Brittany Remote Sensing

- First BreTel Workshop - May 31 - June 1st 2012
- Monitoring of the environment in the framework of the NEREUS working group on GMES

Land cover monitoring with Radarsat-2 data in Brittany

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([1]LETG Rennes COSTEL ; [2]IETR SAPHIR team; [3]ENSTB CID team)

Plan

Contents	• Team • Main objectives
Land cover monitoring	• Mapping dynamic wetland • Land cover extraction in winter

❖ Team

- IETR – UMR CNRS 6164, SAPHIR Team, University of Rennes 1, France

→ *Development of data processing methods*

- Institut Telecom; Telecom Bretagne, CNRS UMR 3192 lab-STICC, team CID, France

→ *Development of data processing methods*

- LETG Rennes COSTEL, University of Rennes 2, UMR 6554 CNRS, France

→ *Environmental monitoring*

❖ Main objectives

- Evaluating Radarsat-2 (high and very high resolution) in Brittany to :

➢ **Delineate wetlands & Map vegetation**

➢ **Determine watercycle and waterlevels**

➢ **Identify agricultural practices and land use phenology**

Cécile MARECHAL, Eric POTTIER, Sophie ALLAIN, Stéphane MERIC, Laurence HUBERT-MOY, Samuel CORGNE, Sébastien RAPINEL, Jean NABUCET

Evaluating full polarimetric Radarsat-2 data to:

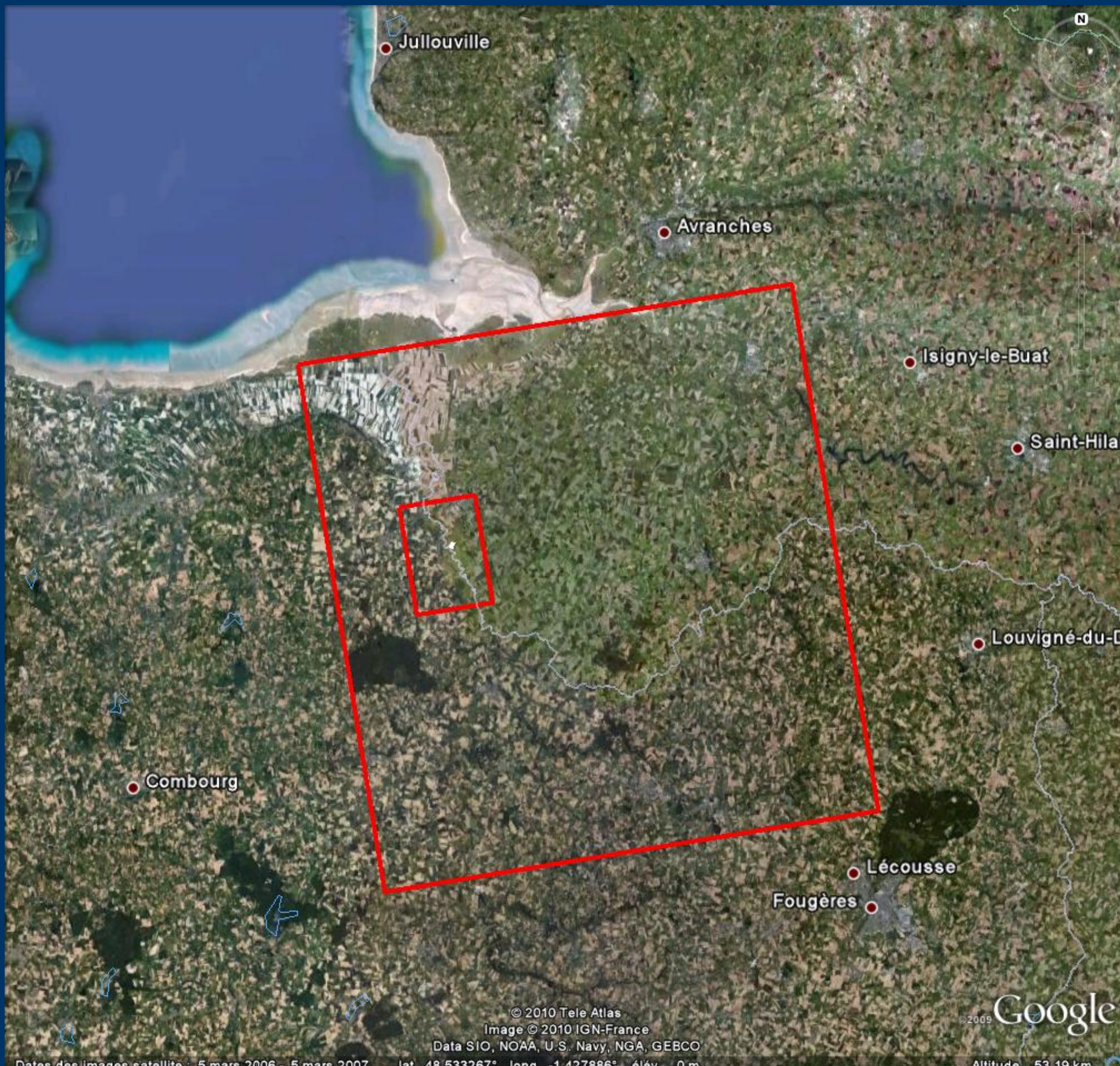
- Delineate wetlands

Prevention of the reduction and degradation to maintain the biodiversity

SOAR – EU

Evaluation of RADARSAT-2 quad-pol data for functional assessment of wetlands (Id6842)

Zone Atelier de Pleine-Fougères



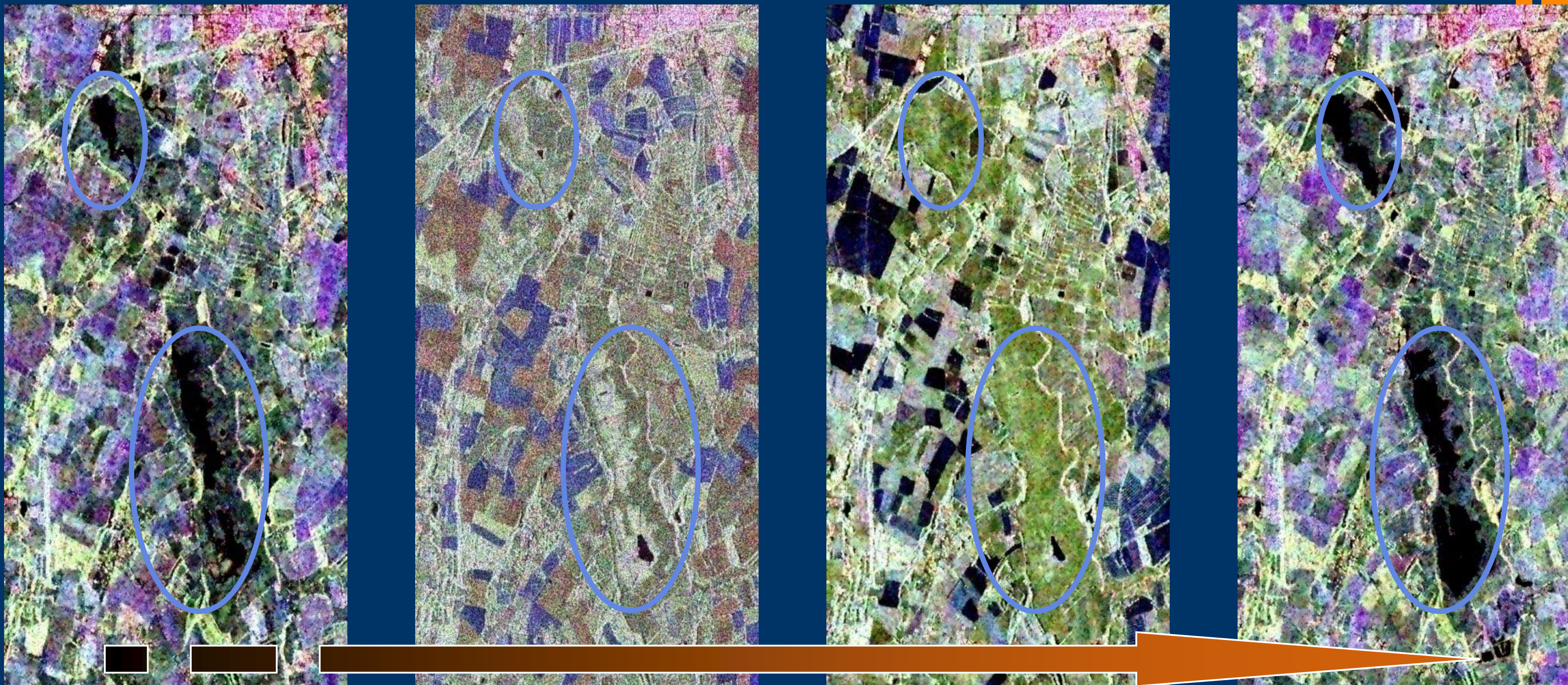
- Located in Brittany (France) near the Mont St Michel (N 48°.31' / E -1°.15').

