

Wetlands delineation and characterization from CASI hyperspectral data

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Outline

- **Problematic and objectives**
- **Valley bottom wetlands delineation and characterization from CASI hyperspectral data**
- **First results obtained on a test-site (The watershed of the Yar, Brittany, France)**
- **Conclusions**

The inventory of wetlands

- Wetlands have been recognized as being of high importance to a number of national and international issues (National Inventory, RAMSAR Wetlands Inventory, Kyoto, Input into climate change scenario, etc...)

- Inventorying wetlands is not an easy task

*“Wetlands are areas where soils are **water-saturated for a sufficient period of time** such that excess water and resulting low soil oxygen levels are principal determinants of **vegetation** and **soil** development.”*

→ Hydromorphic soils and vegetation

→ The non-permanency of wetness conditions in such zones raises scientific questions about wetland delimitation.

The inventory of valley bottom wetlands

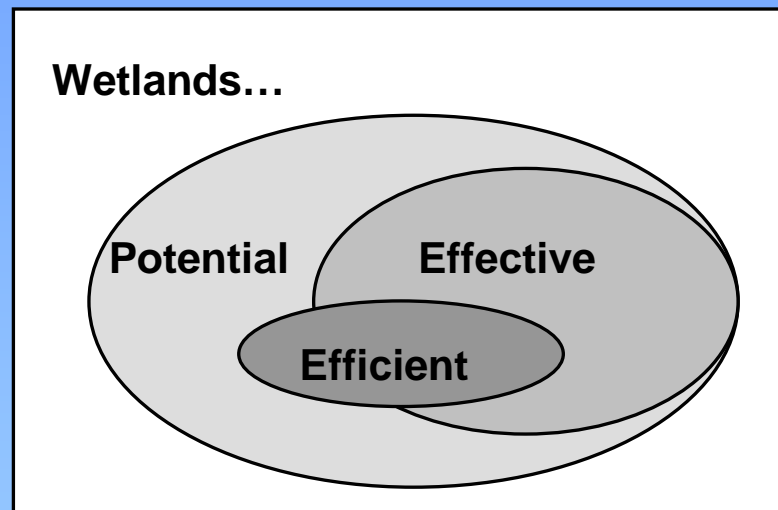
- Valley bottom wetlands included in agricultural landscapes



- often neglected in national and regional wetland inventories
 - small, located in the bottomlands of the headwater catchments, and scattered in the rural landscape
 - strongly influence hydrology, water quality and biodiversity over the whole catchment area
 - progressively disappear in intensive farming landscapes
 - often considered as controversial wetlands(US National Research Council, 1995).
- need to improve tools for controlling wetland management is a primary consideration for decision-makers and land-users

The inventory of valley bottom wetlands

- A methodology based on the functional analysis of Potential, Existing and Efficient valley bottom Wetlands the PEEW approach :



Potential wetlands : from a topographic index using topographic and pedo-climatic criteria computed from a DEM easily accessible databases.

Effective or Existing wetlands : from observed surface moisture, the presence of specific wetland vegetation or soil feature criteria.

Efficient wetlands : through a given function (flow or pollutant regulation, or biodiversity control).

→ Delineating and characterizing “Effective Wetlands”

The inventory of valley bottom wetlands

Levels of “existing wetland” definition with the identification methods and criteria

Criteria	Approach	Typology
Moisture conditions (NP)	Field observations or measurements (piezometer, water content,...) or remote sensing data (radar)	Effective <i>Evaluation of moisture conditions averaged in time by direct or indirect measurements</i>
Hydromorphic soil features (P)	Field observations or geophysical measurements (electric methods)	<i>In addition : Indirect evaluation of specific functions based on simplified hypothesis</i>
Biota – Land cover/land use (P)	Field observations or remote sensing data (hyperspectral)	

[NP : Non Permanent; P : Permanent]

→ **Objective : Evaluating hyperspectral data for delineating and characterizing “Existing Wetlands”**

