Bambey (Sénégal)

JECAM/GEOGLAM Science Meeting, Kiev, 11-12 October, 2016

Soti V.[1,2,4], Ose K.[3], Thiaw I.[1], Ousman B.[4], Dorego S.[5], Bégué, A[2].

[1] CIRAD - AïDA Research Unit – Dakar - Senegal - [2] CIRAD - TETIS Research Unit - Montpellier - France

[3] IRSTEA – TETIS Research Unit - Montpellier - France ; [4] CSE - Dakar - Senegal; [5] ISRA - Bambey - Senegal

1. Site description & Project Objectives

Fig. 1 Faidherbia Albida parkland mixed with groundnuts and millet crops

STUDY AREA

- **Crop Types:** Millet, Groundnuts
- **Location:** 20*20 km centered on Dangalma village , near Bambey in Diourbel region (14° 43' 42'' N - 16° 33' 98'' E)
- **Topography:** low slope, 30 m mean elevation
- **Soils:** Ferruginous tropical sandy soils (Joor and Deck soils)
- **Drainage class / irrigation:** Very poorly drained; No irrigation
- **Crop calendar:** July - October
- **Field size:** 0.1 ha
- **Climate and weather:** sub-Saharan climate with a wet season from July to November and a dry season from December to June.
- **Agricultural methods used:** low level mechanization dominated by drought animal and manual labour

OBJECTIVE ⟹ CROP TYPE IDENTIFICATION IN A SUB-SAHARAN ENVIRONMENT

2. Data (2014 growing season)

SATELLITE DATA

- **Optical VHSR :** PLEIADES image (0.5 m, 4 bands: B,G,R,NIR) – 1 tile (Figure2) acquired on October 19, 2014.
- **Optical HSR time series :** LANDSAT 8 (15 or 30 m , 11 spectral bands) – 12 scenes acquired from 29/05/2014 to 21/11/2014 during the growing season (16-days frequency).

GROUND DATA (collected over 400 km²)

Missions	Number of fields	Number of trees
February 2013	397	427
February 2014	400	356
October 2014	458	758
Total	1255	1541

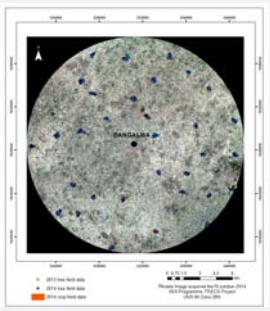


Fig. 2 GPS points on land use for 2014 growing season

3. Methods

Step 1: Pre-processing data

Satellite image data correction

- TOA reflectance processing
- Orthorectification
- Cloud masking
- Tree and house masking using Touzi algorithm (Touzi et al. 1988) on VHRS PLEIADES NIR and panchromatic bands

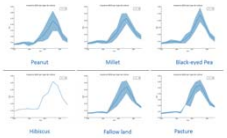
Field data preparation

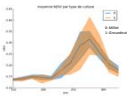
- Field data importation in a GIS software
- Field and trees boundaries digitalization
- GIS field data base construction

TOUZI Ridha, LOPES Armand and BOUSQUET Pierre, 1988. A statistical and geometrical edge detector for SAR images. *IEEE Transactions on Geoscience and Remote Sensing*, 26(6):764-773.

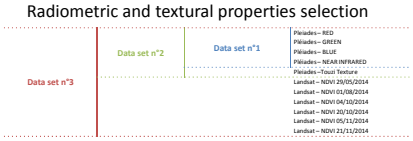
Step 2: Attribute selection

Spectral analysis





Radiometric and textural properties selection



Step 3: Image classification

Random forest classification

- **Segmentation** of the whole study area based on VHSR PLEIADES imagery
- **Extraction** of the optimal volume of variables per feature
- **Classifications** were performed on the data sets n° 1, n°2 and n°3 using a random forest algorithm

Validation

- **Classification accuracy** was evaluated using 50% of the ground truth data not used in the classification process.
- The **quality of the classification** was measured through the *overall accuracy coefficient* and the *Kappa*.