- Referenced in the LTER-Europe (lterEurope.net) and the ILTER networks (http://osur.univ-rennes1.fr/zoneatelier-armorique/)

- Wetland of Sougéal and Le Mesnil

Land cover monitoring

- Mapping dynamic wetland



PolSAR Time-series analysis

15 Images
Repeat Time: 24 days

- ✓ 22 / 02 / 2010
- ✓ 16 / 03 / 2010
- ✓ 11 / 04 / 2010
- ✓ 05 / 05 / 2010
- ✓ 29 / 05 / 2010
- ✓ 22 / 06 / 2010
- ✓ 16 / 07 / 2010
- ✓ 09 / 08 / 2010
- ✓ 02 / 09 / 2010
- ✓ 26 / 09 / 2010
- 20 / 10 / 2010
- ✓ 13 / 11 / 2010
- ✓ 07 / 12 / 2010
- ✓ 31 / 12 / 2010
- ✓ 24 / 01 / 2011
- ✓ 17 / 02 / 2011

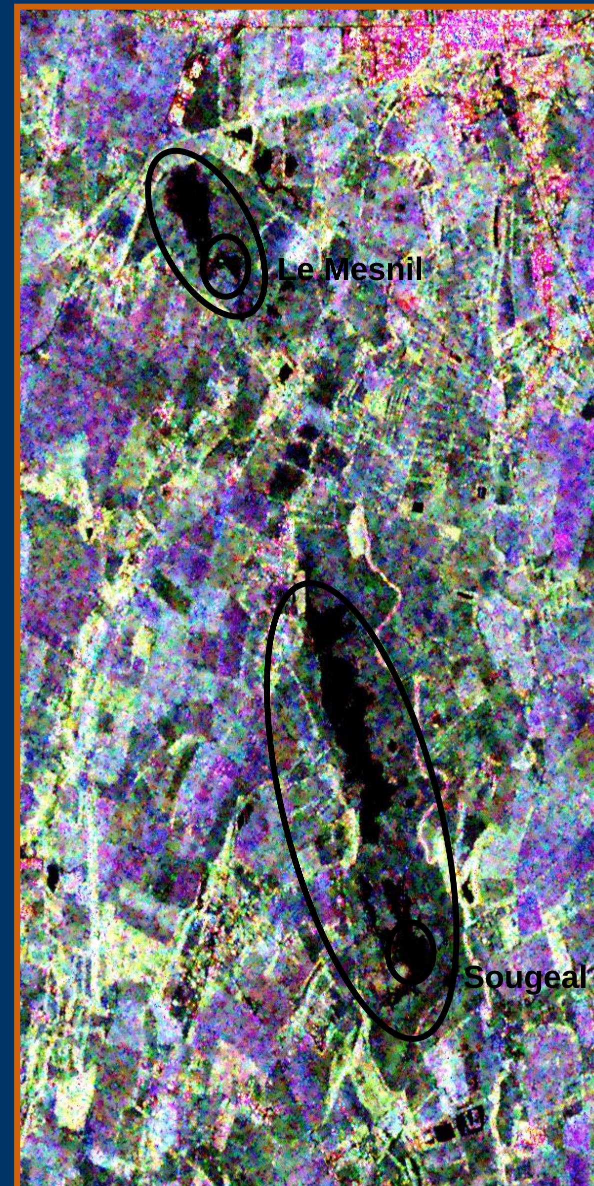
Land cover monitoring

- Mapping dynamic wetland

Pauli RGB Animation

Polarimetric Scattering Evolution

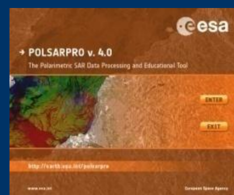
Detect temporal changes



Methodology

Pre-Processing → Processing → Post-Processing

Radarsat-2

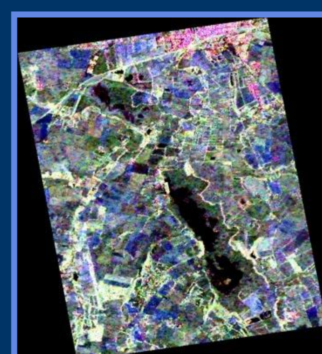


Coherency T3 matrix extraction

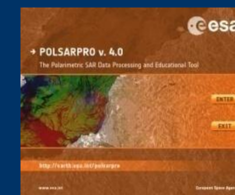
Pauli RGB

GeoCoding T3 Matrix

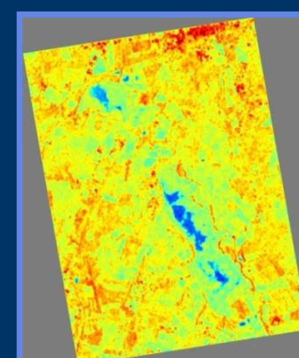
46 G.C.P
rms: 0.9 pix



Geocoded Pauli RGB

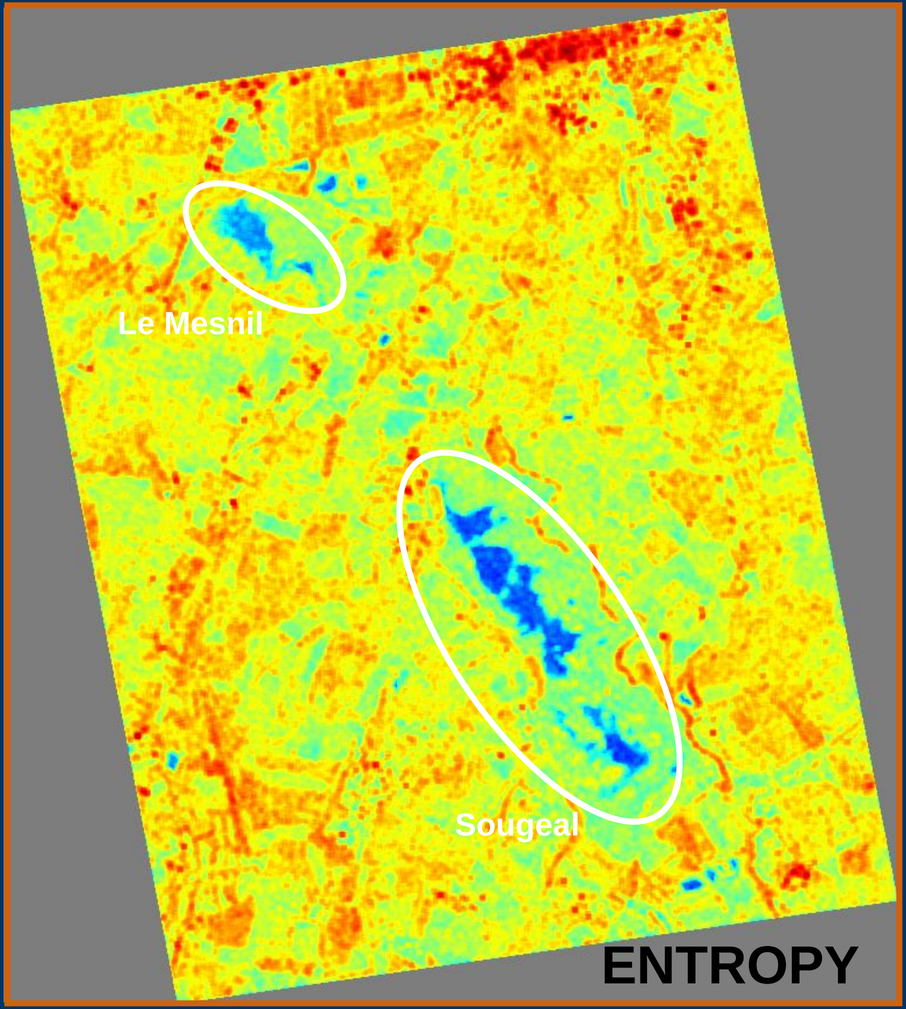


Polarimetric descriptor sensitive to the Temporal Variability of the marsh flooded areas



