ORFEO PREPARATORY PROGRAM

WG7: AGRICULTURE

SPOT IMAGE – Toulouse – 10 June 2008

WG7: AGRICULTURE

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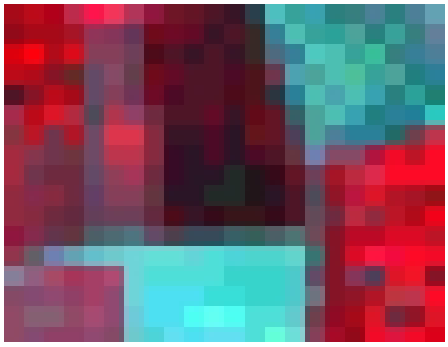
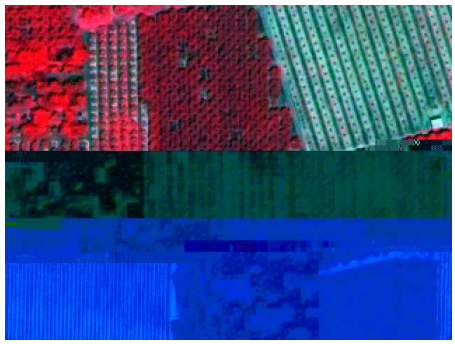
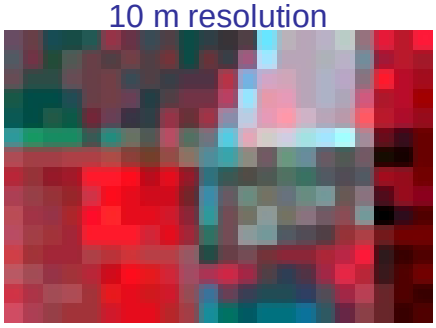
  CNES

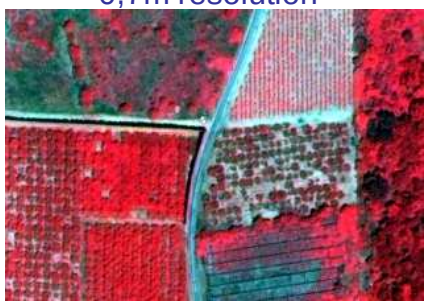


10 m resolution



0,7m resolution





2 scales of information

1) Accurate land use / land cover identification

a) Outlines, area, location accuracy

b) « Crops » intraclass discrimination (≠ types)

c) Spotting of landscape elements & countryside description

2) Intra field information

a) Agricultural practices and cropping systems

b) Soil characteristics and variability/heterogeneity

c) Crop characteristics and heterogeneity

2 kinds of applications

1. **Management and control of agricultural and agri-environmental aids**
2. **Assistance for crops management and production systems valuation**

with several more specific sub-domains,
⇒ 27 needed products

Management and control of agricultural and agri-environmental aids

1. Detection, recognition and characterization of perennial crops
South of France, French Indies
CIRAD, C. Lelong, B. Mougel, D. Réchal

2. Mapping and Monitoring of agri-environmental conditions
Belgium
CRA-W, D. Buffet

3. Metric radar contribution to applications control: parcel area measurement
South of France
JRC/AGRIFISH/MARS-PAC, H. Kerdilès