4. Results

File 1: PLEIADES (R,G,B,NIR)

		Peanut	House	Hibiscus	Road	Fallow land	Millet	Black-eyed pea	Pasture	Bare Soil	Sorghum	Total	Producer precision	Erreur omission
		1	2	3	4	5	6	7	8	9	10			
Peanut	1	3821	0	821	0	548	461	1656	463	249	110	8131	46,99%	53,01%
House	2	0	105	0	0	0	0	0	0	0	0	105	100%	0,00%
Hibiscus	3	2	0	113	0	0	0	5	8	0	0	126	89,10%	11,90%
Road	4	0	0	0	73	0	0	0	0	0	0	73	100%	0%
Fallow land	5	35	0	11	0	537	120	23	95	21	24	846	61,11%	38,89%
Millet	6	1878	0	277	35	3095	7186	2815	5111	1321	2261	23988	29,99%	70,01%
Black-eyed pea	7	2244	3	520	0	534	1048	2685	259	97	699	8029	33,44%	66,56%
Pasture	8	118	0	169	2	174	199	95	1134	10	128	2029	55,89%	44,11%
Bare Soil	9	1	0	0	0	7	42	2	0	1355	1	1408	96,24%	3,76%
Sorghum	10	2	0	1	0	32	8	8	2	0	165	218	75,69%	24,31%
Total		8101	108	1918	110	7907	9071	7291	7072	3053	3328	44951		
Producer precision		47,17%	97,22%	5,31%	66,30%	10,54%	79,30%	36,83%	16,04%	44,38%	4,96%		Global accuracy	38,18%
Erreur omission		52,83	2,78%	94,19%	33,64%	89,46%	20,70%	63,17%	83,96%	55,62%	95,04%			

We applied a **Random Forest classification** on *data set n°1* with the proposed default parameters, and a **maximal depth value** fitted to **10**.

The overall accuracy is low with **38 % well classified classes**. This result highlights the difficulty in characterizing the crop types with one image only, even its very high spatial resolution.

File 2: PLEIADES (R,G,B,NIR + Touzi Texture)

		Peanut	House	Hibiscus	Road	Fallow land	Millet	Black-eyed pea	Pasture	Bare Soil	Sorghum	Total	Producer precision	Erreur omission
		1	2	3	4	5	6	7	8	9	10			
Peanut	1	3637	0	958	0	572	518	1448	456	475	66	8131	44,73%	55,27%
House	2	0	105	0	0	0	0	0	0	0	0	105	100%	0,00%
Hibiscus	3	0	0	117	0	0	0	4	6	0	0	126	92,86%	7,14%
Road	4	0	0	0	73	0	0	0	0	0	0	73	100%	0%
Fallow land	5	19	0	7	0	536	140	26	83	17	20	846	63,12%	36,88%
Millet	6	1713	0	301	7	3090	10620	2136	4620	527	965	23988	44,27%	55,73%
Black-eyed pea	7	2060	7	515	0	553	1569	2487	233	242	383	8029	30,73%	69,27%
Pasture	8	88	0	221	2	169	350	65	1079	4	51	2029	53,18%	46,82%
Bare Soil	9	24	0	0	0	7	113	1	0	1205	0	1408	85,13%	14,87%
Sorghum	10	4	0	2	0	26	30	5	1	0	153	218	70,18%	29,82%
Total		7545	112	2120	82	4965	13340	6173	6478	2520	1644	44951		
Producer precision		48,22%	93,75%	5,52%	89,02%	10,76%	79,61%	40,09%	16,66%	46,80%	9,33%		Global accuracy	44,58%
Erreur omission		51,78	6,25%	94,48%	10,98%	89,24%	20,39%	59,91%	83,34%	50,20%	90,67%			

The same classification parameters were applied on *data set n°2*.