The inventory of valley bottom wetlands

The experimental study Area

The watershed of the Yar

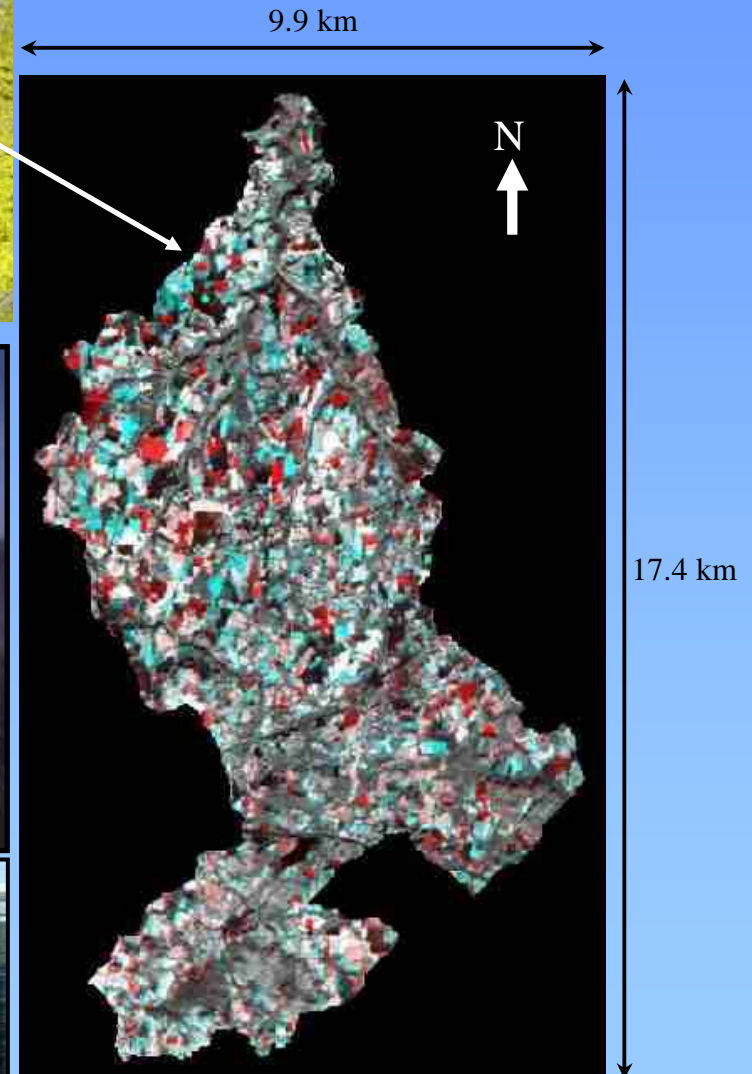
- 6200 ha (250 farms)
- Intensive farming activities
- Winter bare fields (average 15-20%)

→ Water pollution (NO₃)

→ Bloom algae

→ Map the extent of existing wetlands and, if possible, efficient wetlands (pollutant regulation)

National Wetlands Research Program (PNRZH)



Valley bottom wetlands delineation and characterization from CASI hyperspectral data

CASI campaigns



- 3 campaigns
 - 07/25/1998 (Calibration)
 - 03/19/1999 (Soil moisture)
 - 09/13/2000 (Wetlands mapping)

<http://www.uhb.fr/gstb/>

Univ. Rennes 2/ENSB/Univ. Rennes 1



Valley bottom wetlands delineation and characterization from CASI hyperspectral data

