



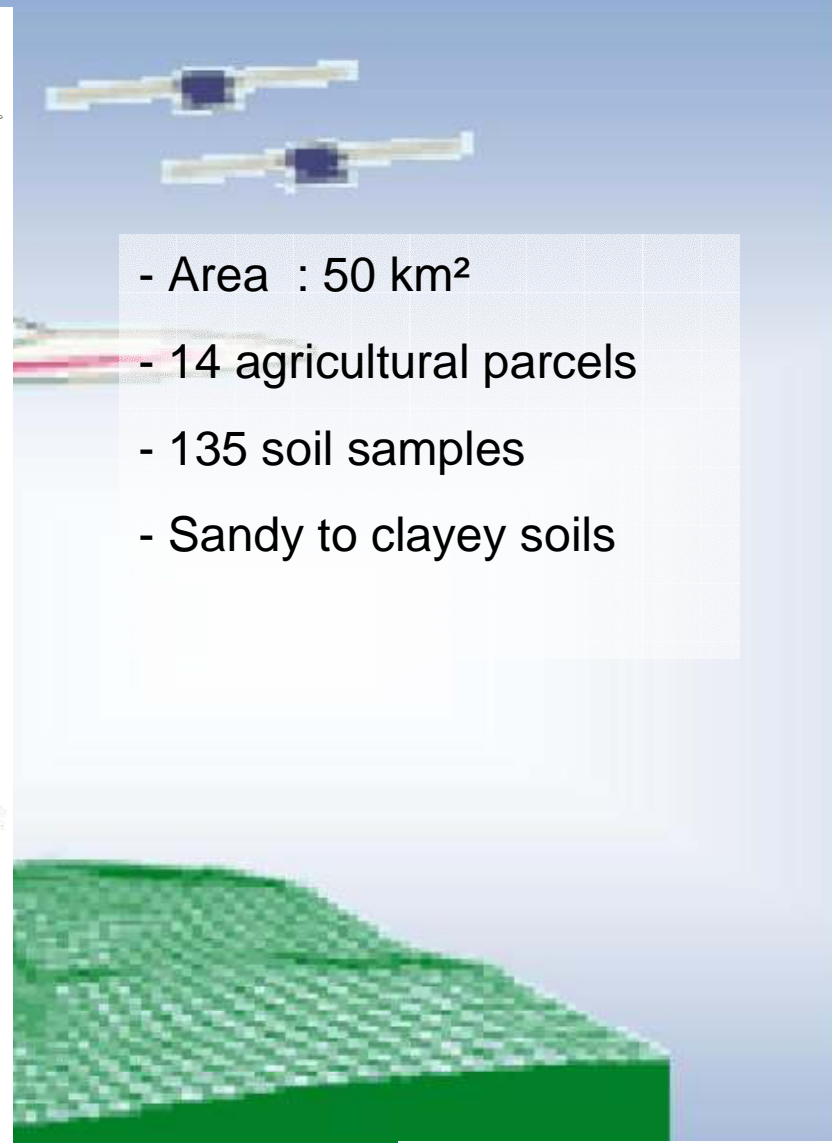
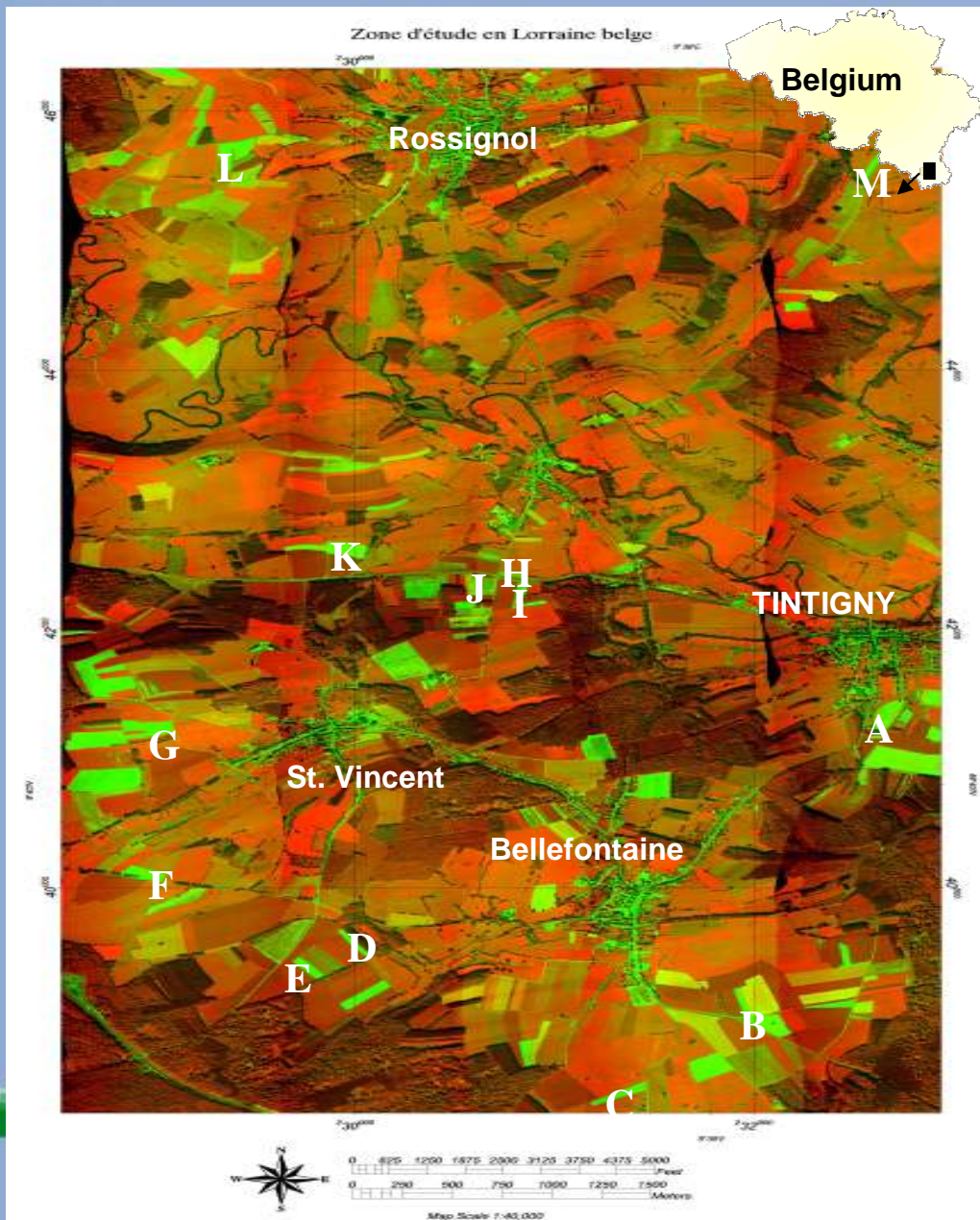
ESTIMATION OF SURFACE SOIL ORGANIC MATTER BY MEANS OF HYPERSENSPECTRAL DATA ANALYSIS

Objectives



- **Determine Soil Organic Matter by Means of Hyperspectral Images**
- **Compare CASI-2 & SASI Capabilities**
- **Detect Factors Disturbing the signal**
- **Perform a Model of Prediction**