The overall accuracy is slightly better with **45 % of well classified pixels** showing the input of the Touzi texture neo-canal. Nevertheless, confusions between the different cultures remain high.

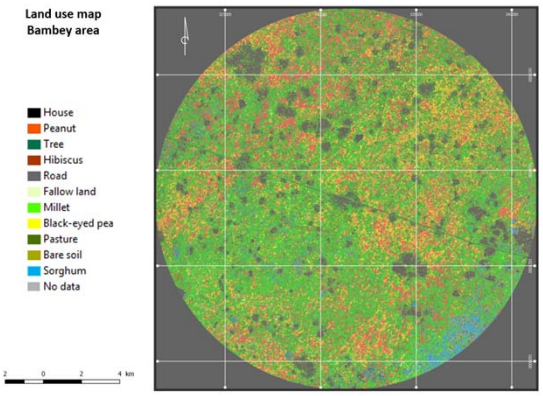
File 3: PLEIADES (R,G,B,NIR + Touzi Texture) + 12 Landsat-8 images (NDVI)

		Peanut	House	Hibiscus	Road	Fallow land	Millet	Black-eyed pea	Pasture	Bare Soil	Sorghum	Total	Producer precision	Erreur omission
		1	2	3	4	5	6	7	8	9	10			
Peanut	1	6001	0	65	0	75	385	1307	257	27	14	8131	73,80%	26,20%
House	2	0	105	0	0	0	0	0	0	0	0	105	100,00%	0,00%
Hibiscus	3	0	0	126	0	0	0	0	0	0	0	126	100,00%	0,00%
Road	4	0	0	0	73	0	0	0	0	0	0	73	100,00%	0,00%
Fallow land	5	19	0	0	0	760	66	0	17	0	1	846	89,83%	10,17%
Millet	6	1713	61	47	1	1057	18009	1222	2553	149	205	23988	75,06%	24,94%
Black-eyed pea	7	2060	0	9	0	12	1012	5498	192	139	39	8029	68,48%	31,52%
Pasture	8	88	0	11	0	0	396	12	1610	0	0	2029	79,35%	20,65%
Bare Soil	9	24	0	0	0	0	47	6	7	0	0	1408	96,16%	3,84%
Sorghum	10	2	0	0	0	0	8	0	1	0	213	218	97,71%	2,29%
Total		7543	166	258	74	1904	19856	8040	4637	1669	472	44951		
Producer precision		76,59%	63,25%	48,84%	98,65%	39,92%	90,69%	68,38%	34,72%	81,13%	45,13%		Global accuracy	75,07%
Erreur omission		23,41	36,75%	51,16%	1,35%	60,08%	9,31%	31,62%	65,28%	18,87%	54,87%			

Finally, using the same classification parameters as above, the ***data set n°3***, composed of the PLEIADES image and the 12 Landsat images, shows better results.

With an overall accuracy of **76 %**, the crop types (groundnuts, millet, sorghum, black-eyed pea, etc...) are well classified.

Data set n°3, composed of one PLEIADES image and 6 LANDSAT-8 images, gives the best result for image classification and permits to obtain a detailed land use map of Bambey study area (***12 land use classes).***



5. Conclusions and Perspectives

Conclusions

- The study shows that one PLEIADES image acquisition during the growing period is not enough to identify the main crop types in Bambey area. Indeed, the sub-metric spatial resolution of PLEIADES allows to underline the field boundaries, but the four spectral bands do not permit to identify the field content.
- The joint use of the PLEIADES image and a Landsat-8 time series improved considerably the land use map, in particular the crop type identification, even if there is no image acquisition during two consecutive months, at the peak of the rainy season.

Perspectives

- Reinforced by the results obtained in this study, we believe that the use of multi-source images (optical and microwave) will improve the crop type identification. In particular, we have high expectations on the joint use of Sentinel1 and Sentinel2 image time series, that will be tested in 2016-2017.

JECAM Joint Experiment for Crop Assessment and Monitoring

GEO GROUP ON EARTH OBSERVATIONS