Land cover monitoring

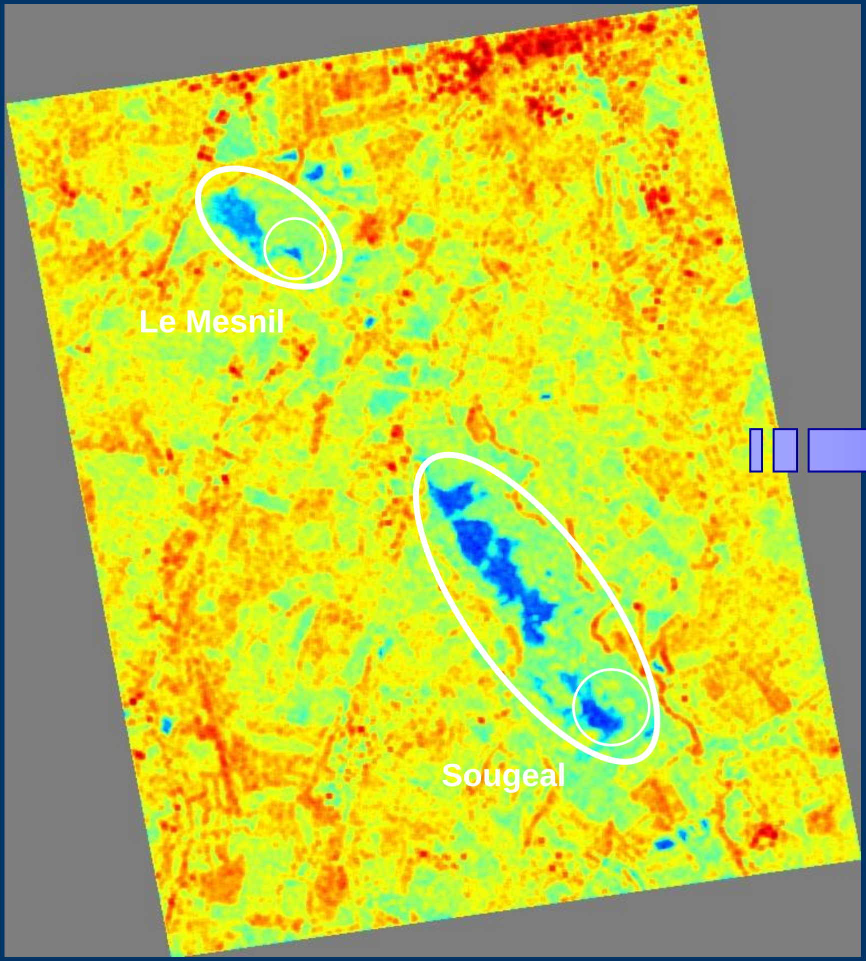
- Mapping dynamic wetland

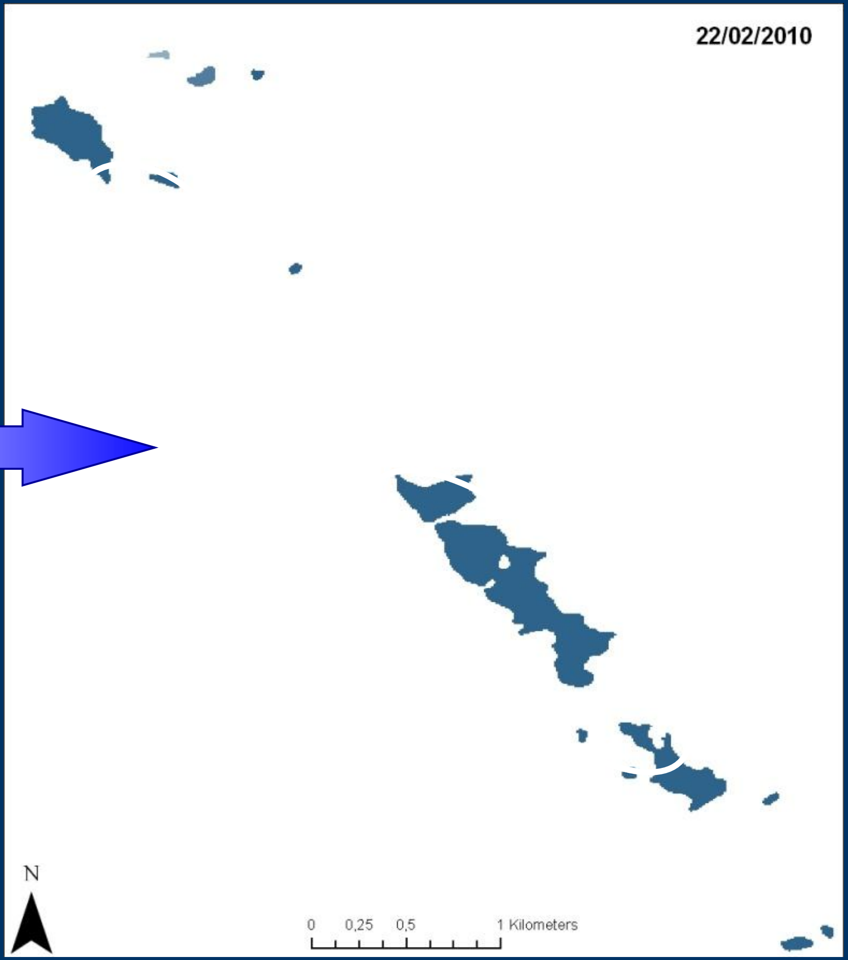


Entropy provides information on the flooded area

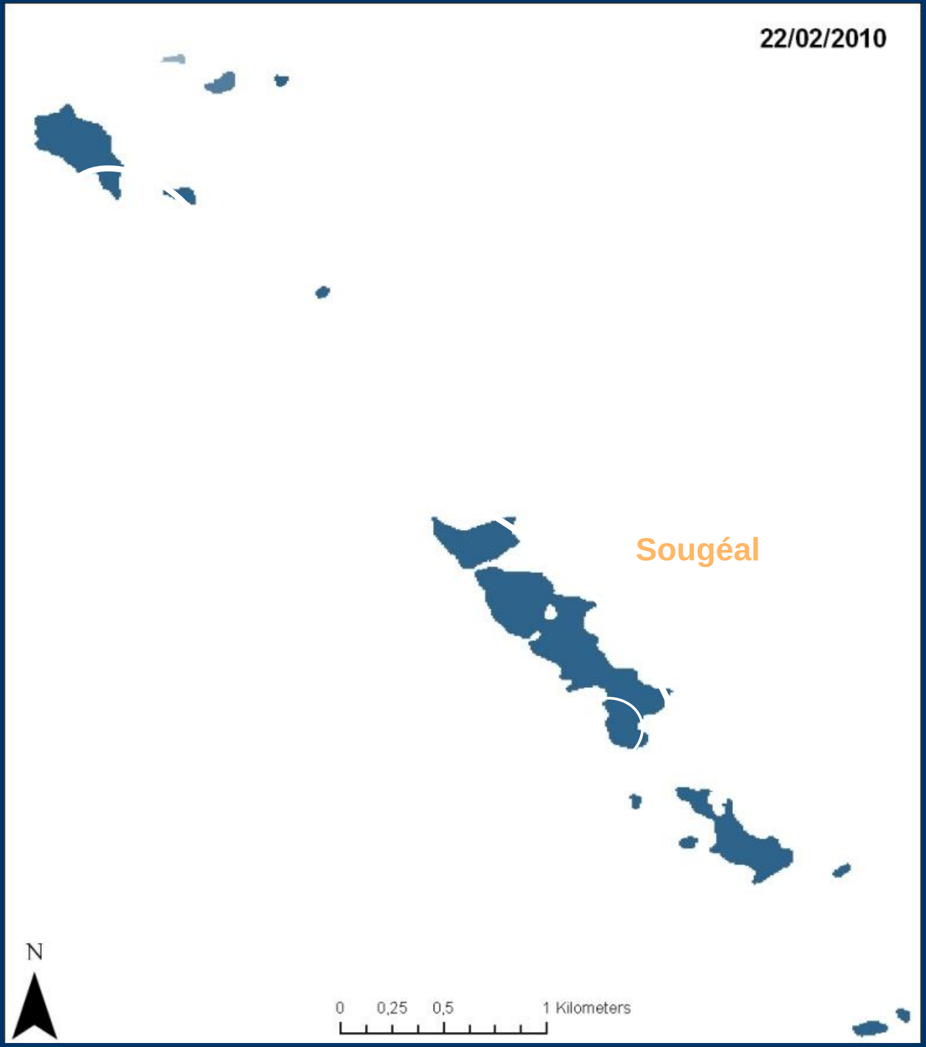
POLSAR Descriptor

Entropy Segmentation → **Open water Extraction**





Segmentation methodology



Segmentation parameters

Entropy value, population, neighborhood

↓

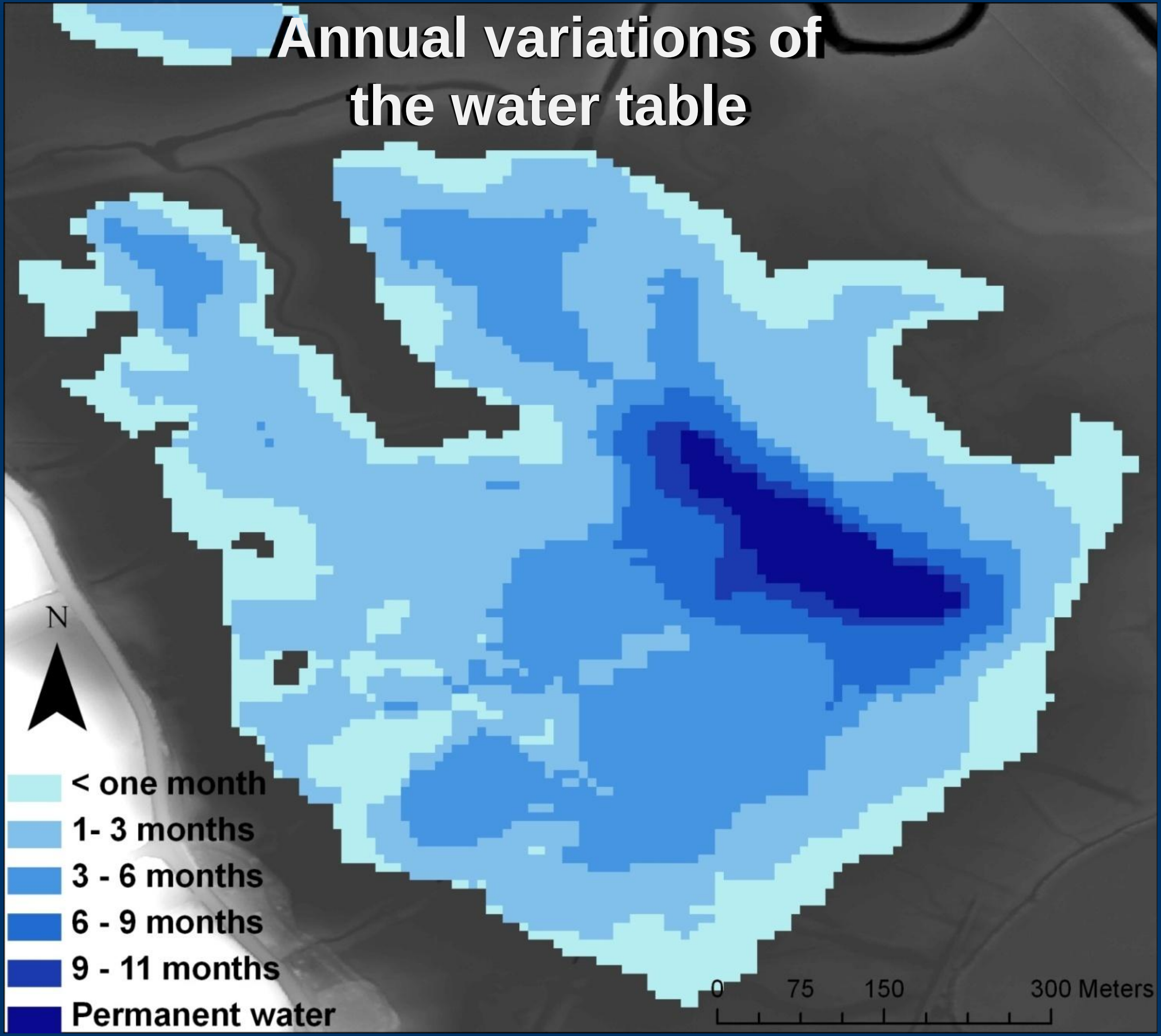
Trained on the 1st Image of entropy

↓

Once trained and fixed

Same values applied to all the geocoded entropy images

- Mapping dynamic wetland



Map product

Limit of endemic hydrophilic plants

Summary

- **The results show the potential of polarimetric SAR data for mapping and monitoring wetland areas;**
- **The use of entropy parameter is a very promissive descriptor to extract the limit and the evolution of the open water:**