STUDY SITE : LORRAINE BELGE



- Area : 50 km²
- 14 agricultural parcels
- 135 soil samples
- Sandy to clayey soils

Methodology : Forward Stepwise Multiple regression

1) Statistical Study of Soil Organic Matter

2) Spectral Signature Analysis

3) Multiple Regression by a Stepwise Procedure :

- find the Best Correlated Bands

- $SOM_p = A_0 + A_1R_1 + A_2R_2 + \dots + A_nR_n$

SOM_p = predicted soil organic matter

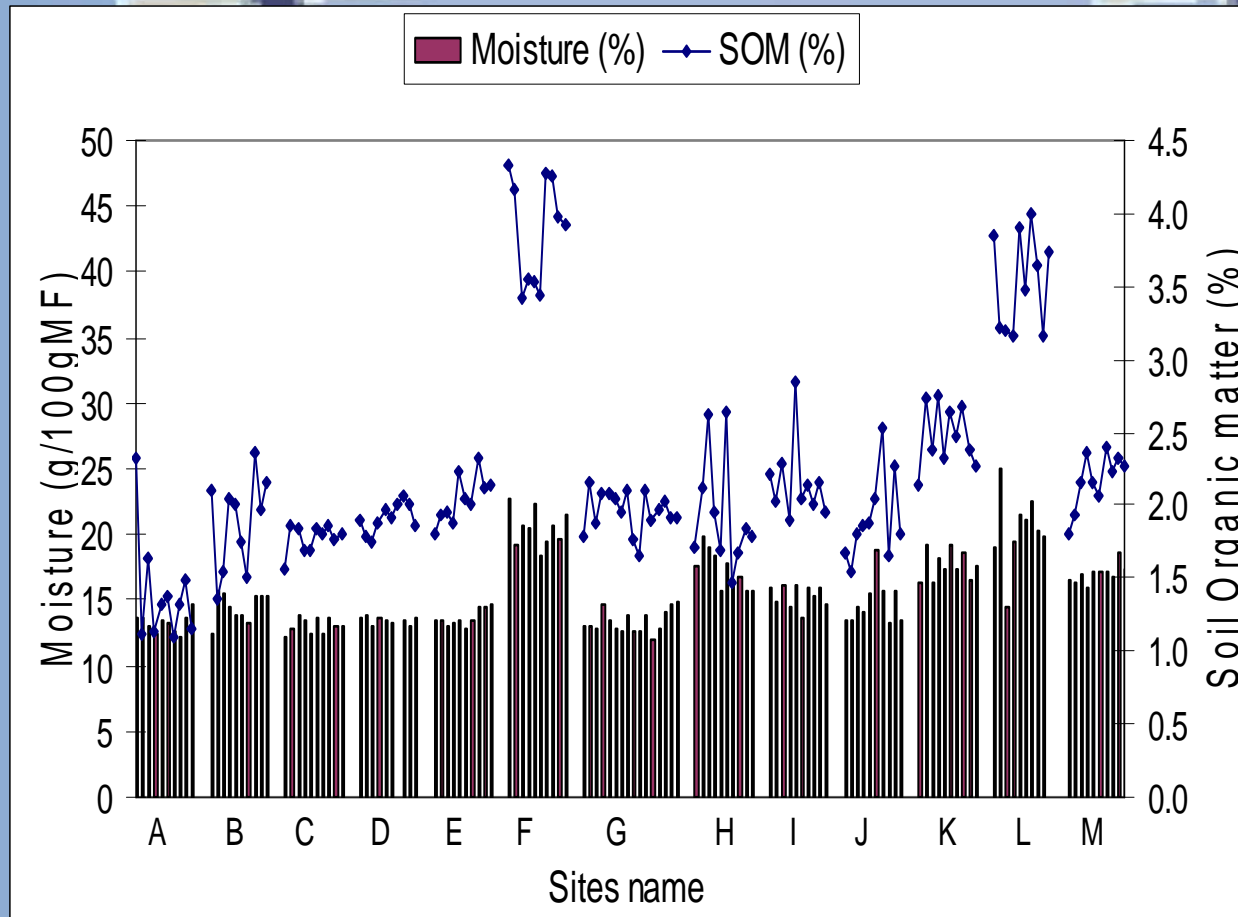
4) Validation

- 20 Samples for validation

- Accuracy via PRMSE

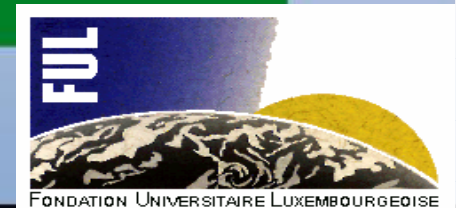
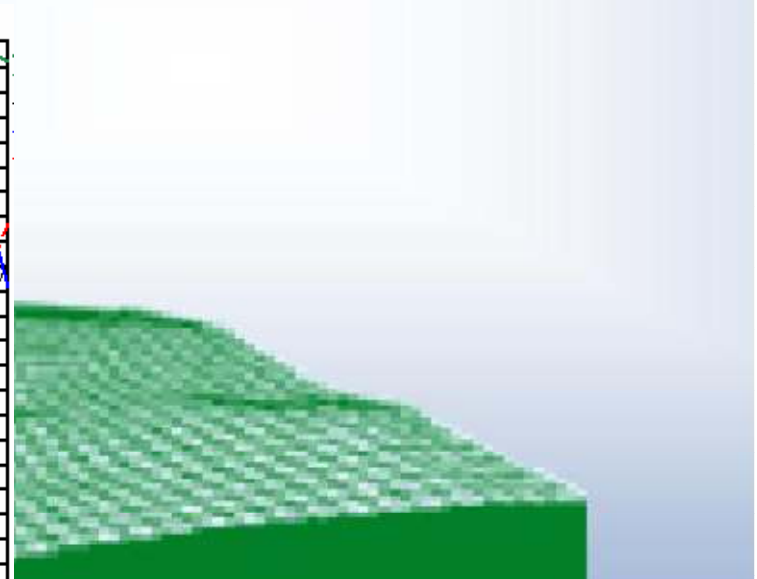
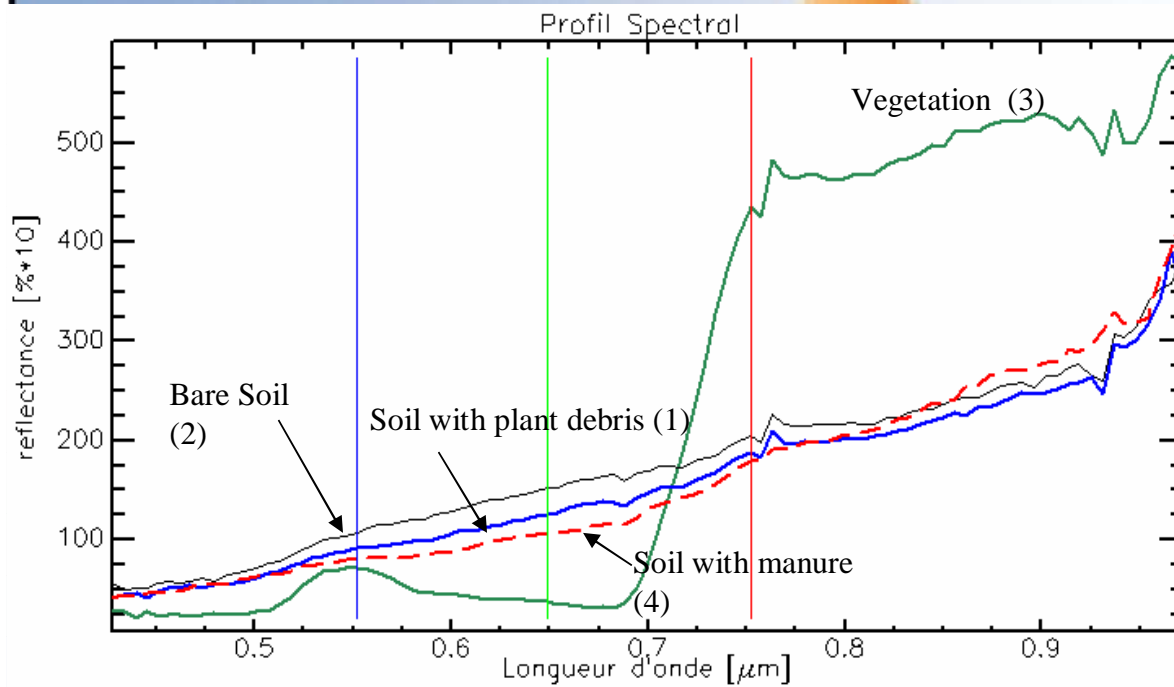
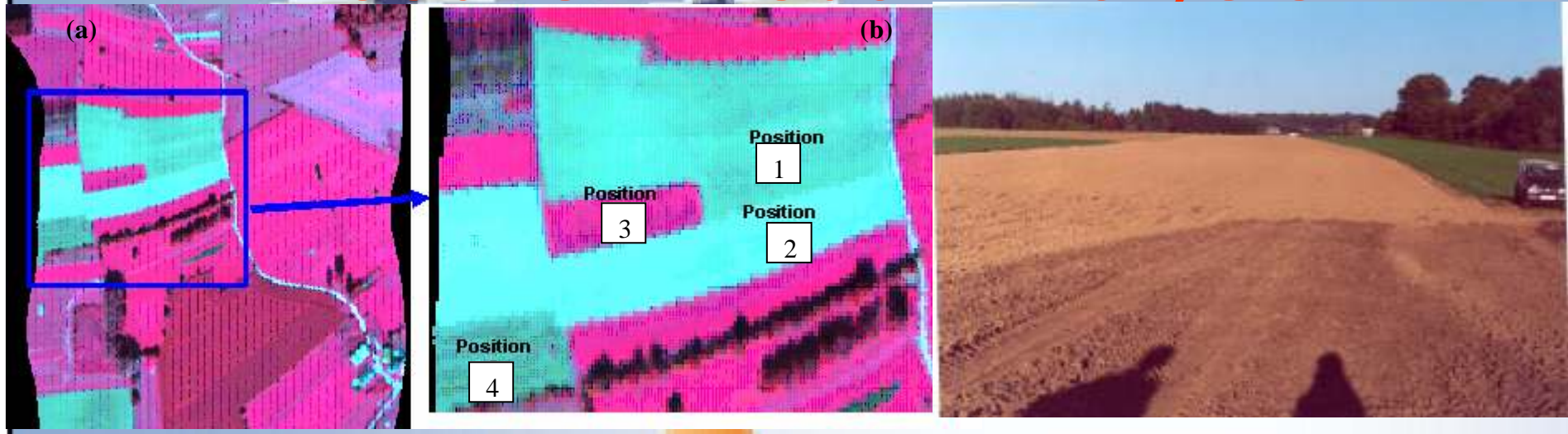
$$PRMSE = \sqrt{\frac{\sum_{i=1}^n (V_{ri} - V_{pi})^2}{n-1}}$$

Results : Soil Organic Matter

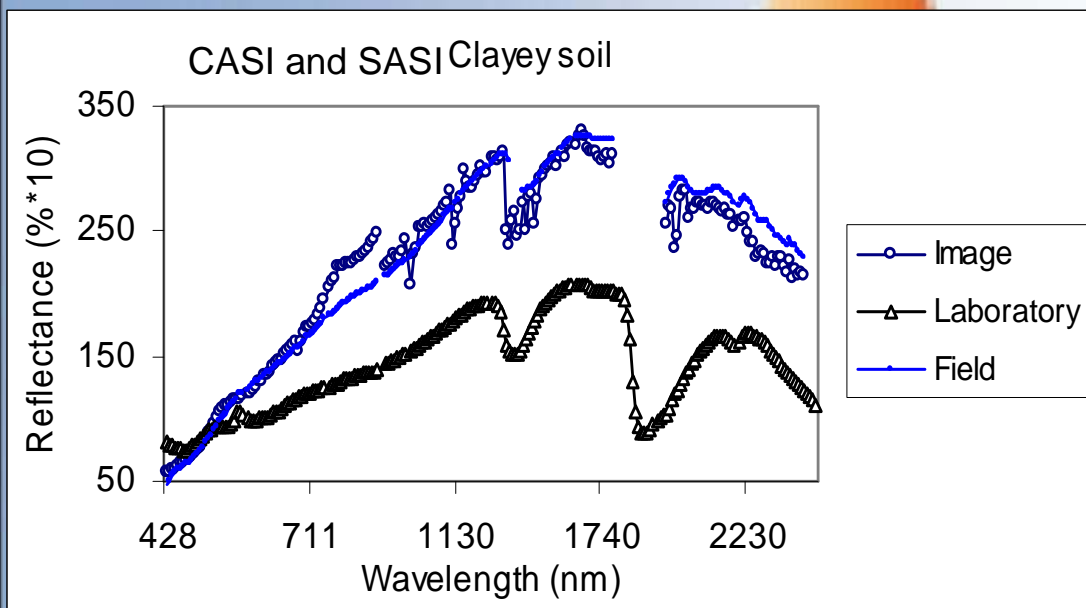
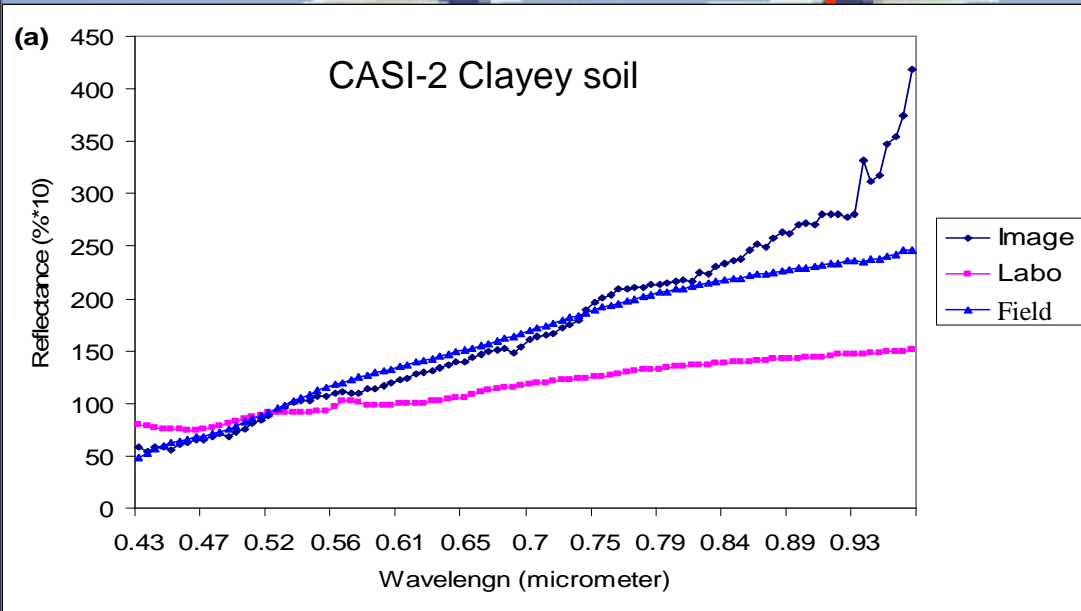