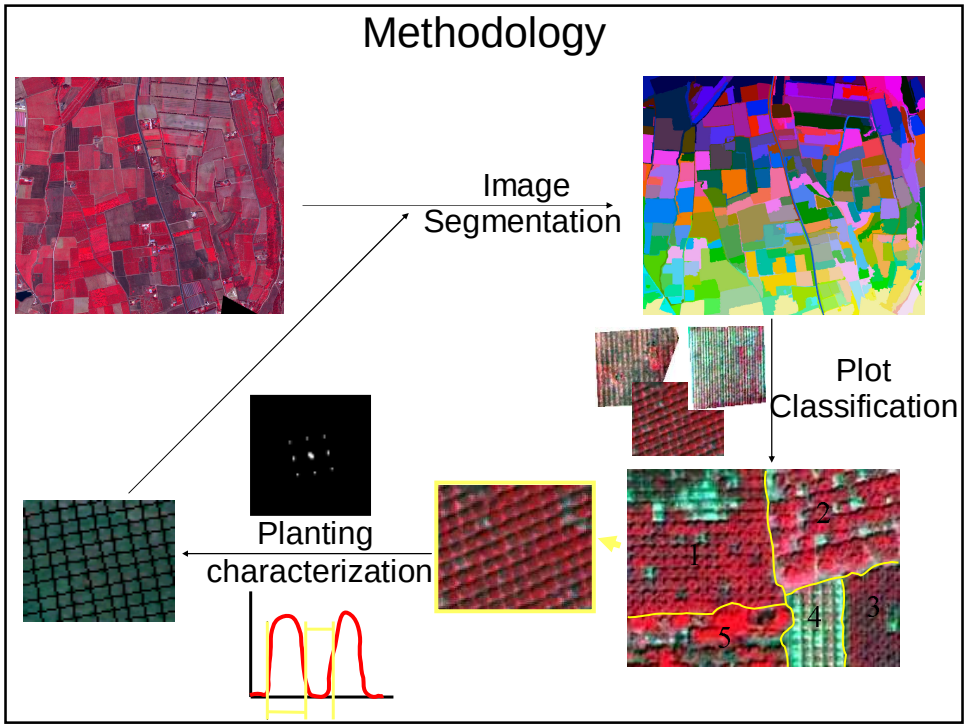
Assistance for crops management and production systems valuation

1. Soil variability mapping and characterization
Beauce plain (France)
INRA and ARVALIS – Institut du végétal, E. Vaudour, D. King, B. de Solan

2. Sugar cane intra field variability and yield prediction
Île de la Réunion
CIRAD, A. Bégué, V. Lebourgeois

Detection, recognition and characterization of tree crops and other groves in VHR images

- **Establish the plots limits with high accuracy**
- **Assign to each plot a precise use > « crops »:**
  - ~ **field crops**
  - ~ **row crops**
  - ~ **tree crops (orchards, groves, vineyards…)**
  - ~ **vegetables**
  - ~ **forests**
  - ~ **hedges**
  - ~ **fallow and bushes**
- **Recognize tree crops and other groves**
- **Characterize crop system or plantation**


Methodology
Image
Segmentation
Plot
Classification
Planting
characterization
1
2
3
4
5

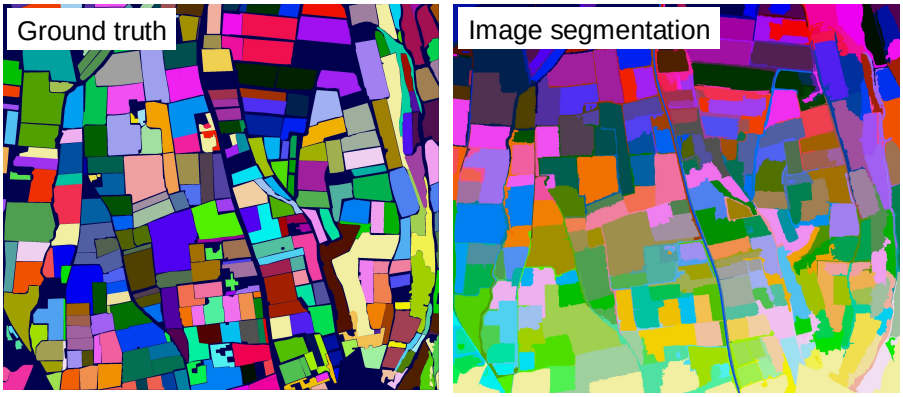
1/ Segmentation

- Several methods tested:

  multiscale and object-oriented (Ecognition),
  hierarchical (SxS),

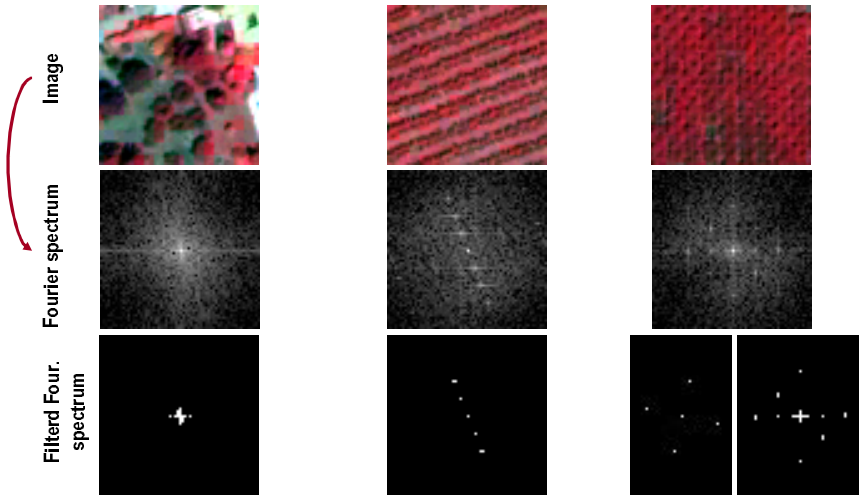
  watershed (OTB),

  Mumford-Shah (M. Fried)…



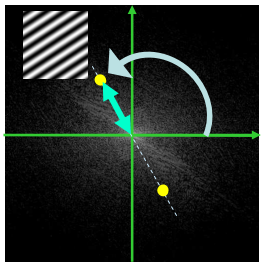
2/ Plot classification

- Plot classification as a whole object
- Based on the Local Fourier Transform



3/ Plot characterization

- Fourier descriptors

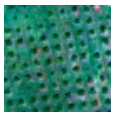


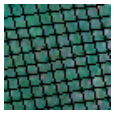
Type of plantation (rows/grid)

Plantation period

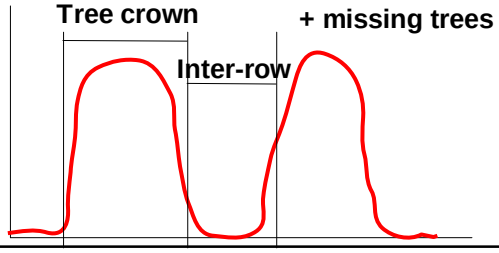
Plantation orientation

⇒ **Theoretical grid**





- Intra-grid profile



Cartography and monitoring of agri-environmental measures using VHR images

Farmers are encouraged to adopt good environmental farming practices (GAEC & AEM):

- More than 30% of farmers have subscribed to AEM.
- 40% of subsidies for **margin fields**.
- 20% of subsidies for **soil winter cover** before spring crops.

As Regional and European agricultural policies are changing, new tools are needed to:

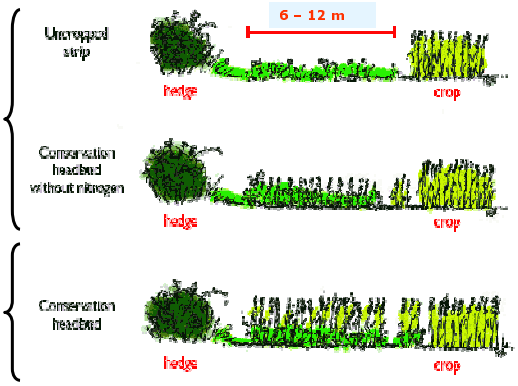
- **Cartography** of agri-environmental objects and to **Control** cross-compliance requirements.
- **Monitor the evolution and the potential** use of GAEC and AEM.
- **Advise farmers**.

Cartography and monitoring of agri-environmental measures using VHR images

- Focus on **margin fields** = cultivated or uncultivated buffer zones at the edges of cultivated fields.