Field observations

SPECTRORADIOMETRIE *Agrostis/Holcus lanatus/Glyceria Fluitans*

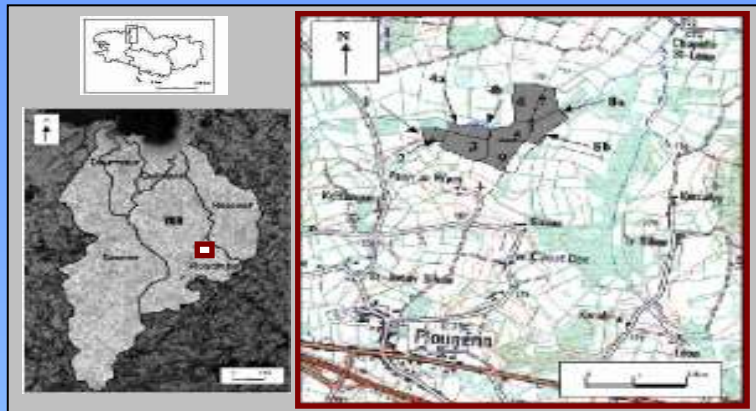


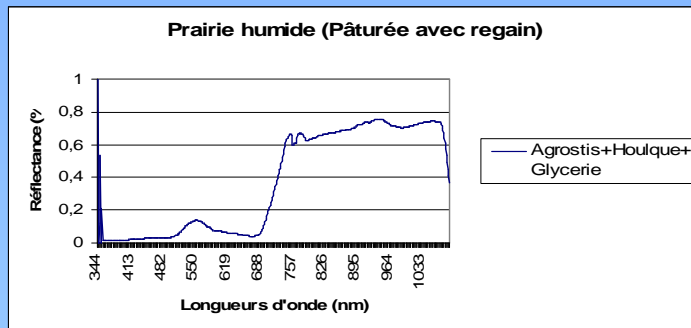
PHOTO - 1



Points de mesures



SOURCE : Orthophotoplan 98 ,
Conseil général des Côtes d'Armor



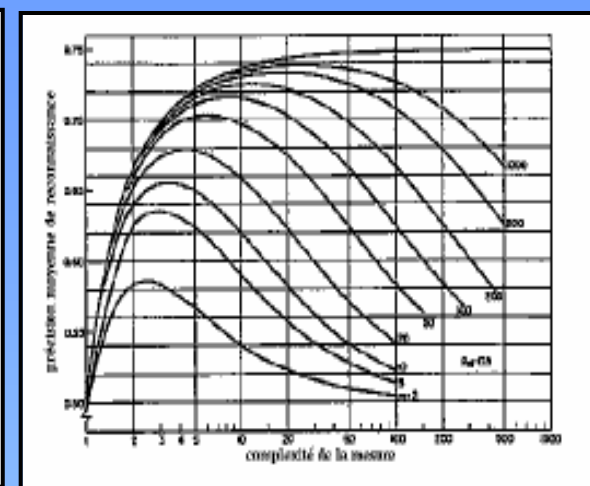
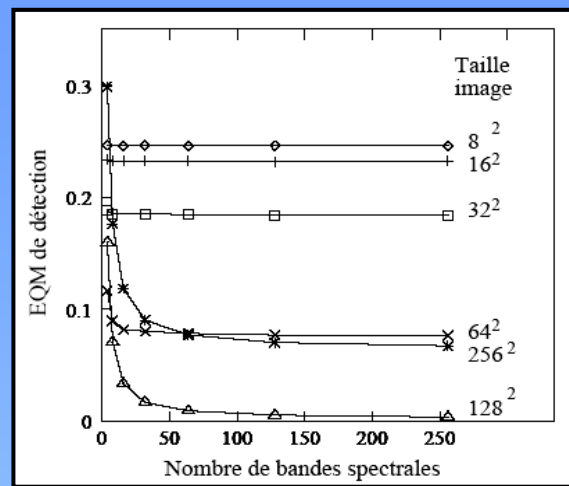
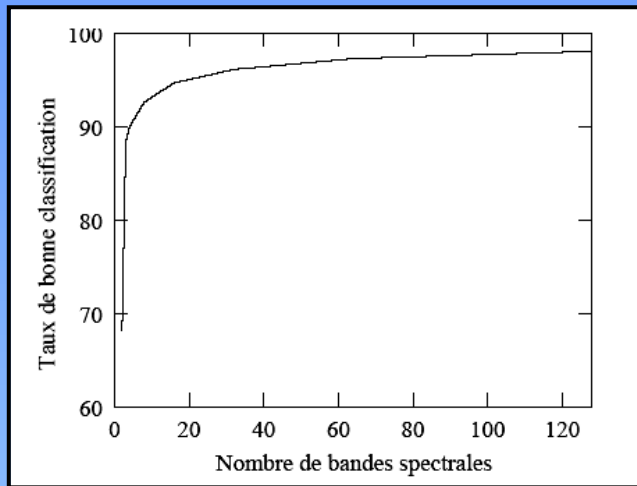
Fichier de données : P1_Agr_Holc_Glyc- Format : Excel 97

Mission : 13 SEPTEMBRE 2000
 Début des mesures : 12 H- Fin des mesures : 12 H10
Matériel utilisé : Spectro-radiomètre ASD
 Autres caractéristiques techniques :
Zone d'étude : BASIN VERSANT DU YAR (partie amont)
 PARCELLE : N° 6 Lieut-dit : PEN AR WENN
 Commune : PLOUNERIN Département: CÔTES D'ARMOR
Objectif : Caractérisation végétation des zones humides de fonds de vallées
Nombre de mesures : 10
 1 à 10 : *Agrostis canina* + *Holcus lanatus* + *Glyceria fluitans* (prairie humide pâturée)
Responsable de mission : L.HUBERT-MOY TEL : 0299141852
 EMAIL : laurence.hubert@uhb.fr

→ VNIR Spectral library of hydromorphic vegetation
 (field spectroradiometry- <http://www.uhb.fr/gstb/>)

Valley bottom wetlands delineation and characterization from CASI hyperspectral data

CASI data specification



- 18 bands
(415 nm- 890 nm)
- FWHM : 9.2 nm

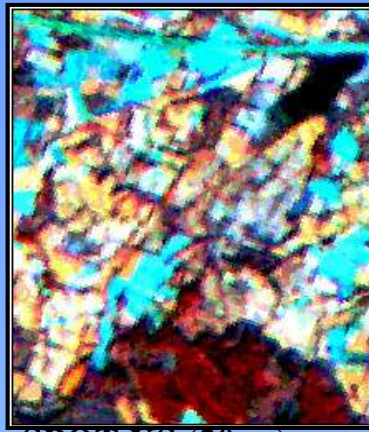
Band number	1	2	3	4	5	6	7	8	9
Wavelet center (nm)	420,0	442,1	485,0	497,8	528,6	551,1	571,5	600,9	636,5
FWHM(nm)	11,0	12,2	11,0	12,4	14,2	8,4	10,2	8,4	8,4
Band number	10	11	12	13	14	15	16	17	18
Wavelet center (nm)	677,7	694,9	706,4	715,9	737,9	749,5	799,9	839,5	884,0
FWHM(nm)	8,4	10,6	10,6	7,4	12,5	8,4	8,4	12,6	10,0

Valley bottom wetlands delineation and characterization from CASI hyperspectral data

CASI data specification



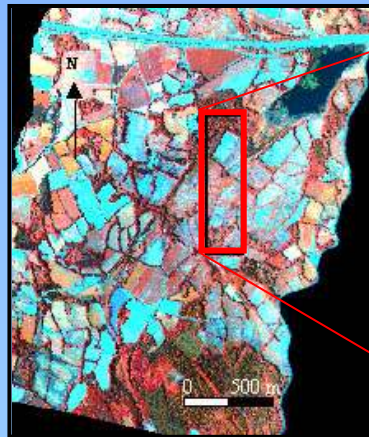
Landsat TM (30 m)