- large range of SOM
- Mean of SOM = 2.2%
- Soil Moisture variability
- Positive relationship between SOM and moisture ($R^2 = 0.61$)

Results : Visual Analysis



Results : Spectral Analysis



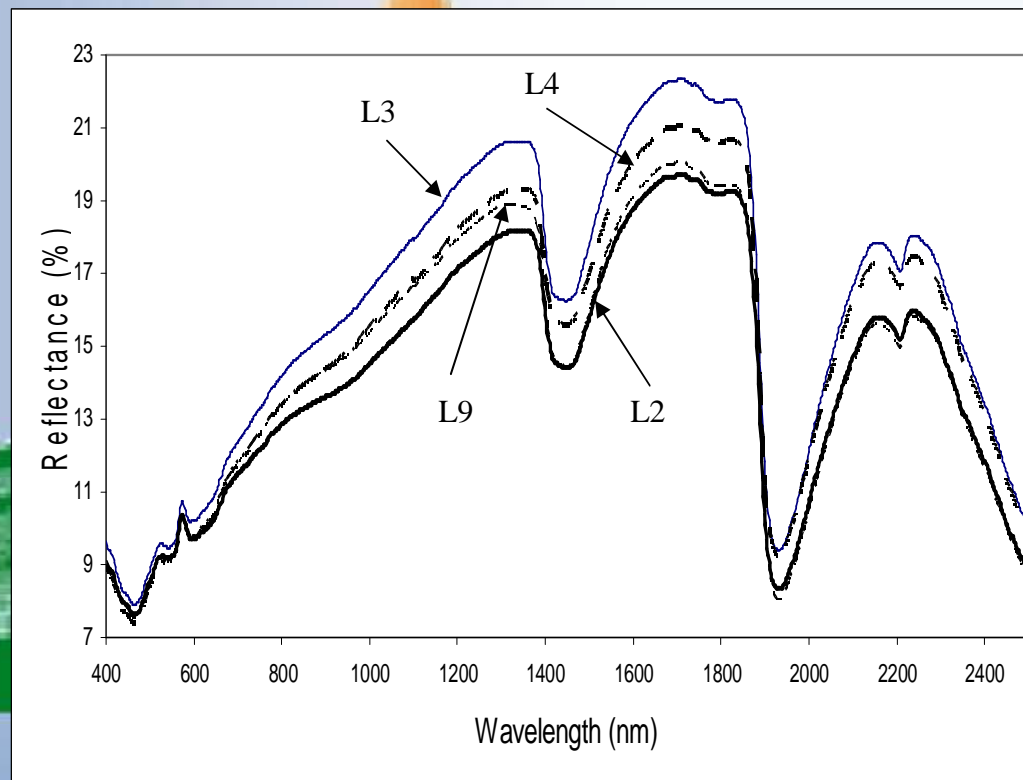
- Three hyperspectral measurements of the same soil surface.

- Good overlapping of the ASD and the CASI/SASI but in some expected regions of the spectrum

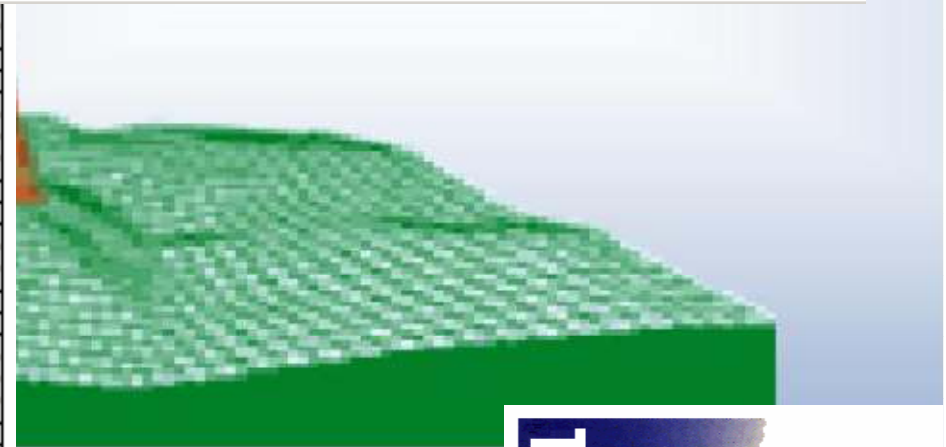
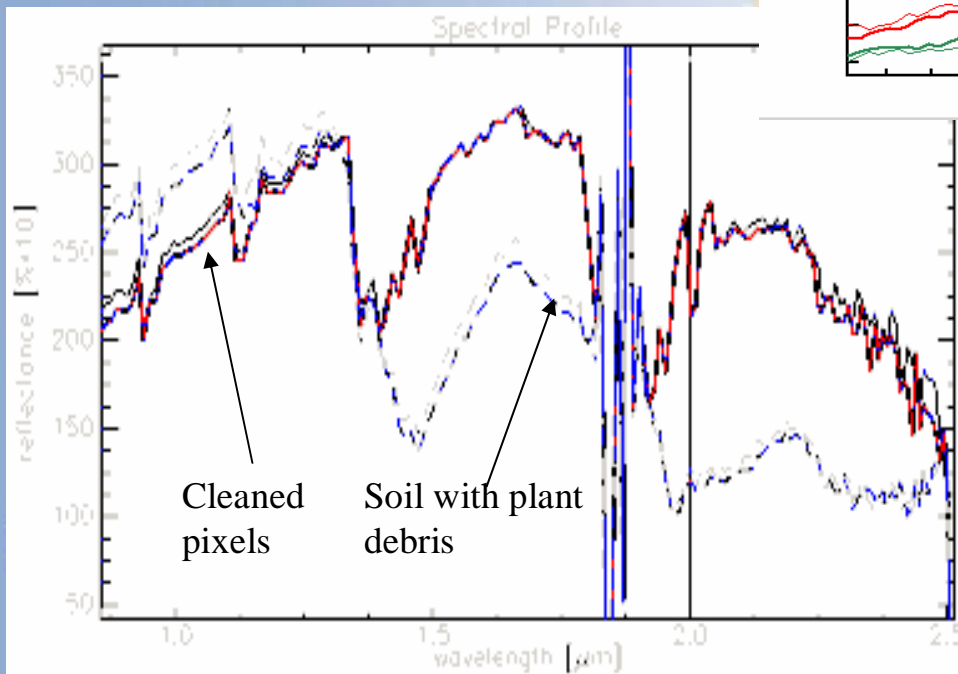
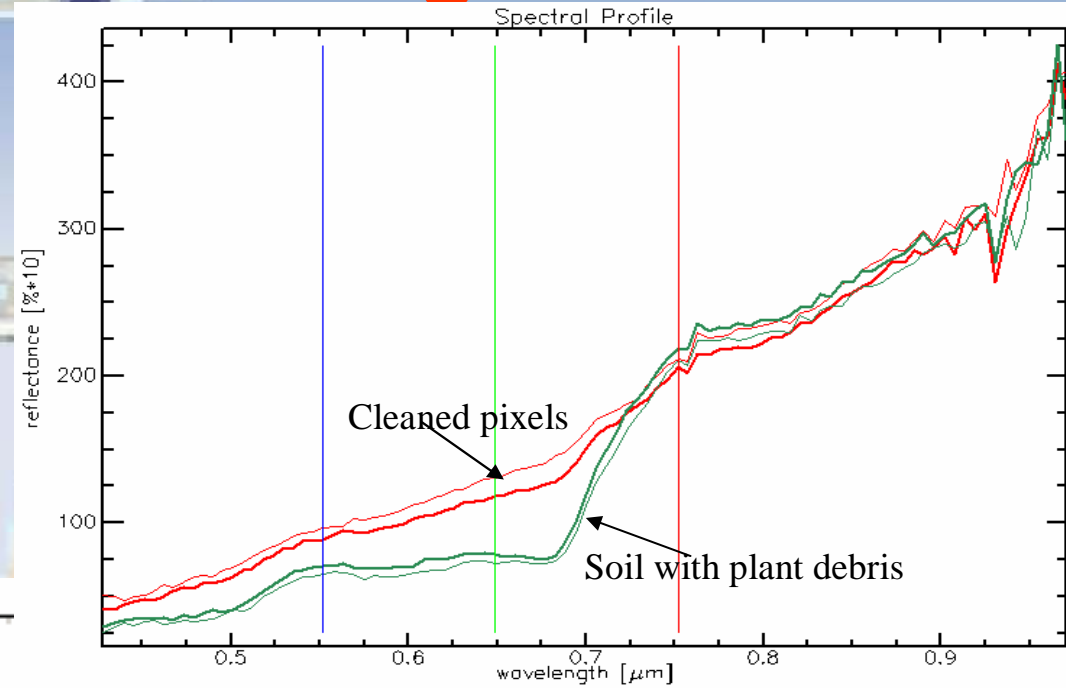
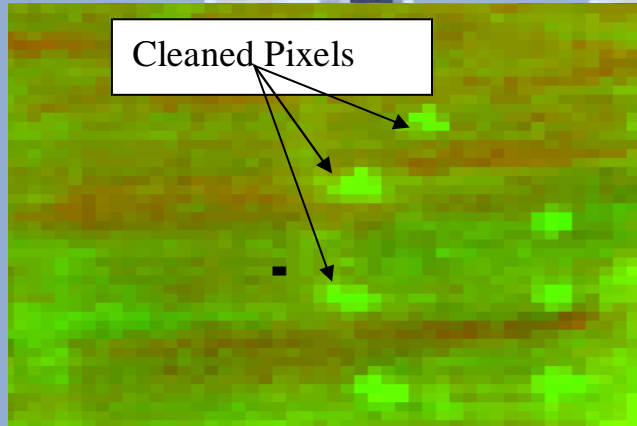
- large shift of the NIR spectrometry measurements in the laboratory (? Soil moisture)