Grass margin strip

Crop margin strip



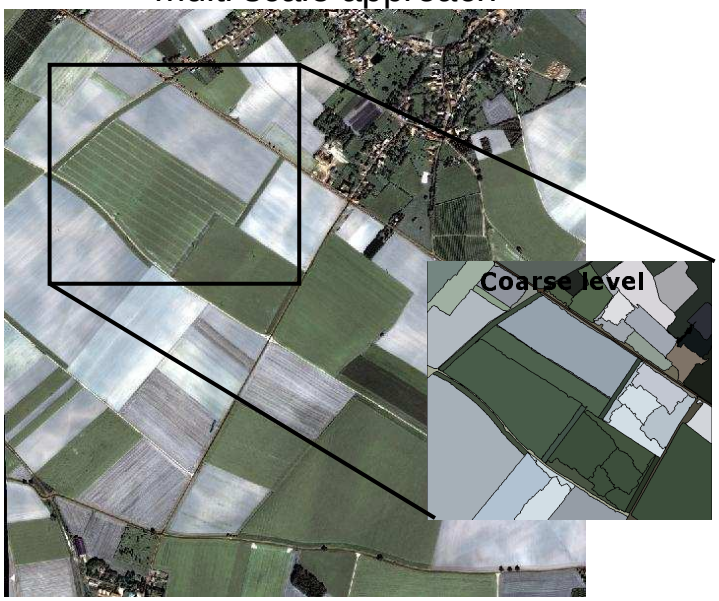
=> Small Land Parcels

Methodology

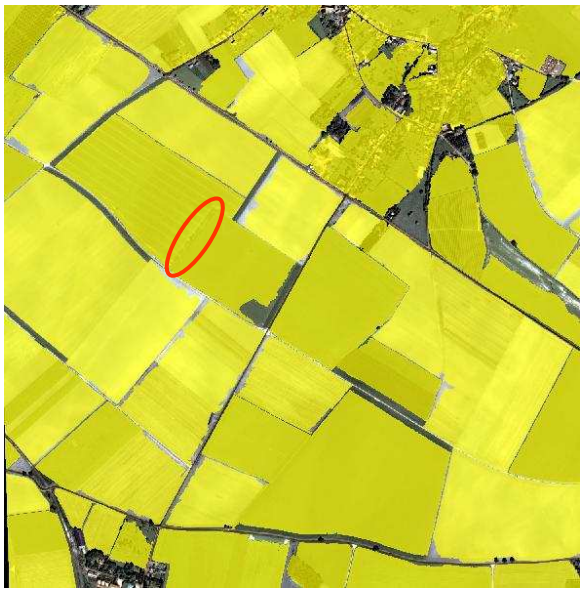
- Step 1: Segmentation in meaningful objects (field, margin field, other).
- Step 2: Objects characterisation by calculating spectral and shape features.
  - Spectral features are channel means, standard deviations…
  - Shape features were identified by the geospatial analysis.
- Step 3: Classification performance evaluation.

Segmentation

multi scale approach



Segmentation



Classification

Conclusion

- Agricultural parcel and margin fields geometries obtains by image segmentation are closed to the real agricultural parcels and margins boundaries.
  - **BUT** this is highly influenced by the quality of the raster image AND by the acquisition date
  - A set of 2 images during the year would give better classification results.
- For these objectives, the classification results are satisfactory and indicate the high potential of object-oriented classification

Characterizing and mapping soil variability

Context :

- Need to adapt agricultural practices to soil variability
  - save water and fertilizers
  - hinder soil degradation
  - keep high productivity
- Farmers get a number of spatialized data on crop development but lack exhaustive spatial soil data.
  - difficult to take soil constraints into account

Aims of the study :

- Characterize soil spatial variability and soil surface changes
- Detect soil boundaries

  -> Basis for agricultural soil management and precision farming

Methodology

1/ Identify factors of variability in the field's image:

- Soil class
- Field's history (older field's boundaries)
- Usual agricultural practices (organic matter input, soil tillage depth leading to more or less stones on topsoil)
- Recent practices (sowing, plowing, harrowing, …)