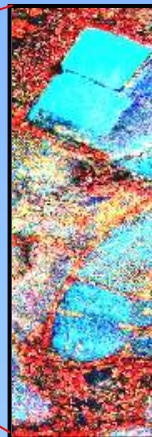
SPOT XS (20 m)



Orthophoto



CASI (4 m)



CASI (2 m)

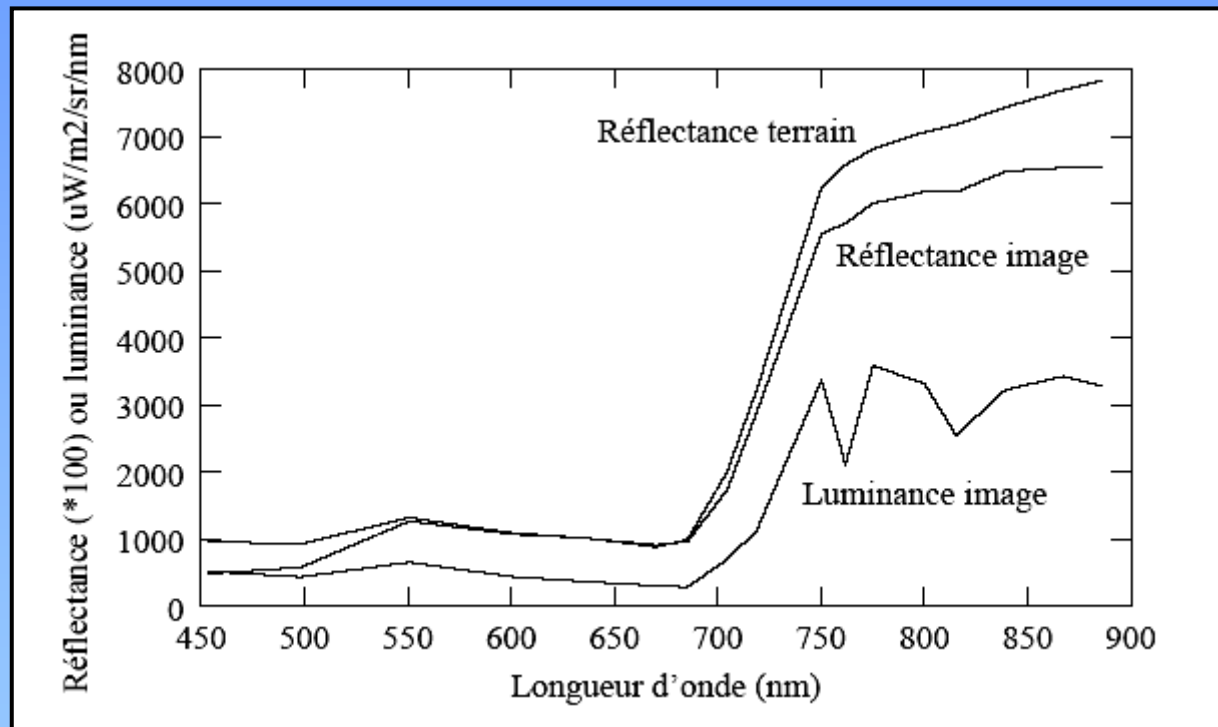


CASI (1 m)

- Spatial resolution : 2 m

Valley bottom wetlands delineation and characterization from CASI hyperspectral data

Pre-processing : Geometric and Atmospheric corrections



Comparison of the spectroradiometric data from the ASD field spectroradiometer vs the spectral data from CASI images for monodominant *Carex paniculata* communities

Valley bottom wetlands delineation and characterization from CASI hyperspectral data