Results : Disturbing Factors

Samples	SOM (%)	Moisture (%)
L3	3,20	14,4
L4	3,16	19,4
L9	3,16	20,0
L2	3,22	25,1



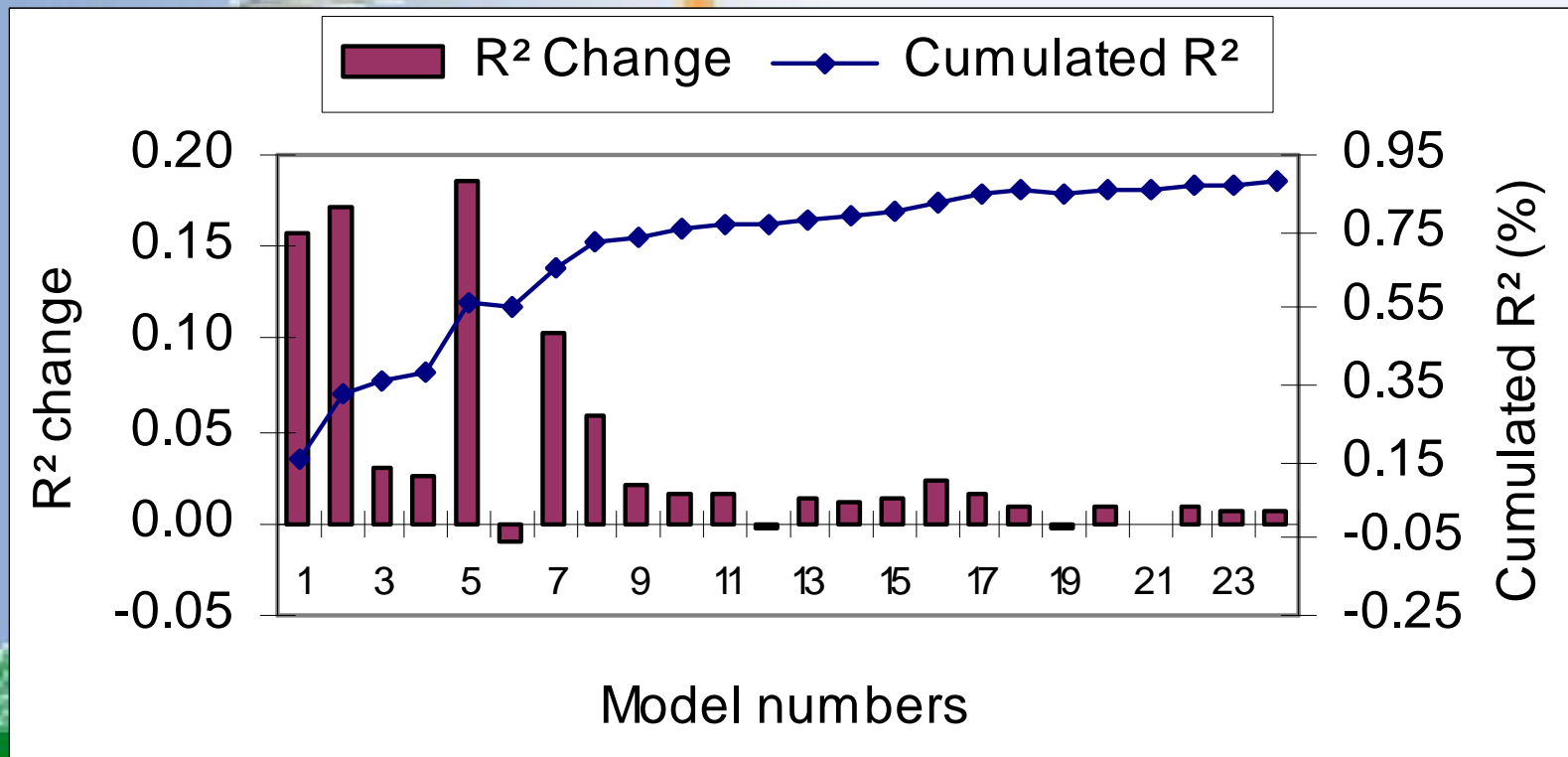
Results : Disturbing Factors



Results : Models analysis