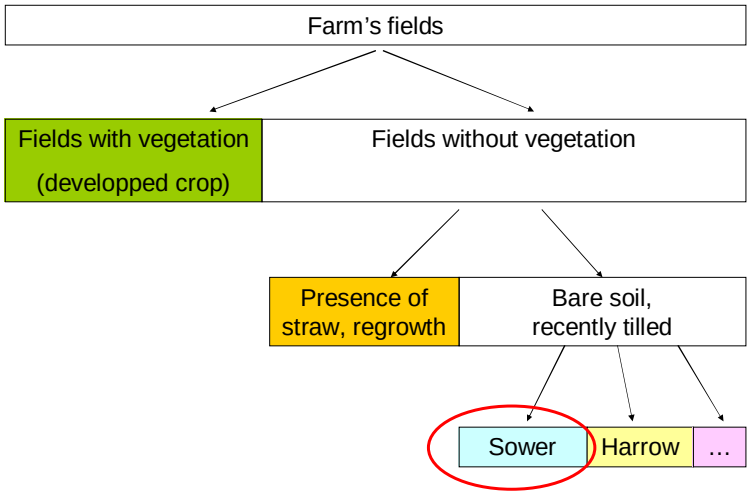
2/ Identify soil classes limits based on surface characteristics :

- Stoniness
- $CaCO_3$ content
- Soil texture

3/ Compare satellite information with other agronomical data

Factors of variability

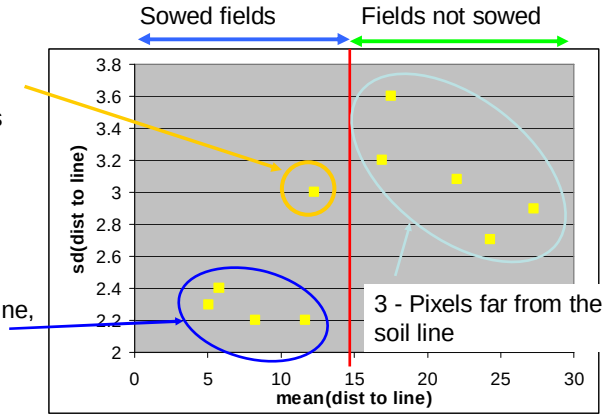
Different soil surface conditions following soil tillage



Bare soil fields : can we identify them ?

2 – Pixels close to the soil line, dispersed
Field sowed earlier : plants have already emerged

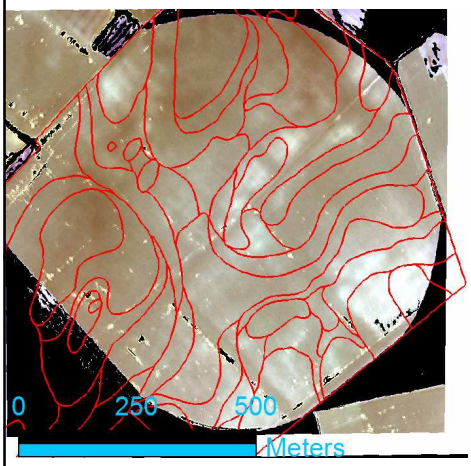
1 - Pixels close to the soil line, low dispersion



- **Good identification of recently tilled fields : the most interesting ones .**

Maximum likelihood classification

4 bands - 31 classes – provisory result



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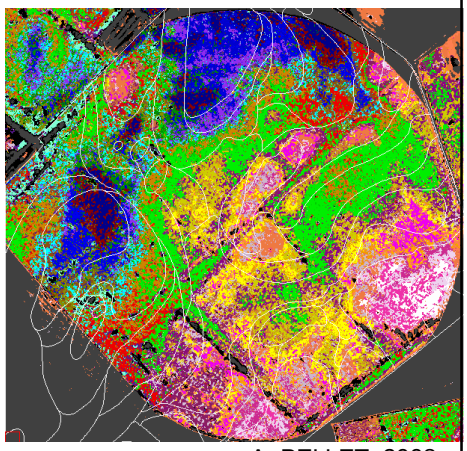