  - **During the time**
  - **Whatever the incidence angle**
- **Entropy's segmentation allows to discriminate open water ;**
- **The segmentation of entropy we performed is:**
  - ✓ **Time invariant**
  - ✓ **Incidence angle invariant**

Samuel Corgne, Grégoire Mercier, Eric POTTIER, Laurence HUBERT-MOY, Jean NABUCET, Julie Betbeder

Application to land cover monitoring in winter

- **Land cover in winter has an important impact on water quality**
- **identification of land-cover dynamics at high spatial scales constitutes a prior approach for the restoration of water resources**

→ Problem : Land use identification and mapping very complex with optical data (cloudy condition in winter !!!)

Land use and land cover characteristics in winter

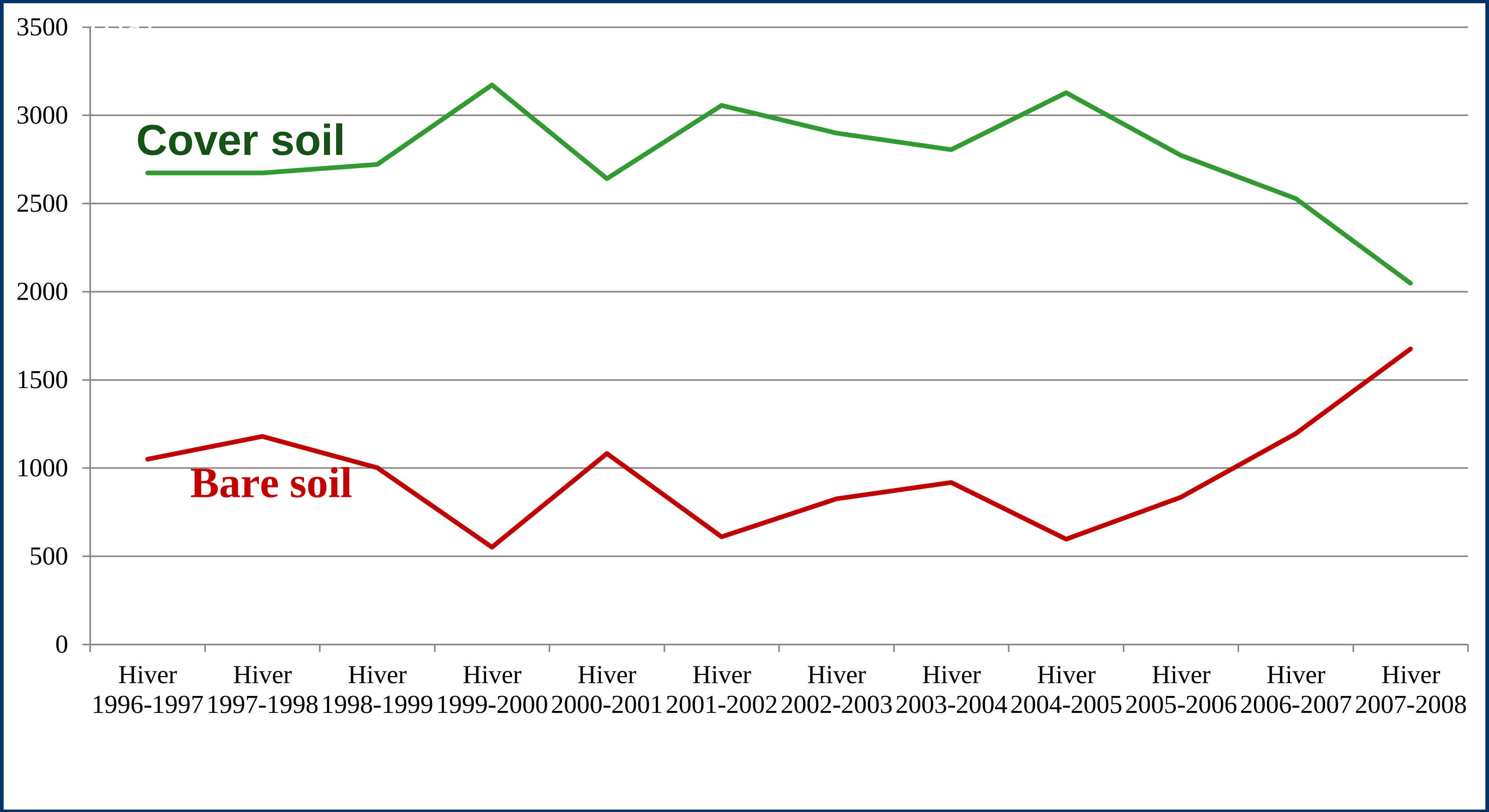
Multiple land use (meadow, mustard, beets…)