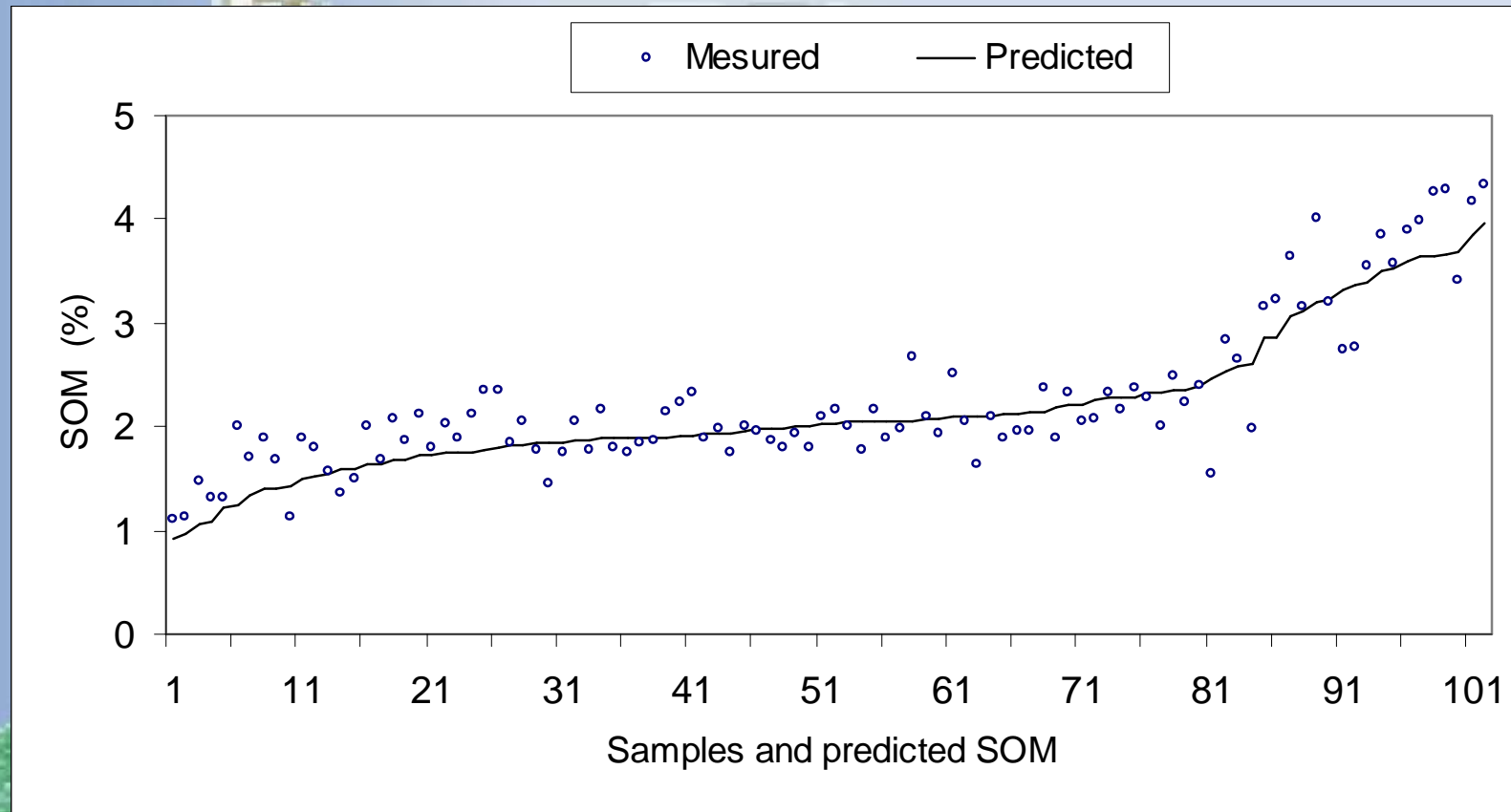
Calibration phase

$$V_p = A_0 + A_1 R_{\lambda_1} + A_2 R_{\lambda_2} + \dots A_n R_{\lambda_n}$$



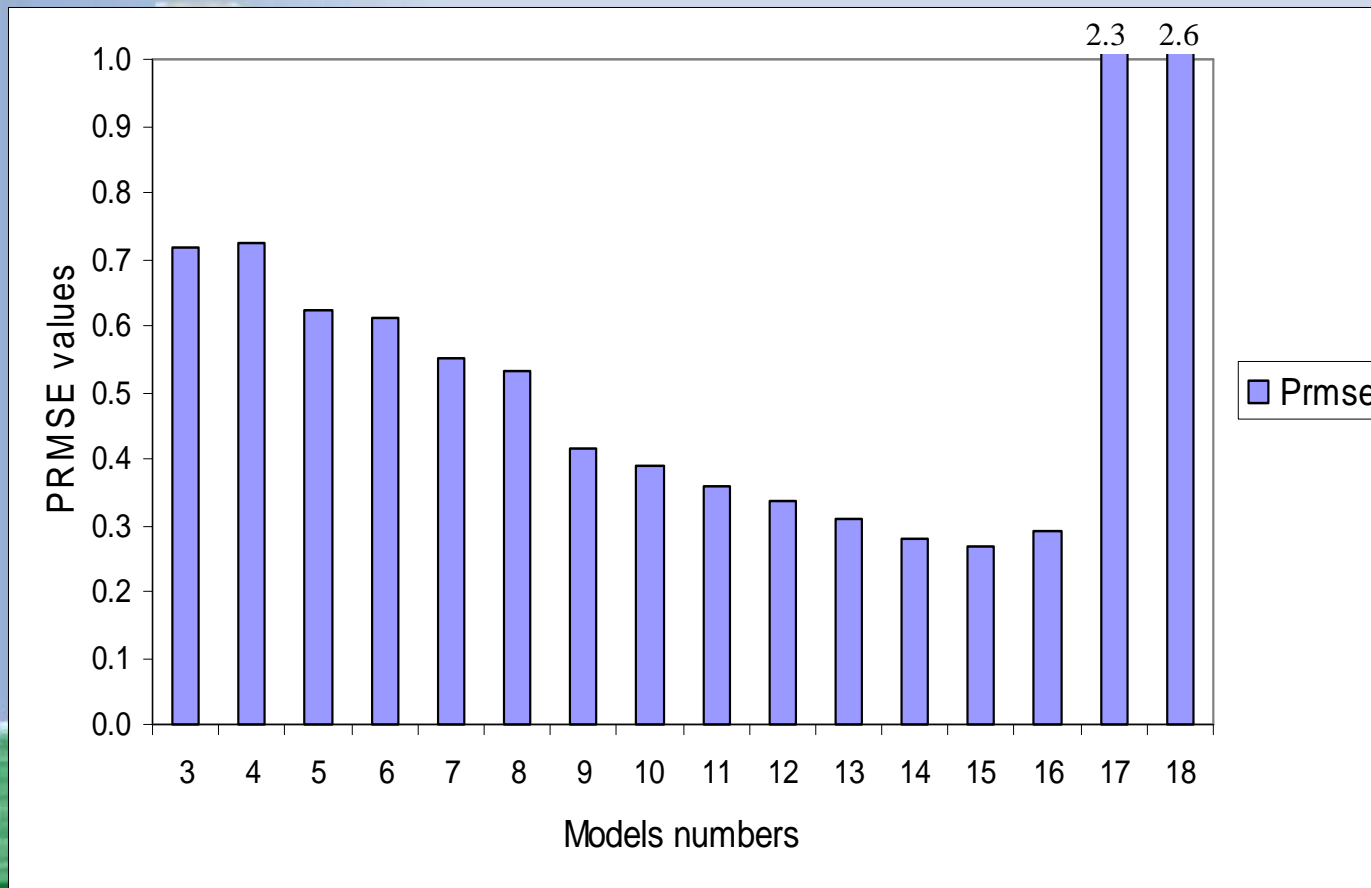
Results : SOM Models (CASI-2 + SASI)