Processing

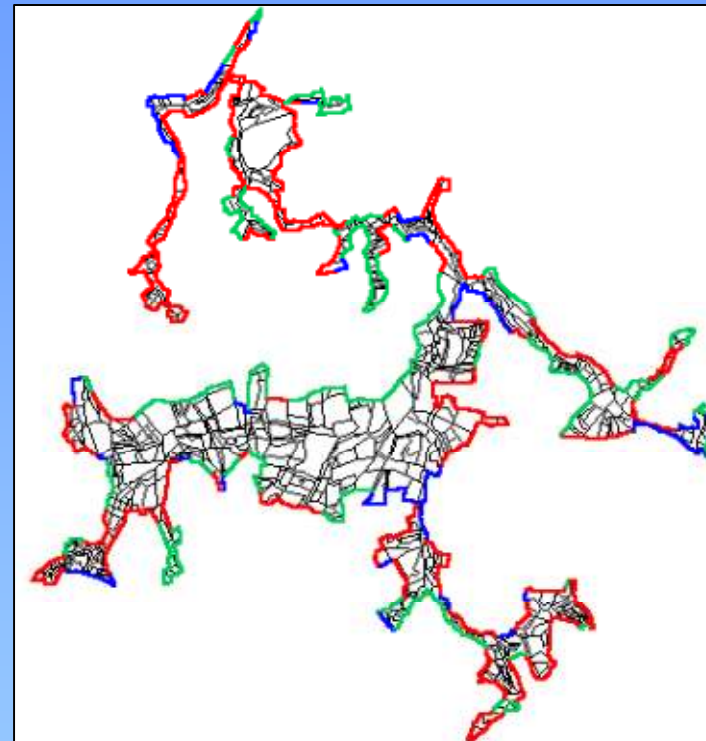
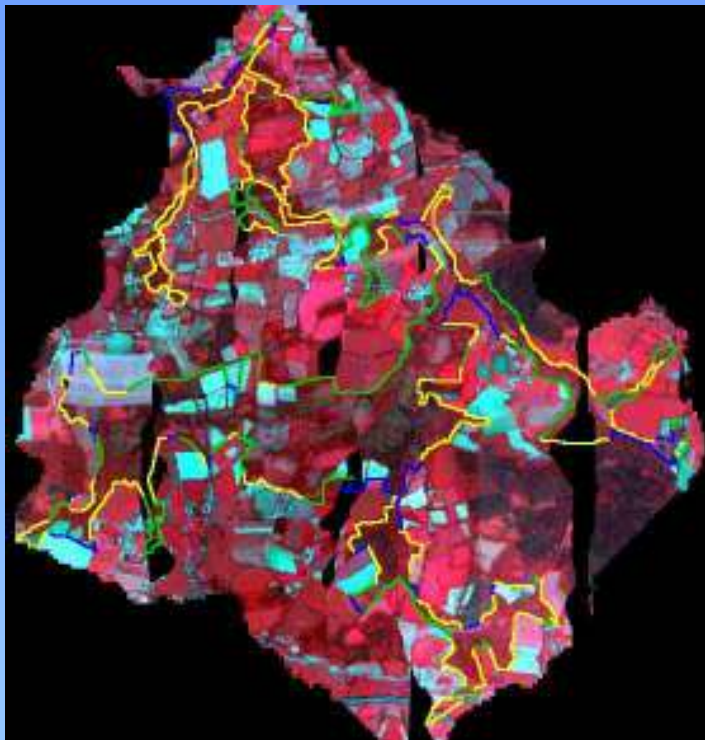
- Hybrid method for wetland delimitation and characterization (except farming practices on meadows): Visual interpretation of Casi images + Spectral unmixing of hyperspectral images with the Independent Component Analysis and wavelet packets
- Automatic classification to determine farming practices on meadows (nonlinear filtering and support vector machines)

* Lennon M., Mercier G., Hubert-Moy L., 2002. « Classification of hyperspectral images with nonlinear filtering and support vector machines », *International Geoscience and Remote Sensing Symposium, IGARSS '02, IEEE 2002 International*, Vol. 3 , pp. 1670- 1672. <http://www.uhb.fr/gstb/>

** Lennon M., Mouchot, Mercier G., Hubert-Moy L., 2001." Spectral unmixing of hyperspectral images with the Independent Component Analysis and wavelet packets", *International Geoscience and Remote Sensing Symposium, IGARSS '01, IEEE 2001 International*, Vol. 6, pp. 2896 –2898. <http://www.uhb.fr/gstb/> 13

Valley bottom wetlands delineation and characterization from CASI hyperspectral data

Results

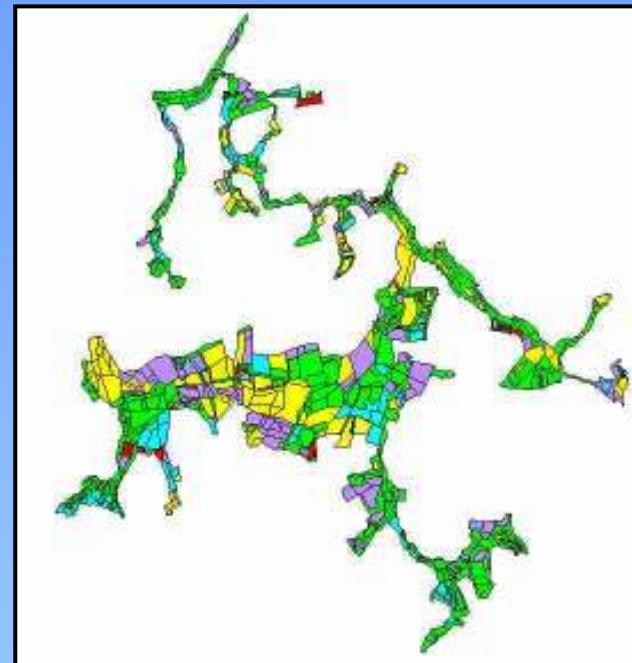
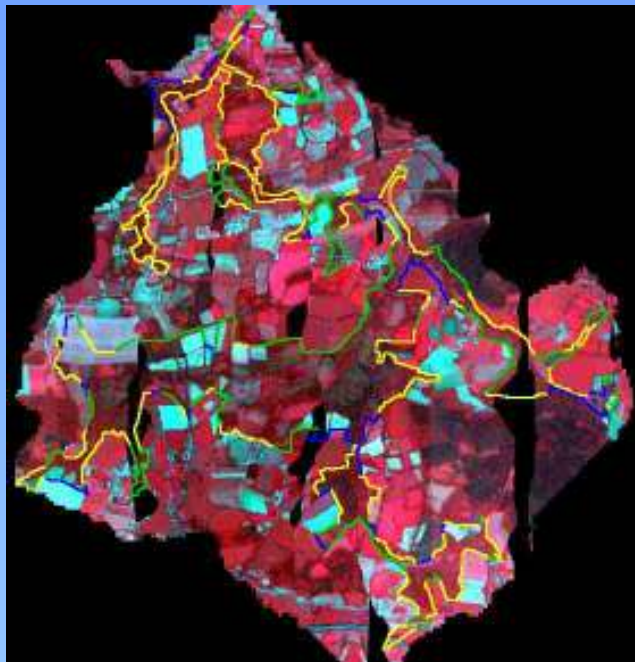