Multiple land cover management (plough, sowing, period of pre-planting, post-harvest…)

Different levels of land cover (inter and intra field)…

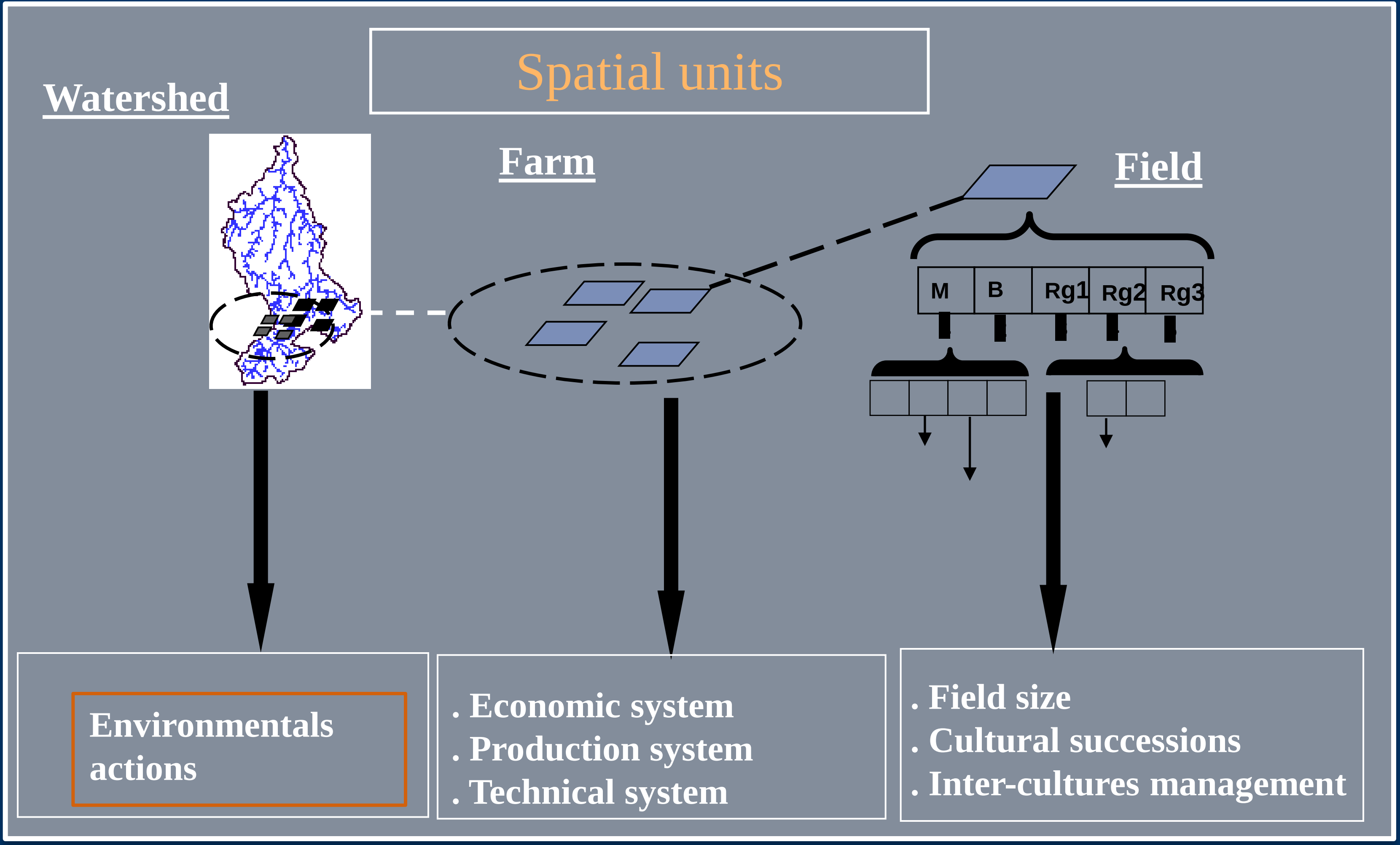
Land use and land cover characteristics in winter

→ **High spatio temporal dynamic at a field scale**



Land use and land cover characteristics in winter

→ **Various factors for land use and land cover management**



Specific objectives

1- Measure potentialities of Radarsat-2 data to extract bare soils and cover soils in a fragmented landscape at a field scale

2- Analyse the potentialities of polarimetric discriminators and decompositions for a finest bare soils characterization

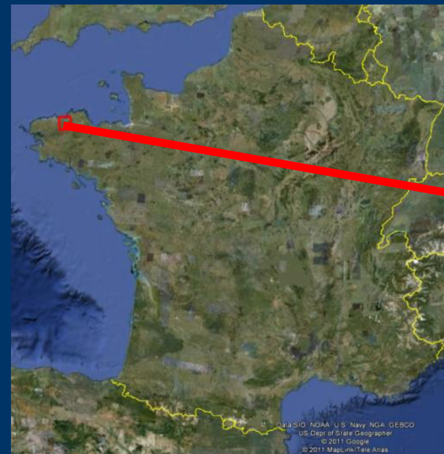
• Land cover extraction in winter

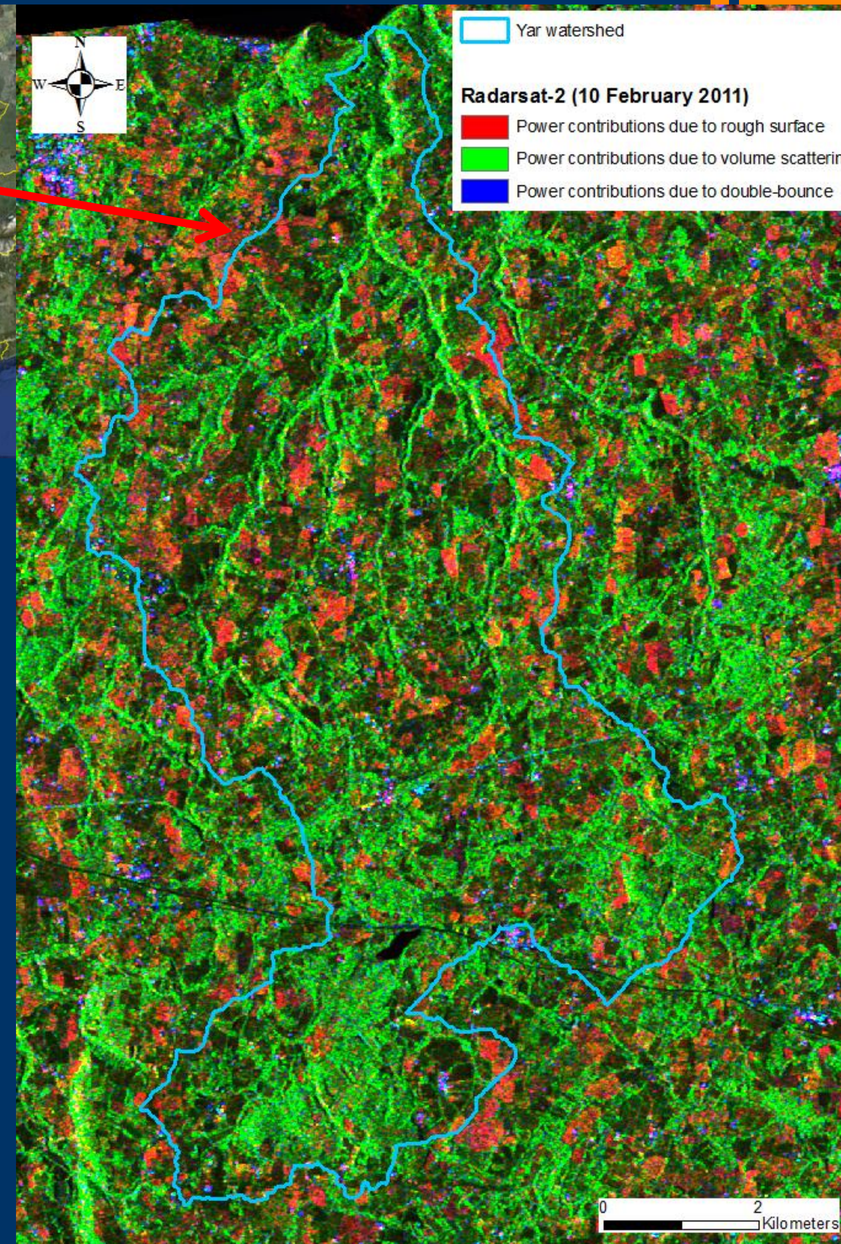
Experimental site

- **Yar watershed**
- **6200 ha**
- **Various land cover management in winter**
- **bare soils (mean of 15-20%)**

