Good linear correlations between some integrals and total biomass, straw biomass, acceptable for grain yield

• Currently not applicable to the whole production area but can give tendencies for food security systems
Research Plans for Next Growing Season

• Will you hold the course, or modify the approach?

Multisource data analysis + Sentinel-2 data processing with a mixed image/signal processing and spatial modeling approach in order to be able to include expert knowledge on cropping systems/landscape organisation

• Do you anticipate using the same type/quantity of EO data next year?  Y/N

YES