Boundaries

- Land use limits
- Physiographic limits
- Fuzzy/ scattered limits

Valley bottom wetlands delineation and characterization from CASI hyperspectral data

Results



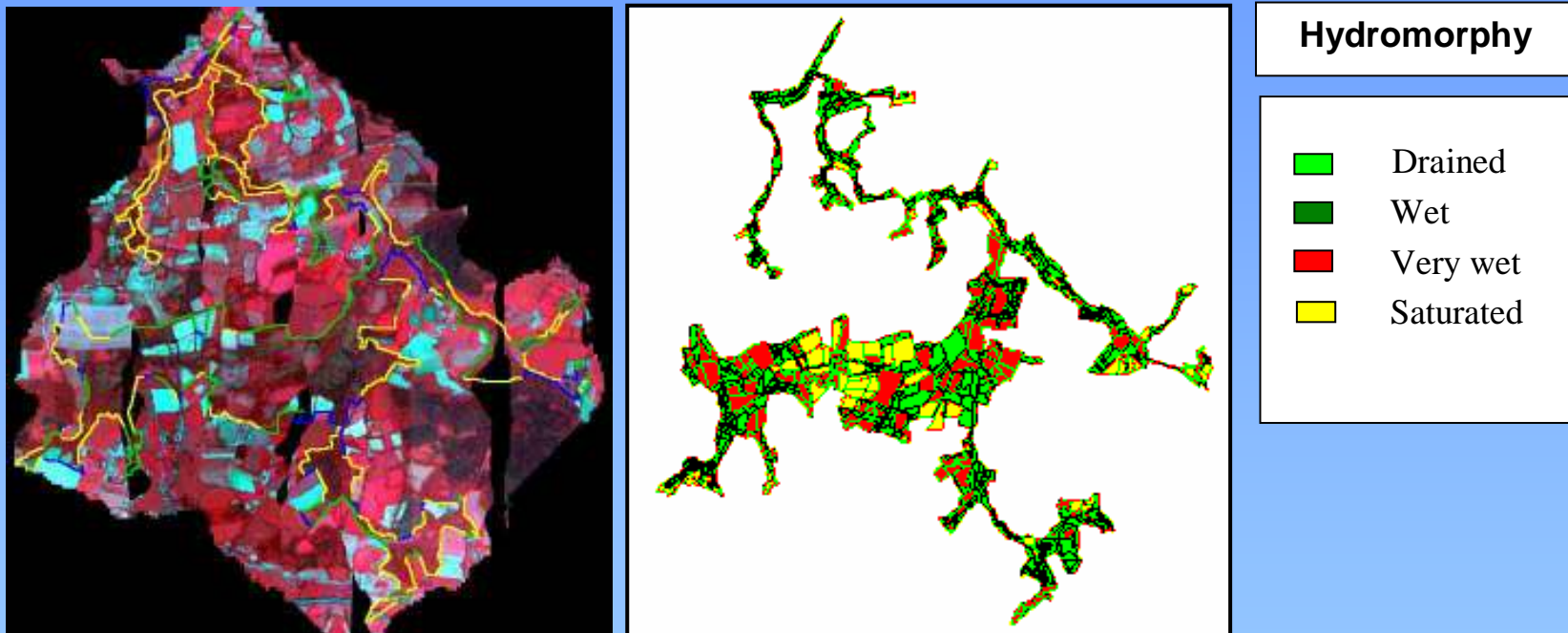
Biota Dominants

- Indetermined
- Oligotrophic
- Oligo-mesotrophic
- Meso-eutrophic
- Eutrophic

→ The CASI data allow certain species or combination of species to be distinguished, and thus to interpret the presence of surface hydromorphy and the trophic type.

Valley bottom wetlands delineation and characterization from CASI hyperspectral data