→ Water pollution (Nitrogen)
→ Bloom algae

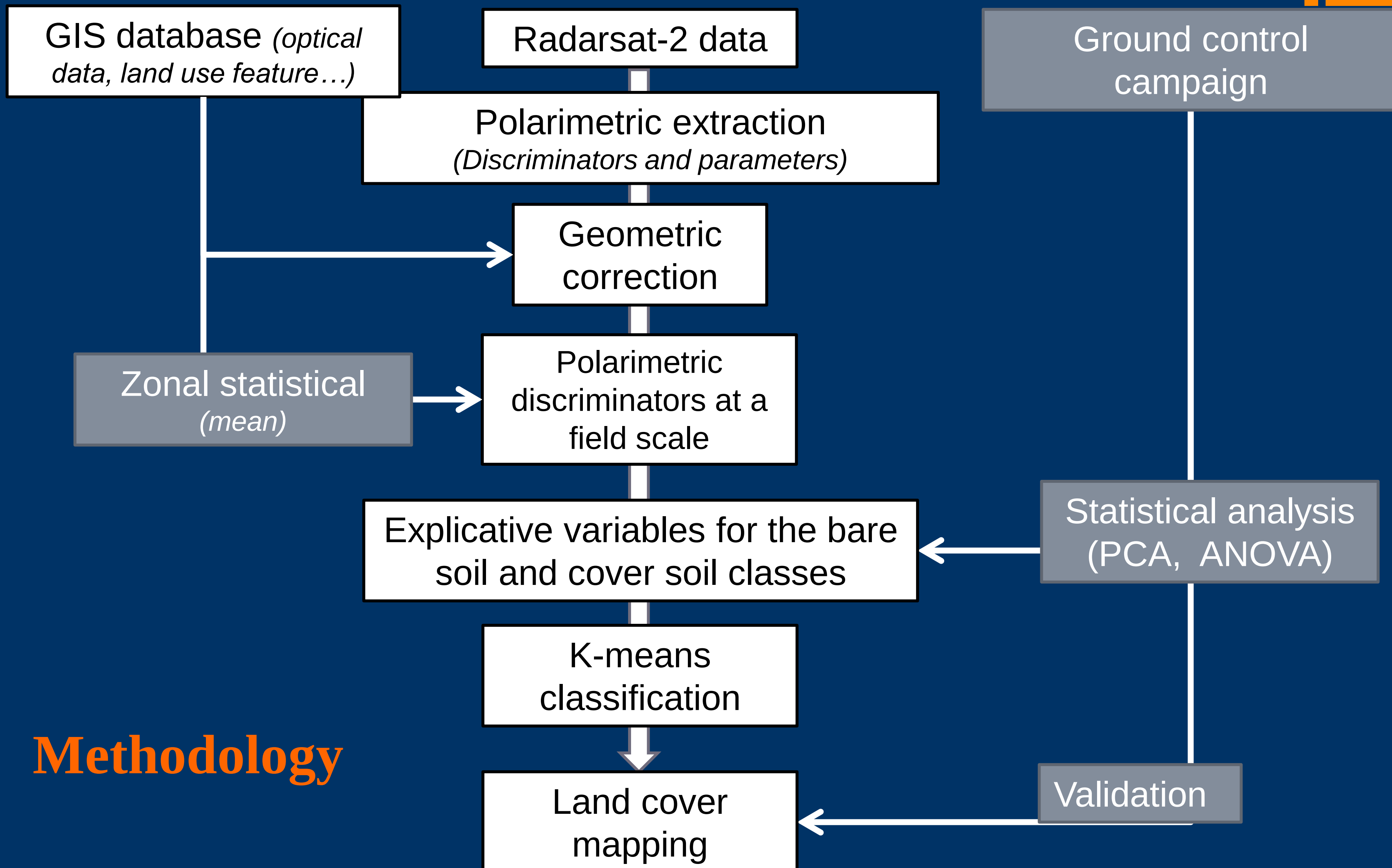
CG 22, CA de Lannion, CA 22





Land cover monitoring

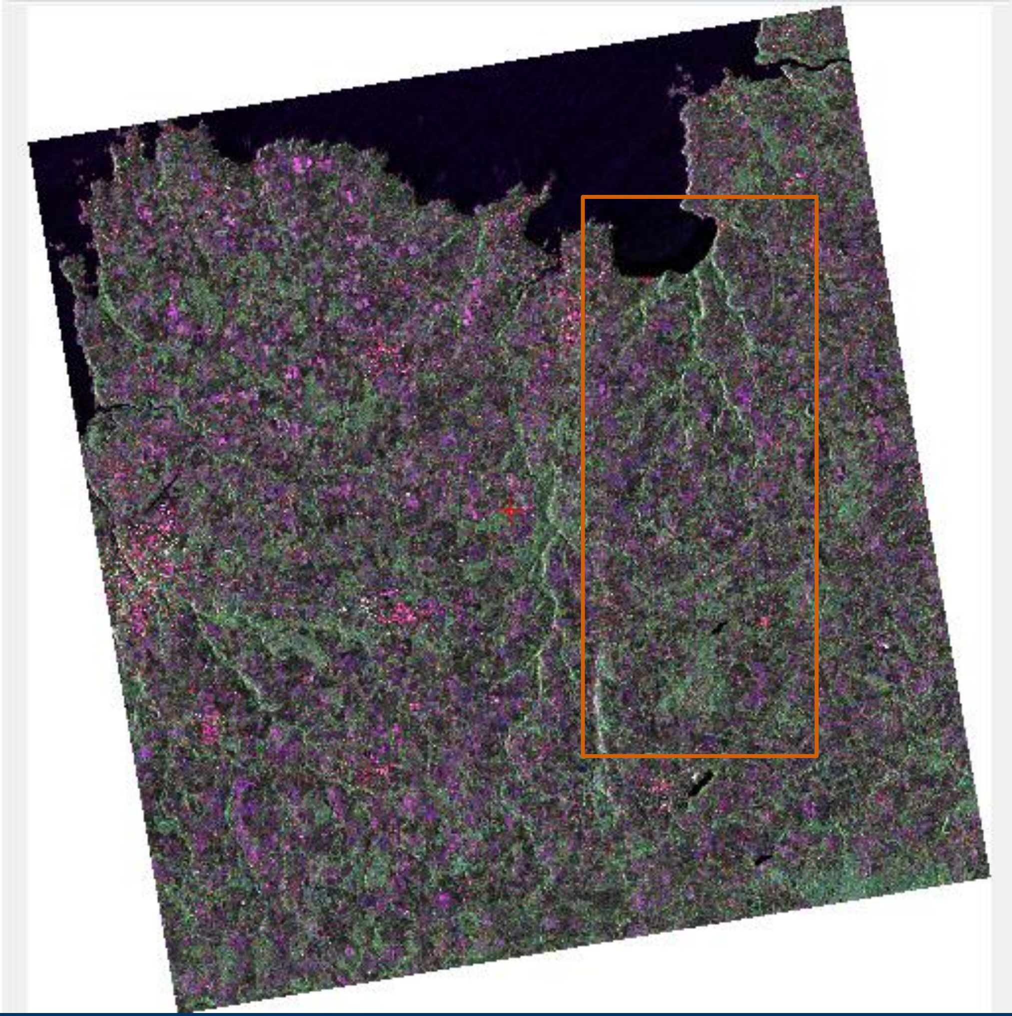
- Land cover extraction in winter



Methodology

Radarsat-2 data

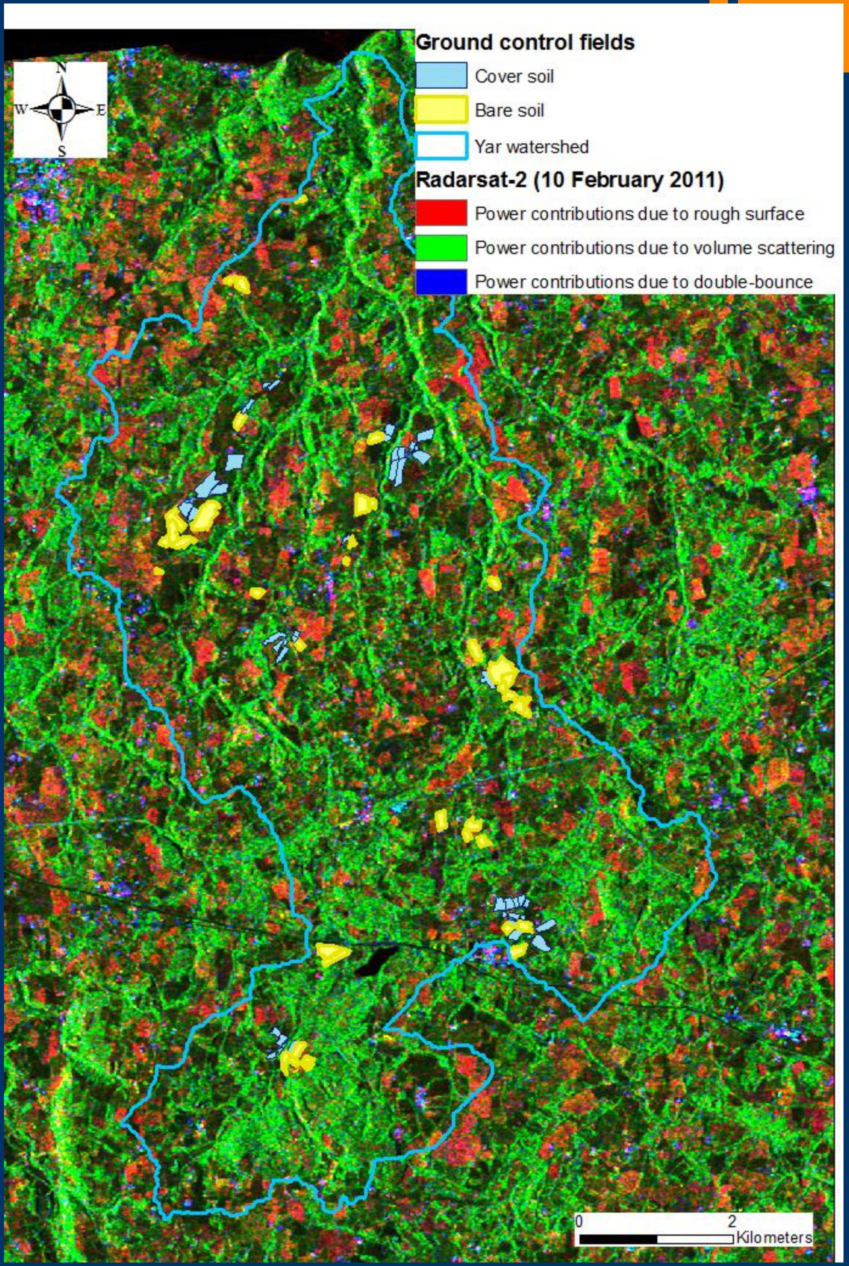
Sensor	**Radarsat-2 (10 feb 2011)**
Sensor type	SAR
Product type	SLC
Acquisition type	**Fine Quad Polarisation**
Microwaveband	C
Polarizations	HH, HV, VH, VV
Number Range/Azimuts Looks	1
Beam mode	FQ18
Incidence angle	**37.40° - 38.90°**
Antenna pointing	**Right**
Data type	Complex
Spatial resolution (X)	4.7 meters
Spatial resolution (Y)	4.9 meters
Pass direction	**Ascending**



Ground control campaign

	Cover soil	Bare soil
Count:	44	38
Minimum:	0.26 ha	0.42 ha
Maximum:	5.77 ha	7.77 ha
Sum:	67.82 ha	77.53 ha
Mean:	1.54 ha	2.04 ha
Standard Deviation:	1.12 ha	1.56 ha

- Global photography of the field / Vertical photography of the field
- Land use / Vegetation density (quadrat)
- Volumetric soil moisture (0 – 5 cm) using a Time Domain Reflectometer (TDR)
- Height of the vegetation / Percent of crop residues



- Imaginary component of the correlation coefficient
- Entropy
- Anisotropy
- Alpha Angle
- Beta Angle
- Power contributions due to double-bounce
- Power contributions due to volume scattering
- Power contributions due to rough surface
- Maximum of the degree of polarisation
- Minimum of the degree of polarisation