Calibration phase



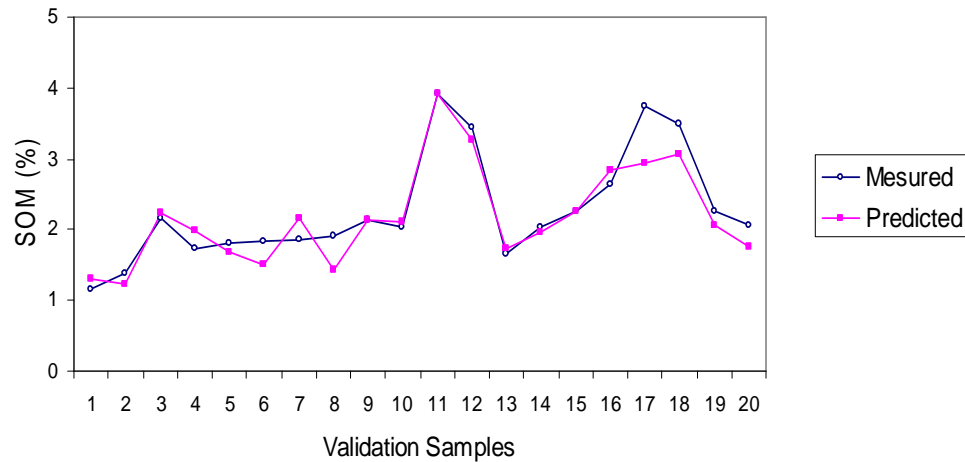
Results : SOM Models (CASI-2 + SASI)

Validation Phase



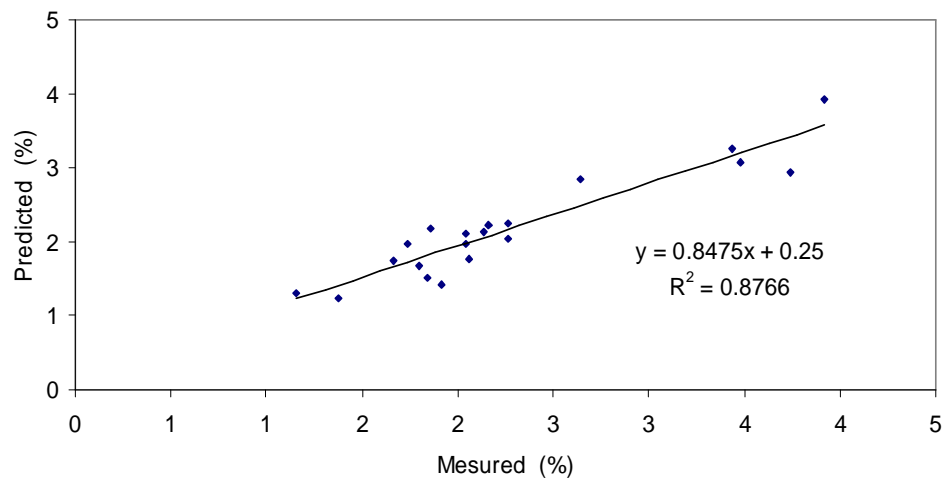
Results : SOM Models (CASI-2 + SASI)

(a)



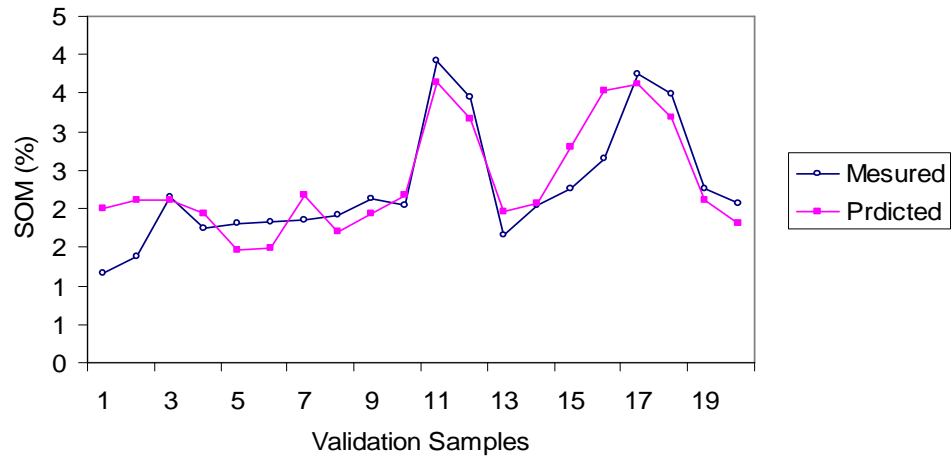
Validation Phase
CASI + SASI

(b)



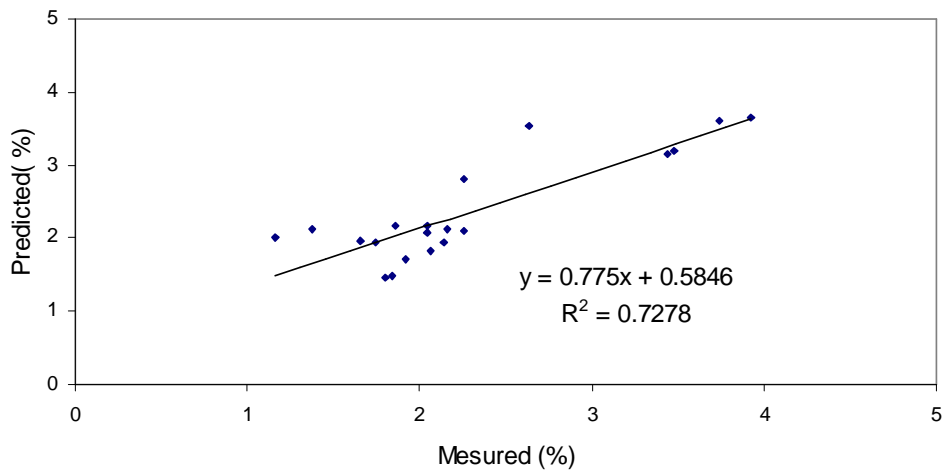
Results : SOM Models (CASI-2)

(a)