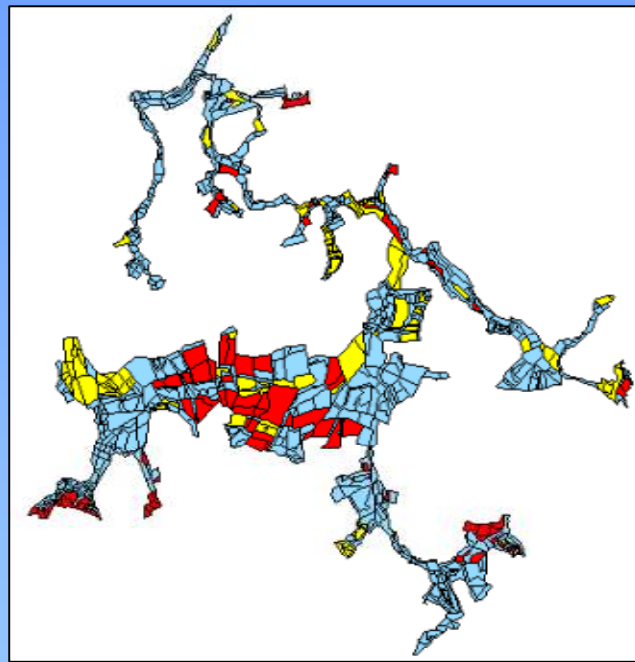
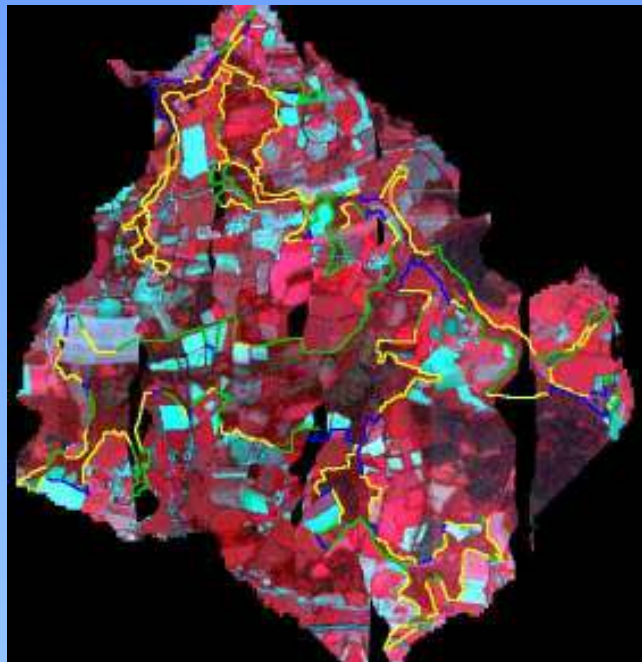
Results



→ The CASI images provide information relative to the surface hydromorphy.

Valley bottom wetlands delineation and characterization from CASI hyperspectral data

Results



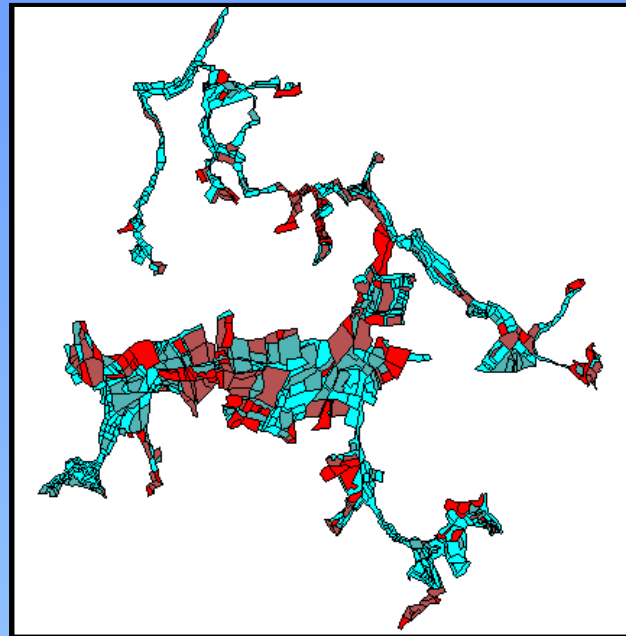
Agricultural practices

- Mowing+aftermath pasturing
- Pasturing
- Afforestation, Absence

→ The CASI images provide information relative to the farming practices within the wetland area (discrimination of mowing and pasturing with a very good precision -94%- when the date of the image is appropriate).