- Maximum of the completely polarised component
- PSI angle for maximum of the completely polarised component
- CHI angle for maximum of the completely polarised component
- Minimum of the completely polarised component
- PSI angle for minimum of the completely polarised component
- CHI angle for minimum of the completely polarised component
- Maximum of the completely unpolarised component
- Minimum of the completely unpolarised component
- Maximum of the receive power
- Minimum of the receive power
- Maximum of the scattered intensity
- Minimum of the scattered intensity
- Coefficient of variation
- Fractional Power
- Pedestal Height
- Phase Difference classification
- Intensity ratio
- Total Power
- Synthesized Backscatter
- Maximum Polarization Response
- Minimum Polarization Response
- Touzi Anisotropy
- Difference between Max and Min Response
- Psi Angle
- Dominant Eigenvalue
- Touzi Alpha_S Parameter
- Touzi Phase
- Tau Angle (Helicity)

Polarimetric variables

❖ **Polarimetric discriminators**

→ Useful to identify the different types of scattering mechanism of a target

→ Based on the polarimetric synthesis

→ Described the polarimetric response of features in the image

❖ **Polarimetric parameters**

→ Coude-Pottier decomposition (Alpha and Beta angle Entropy, Anistropy)

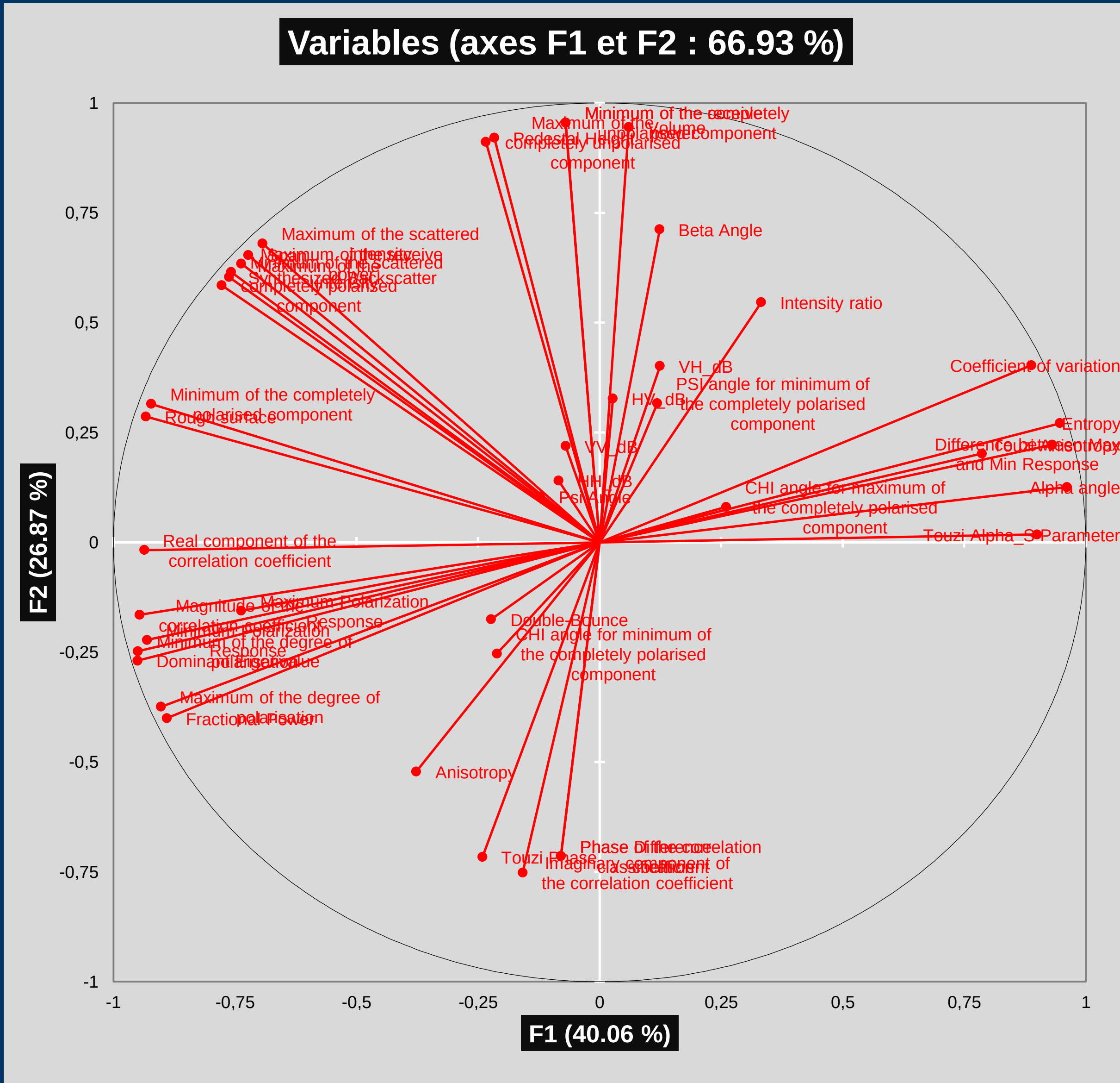
→ Touzi decomposition (orientation angle, dominant eigenvalue, Touzi alpha angle, Touzi phase, and helicity)