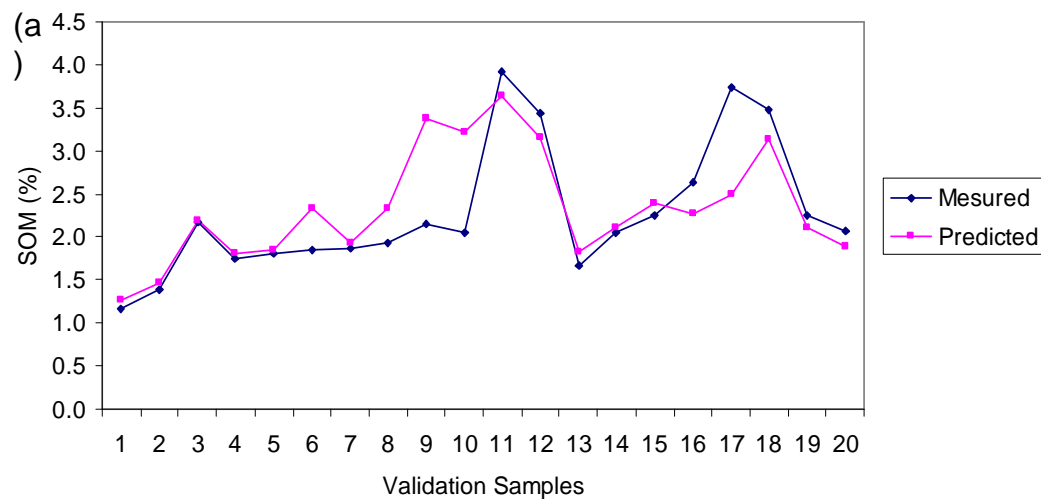


Validation Phase
CASI-2

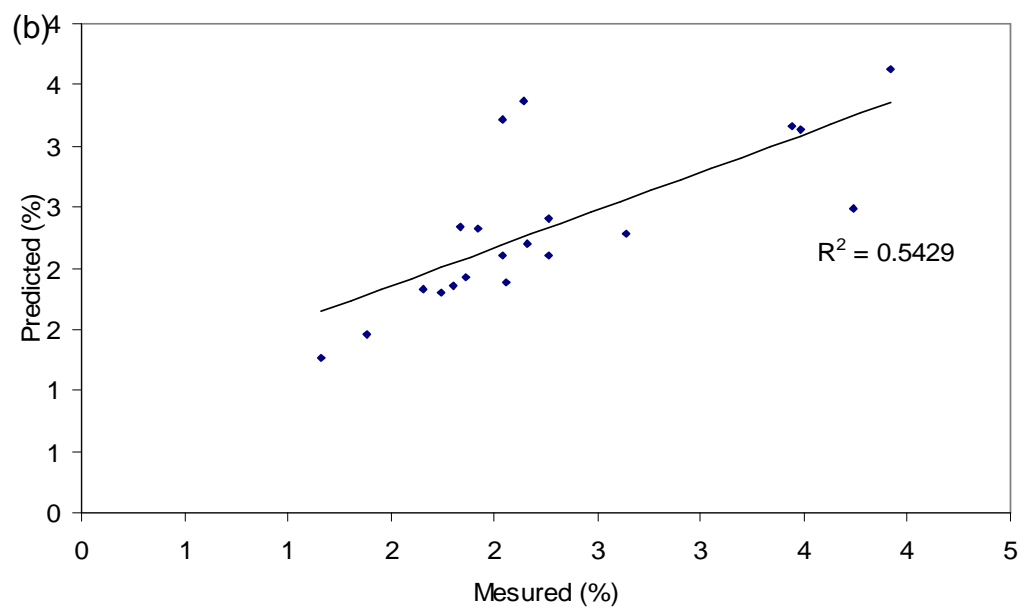
(b)



Results : SOM Models (SASI)



Validation Phase
SASI

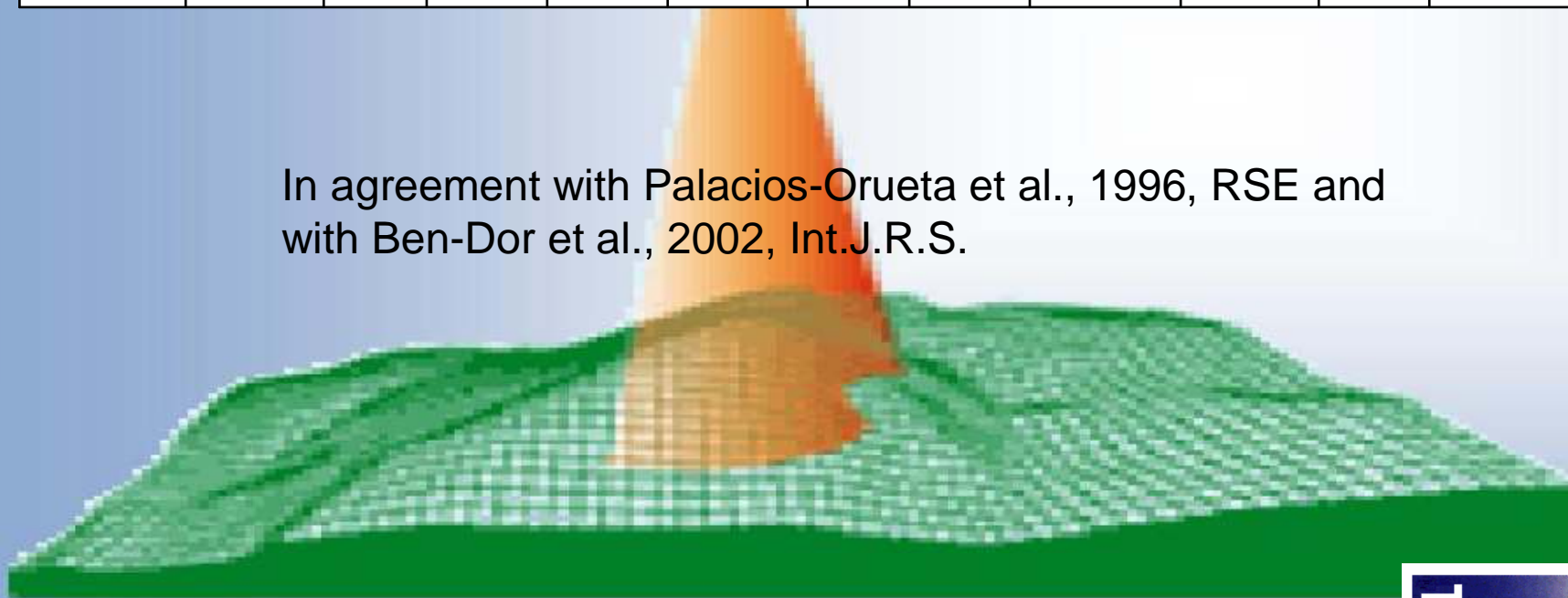


Results : Selected Bands



Order	1	2	3	4	5	6	7	8	9	10	11
λ (nm)	2010	690	520	722	1358	488	526	2104	1970	652	1433

In agreement with Palacios-Orueta et al., 1996, RSE and with Ben-Dor et al., 2002, Int.J.R.S.



Conclusions

- High correlation ($R^2 = 0.88$) between the surface soil organic matter and the selected bands of the two sensors;
- Selected bands are comparable to those found by other authors;
- Both sensors contribute to the model of SOM prediction but among the studied models, the 3 more sensible bands are often given by the SASI sensor;
- Disturbing factors (soil moisture, plant residues, roughness) affect dramatically the relationship between SOM and the selected bands.

Perspectives

- APEX 2002 : preliminary results
- High potential of the hyperspectral methodology for the study purpose
- Pursue the study with the APEX 2003 campaign
 - Extension to a new site for a better validation
 - Use of PCA as an alternative to the present approach
 - Quantify the impact of the disturbing factors