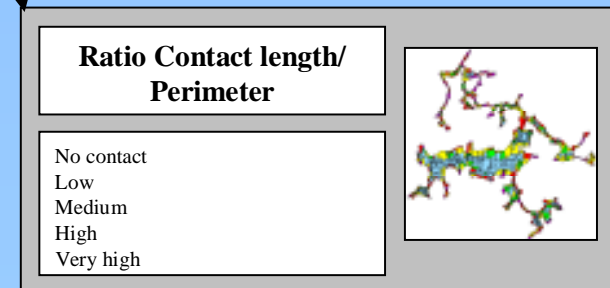
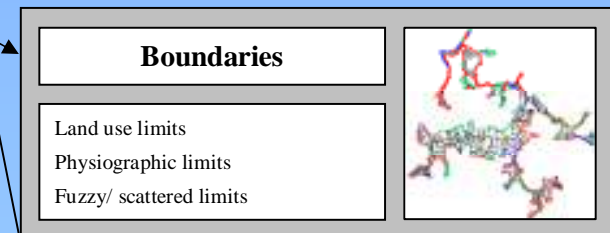
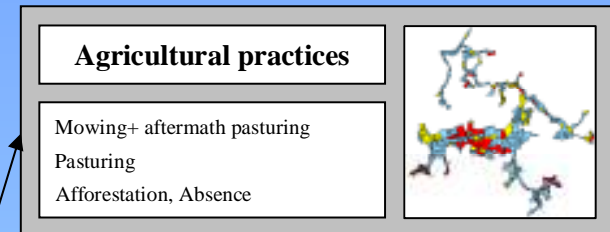
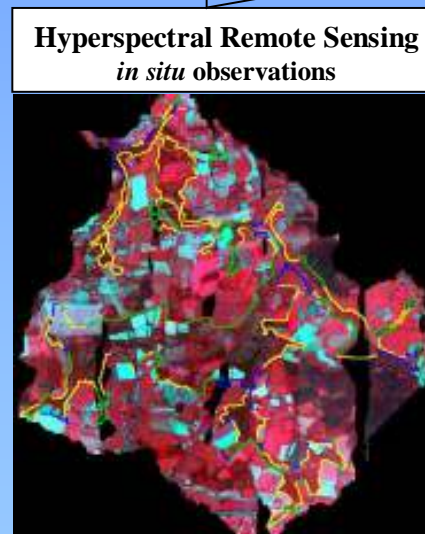
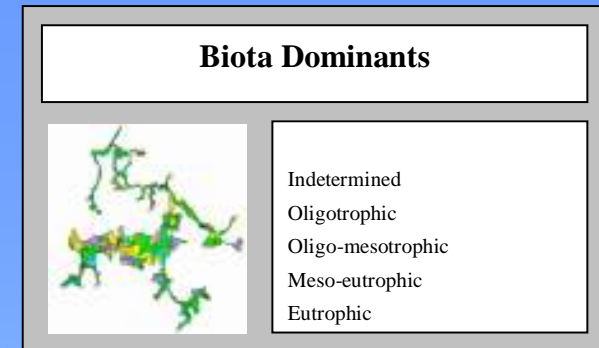
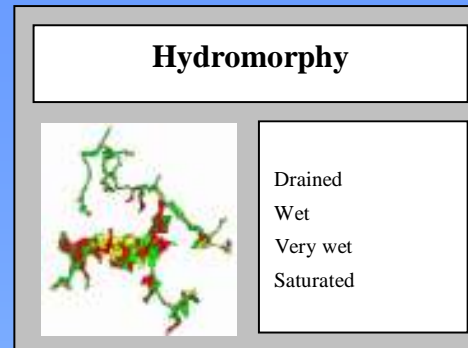
Valley bottom wetlands delineation and characterization from CASI hyperspectral data

Results



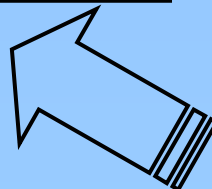
Denitrification potential in the wetland
by using the HGMU Approach (Hydrogeomorphic Units)

- High potential ($8 \leq X$)
- Medium potential ($6 = X < 8$)
- Low potential ($4 = X < 6$)
- No or very low potential ($0 = x < 4$)



**Effective wetland :
delineation of the wet character**

**Evaluation of wetland in relation to
denitrification function : biota field
observations, land use and indexes**



Conclusions

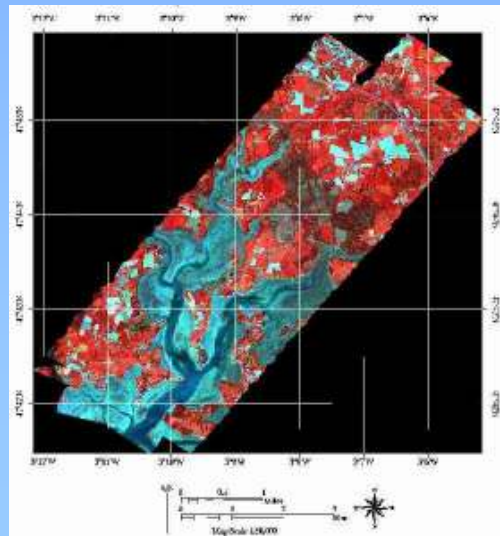
- **This study confirms that the use of hyperpectral imagery is able to improve the mapping of wetland environments (Delineation as well as characterization).**
- **The CASI images provide information relative to the surface hydromorphy, the vegetation (identification of some species or combinations of species), and some farming practices.**
- **Existing wetlands can be mapped, but also potentially efficient wetlands in relation to the transfer of polluting flows, nitrogenous flows in particular.**

Conclusions

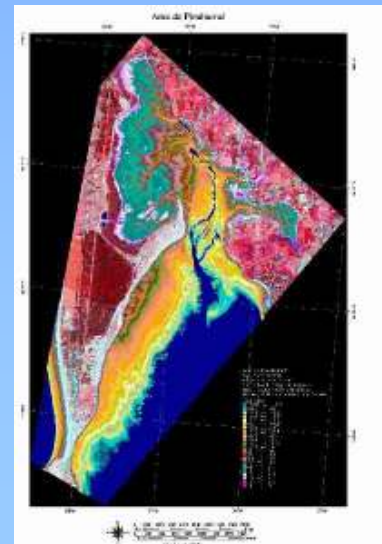
• Perspectives

Wetlands are highly complex landforms and as such a fusion of :

- spectral and spatial analytical approaches for the analysis probably will reduce the manual photo-interpretation of hyperpectral data (Region-based segmentation approach to classification).
- hyperspectral data with LIDAR-based digital elevation data or microwave radiometer data (MWR) can facilitate (1) the designation of areas that have a high likelihood of containing wetlands, and (2) delimitation and characterization of wetlands.



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