→ Freeman-Durden decomposition (double bounce, volume scattering and rough surface)

Land cover monitoring

- Land cover extraction in winter

PCA (Principal Component Analysis)



- Weak percentage of variability represented on the first two axes **(66.93%)**

- Several discriminators with very **high redundancy** (Span, Min and Max of receive power)

- The 4 polarizations HH, HV, VH, VV (in dB) appear little informative

ANOVA (ANalysis Of VAriance)

- 6 redundant variables are deleted (Touzi Anisotropy, Span, Max of the receive power…)

- $R^2 = 0.836$

Explicative variables for land cover in winter (bare soil and cover soil)	Value
✓ Coefficient of variation	-2.282
✓ Dominant Eigenvalue	-3.073
✓ Fractional Power	-2.617
✓ Maximum of the completely polarised component	3.108
✓ Minimum of the completely polarised component	-4.486
✓ Minimum of the scattered intensity	5.413
✓ Pedestal Height	-2.877

Integration of the variables in the K-means classifier

Results

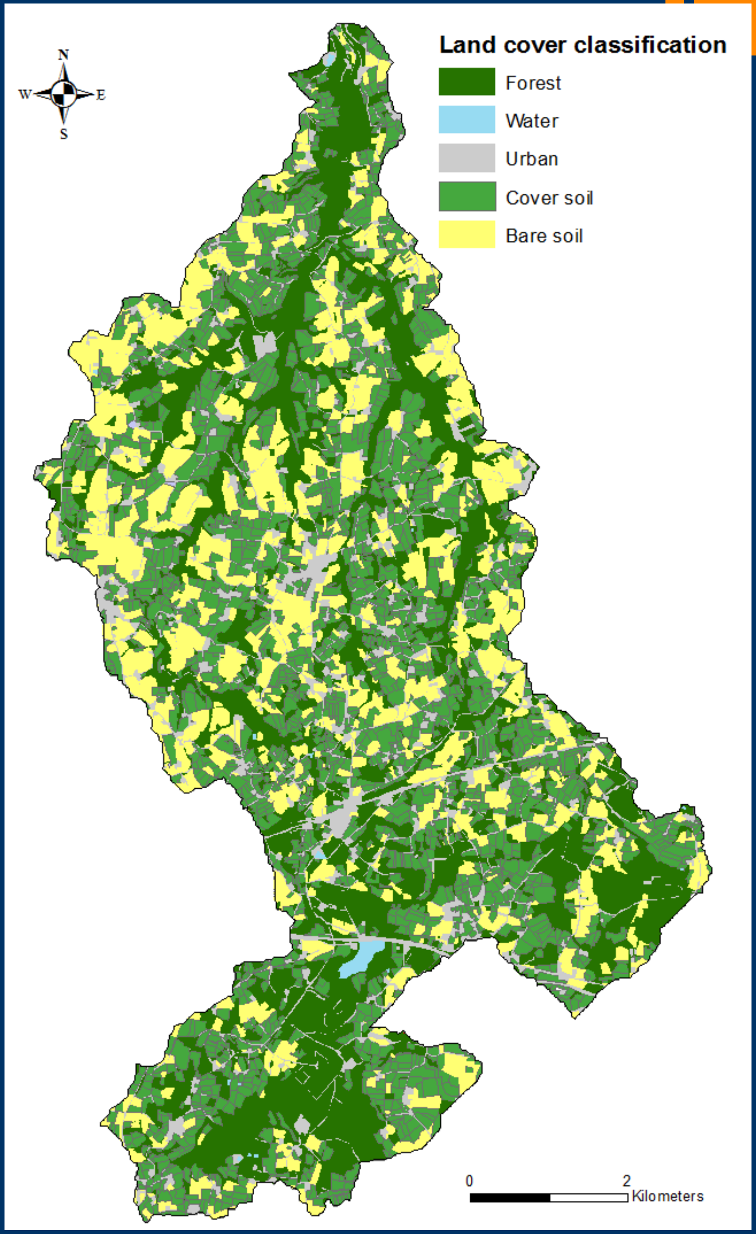
- Land cover classification

→ Kappa Coefficient : 0.91

Classification/ Ground control	Cover soil	Bare soil	Total	Error Comission
Cover soil	6141	0	6141	0
Bare soil	644	7746	8390	0.0768
Total	6785	7746	14531	0
Error Omission	0.0949	0	0	0.0443

→ Very good discrimination of bare soil

→ Confusion when there is crop residues (corn, colza…) and regrowth on bare soil



Summary

• Results show the potential of specific polarimetric discriminators for mapping land cover in winter on a fragmented watershed

• Confusion when there is crop residue on the field

→ Necessity to integrate a third class (**Intersection of the two classe**) in the classification process (Dezert-Smarandache rule)

• Current works are realized on the bare soil characterization :

→ With polarimetric data on the Yar watershed (Igarss 2012)

→ With data fusion (Alos and Radarsat-2 data) on the Zone Atelier de Pleine Fougères (Igarss 2012)

Perspectives

→ Develop collaborative work (GIS BRETEL) on the :

- Evaluation of Radarsat-2 data for land cover monitoring in fragmented watershed (database of Vigisat, 2010 -2012)

→ Master 2 Research

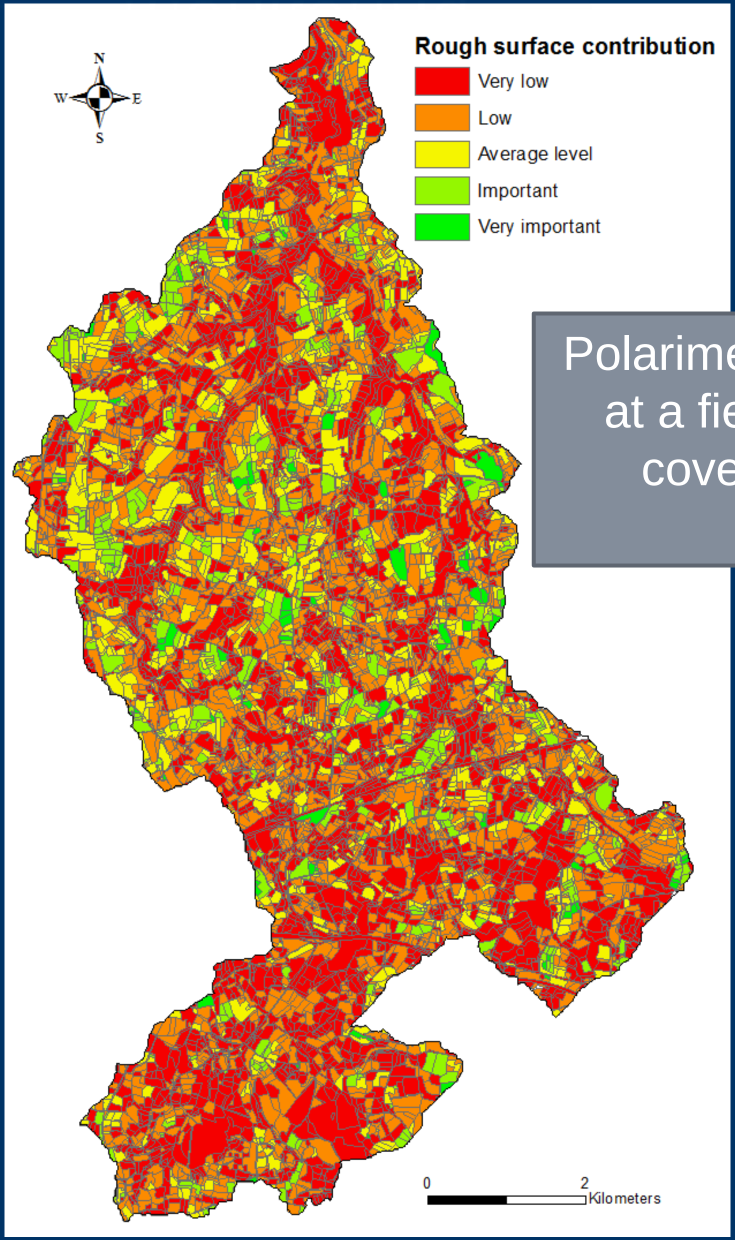
- Data fusion of radar and optical data (very high spatial resolution) for ecological corridors monitoring

- → *Thesis (J. Betbeder, 2011 – 2014)*

THANKS !

- Land cover extraction in winter

Results



Polarimetric discriminators at a field scale for land cover and land use analysis