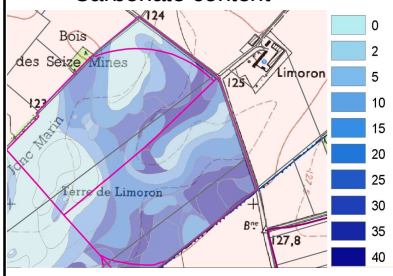
A. PELLET, 2008

Calcosols sur calcaire dur
Calcosols sur calcaire gris
Calcosols sur calcaire tendre
Calcosols caillouteux sur calcaire dur
Calcosols caillouteux sur calcaire gris
Calcosols caillouteux sur calcaire tendre
Calcosols sur cryoturbé beige et gris
Calcosols sur cryoturbé beige
Calcisols sur cryoturbé beige et gris
Calcisols sur cryoturbé beige peu profond
Calcisols sur cryoturbé beige moyen profond

Maps of topsoil properties

Selected from the digital soil map (NICOULLAUD, 1997)

Carbonate content



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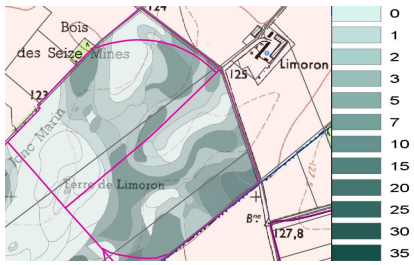
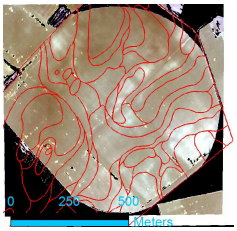
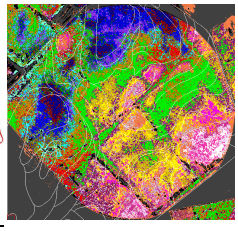
Stoniness



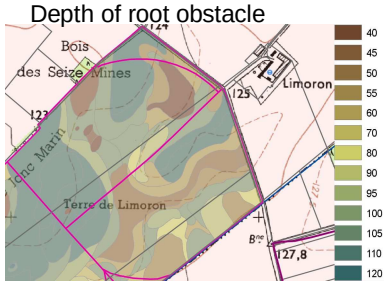
IRC image



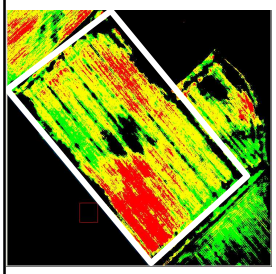
MaxLikelihood



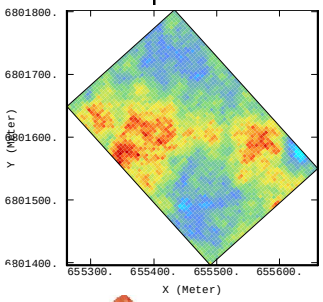
Depth of root obstacle



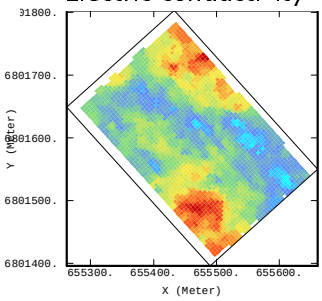
Meaning of soil zones : comparison with other data

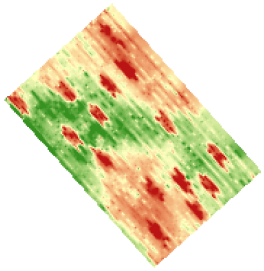


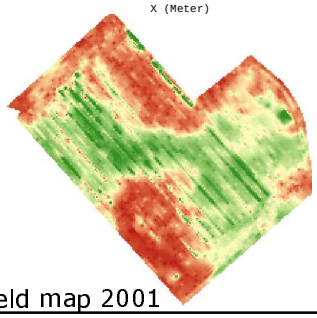
Soil depth



Electric conductivity







Yield map 1999 Yield map 2001

Conclusion

Potential interests

- **For pedologists :**
  - **Help to map soil class boundaries**
- **For farmers :**
  - **Identify 2 to 3 classes of soil properties, at a farm scale, informing on yield potential :**
    - **Which parameter ? soil depth (linked to available water content)**
    - **To be compared with other kind of data (yield maps, LAI maps)**
- **For coops :**
  - **Identify the level of variability in a region to evaluate the interest of precision farming**


Thank you for your attention
Any questions ?