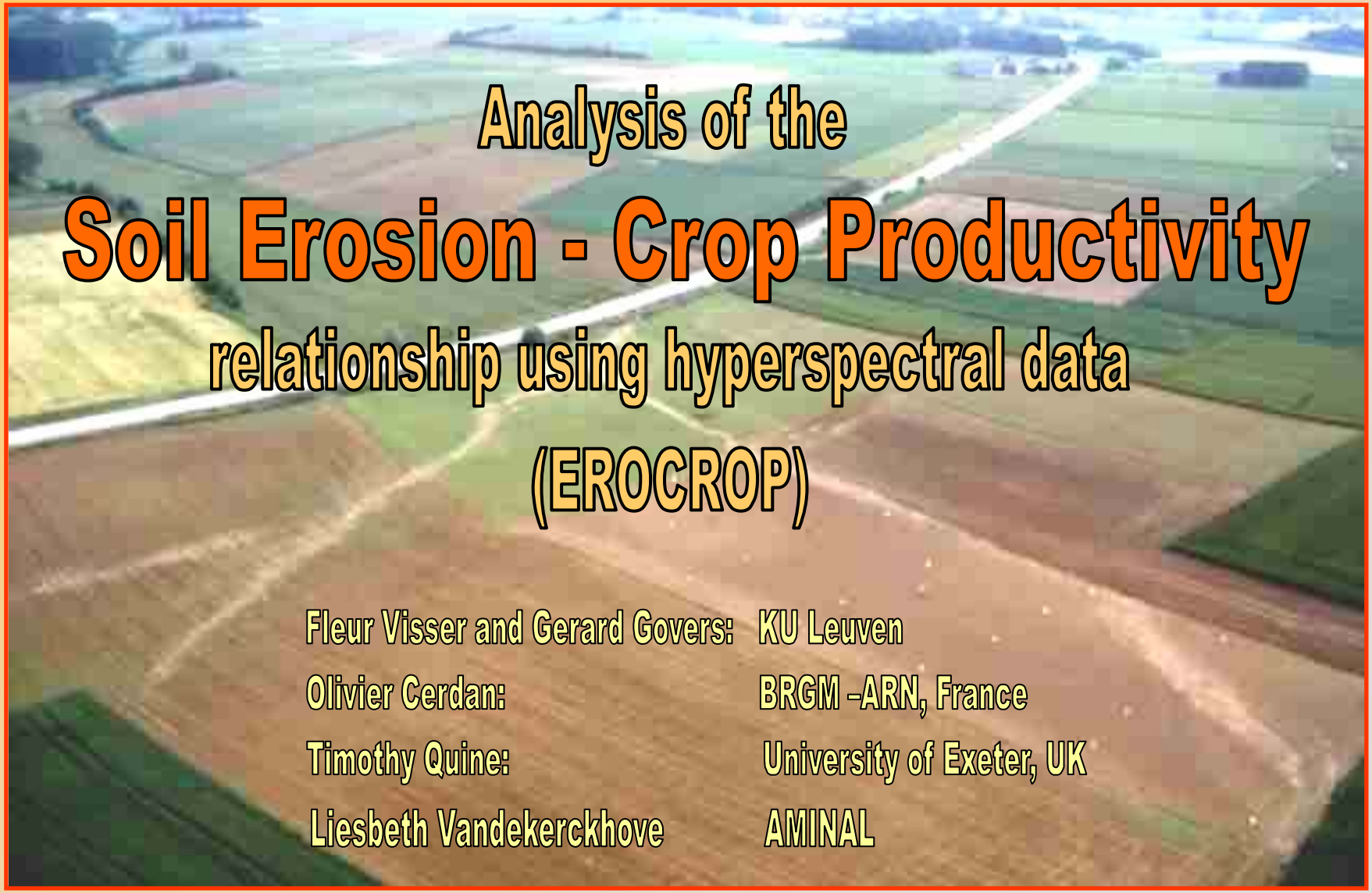


Analysis of the
Soil Erosion - Crop Productivity
relationship using hyperspectral data
(EROCROP)

Fleur Visser and Gerard Govers: KU Leuven

Olivier Cerdan: BRGM –ARN, France

Timothy Quine: University of Exeter, UK

Liesbeth Vandekerckhove AMINAL

Problem statement

Soil erosion ⇒ Soil properties

Soil properties ⇒ Crop response

Relationships are not well understood

Potentially affected soil properties:
Reduction of infiltration
Reduction of water-holding capacity
Nutrient composition
Organic matter content
Soil biota
Soil depth

Resulting plant stress:
Water stress
Nutrient stress

Measurement complicated due to confounding factors: slope, soil moisture

Problem statement

•Can we determine a relationship between soil erosion and crop response for the Belgian Loss Belt using hyperspectral data?

•Can hyperspectral data provide more clues on which, erosion related, factors affect crop growth?

•Is this information available at a regional scale?

Benefits:

•Improvement of soil conservation strategies

•Better soil suitability maps for high risk areas

Approach

1. Hymap image **acquisition** and field data collection for the Hageland region
2. Image **preparation**
3. **Correlation** of field data with single band reflectances and known vegetation indices
4. **Mapping** of crop response using the results of (3/4)
5. **Modelling** Soil erosion patterns with WaTEM/SEDEM
6. C**omparing** response maps with soil erosion patterns and topographic variables (slope, curvature)

Study area

The Hageland region

Data acquisition

HYMAP 2004 image data:

- 4 strips 6.5m resolution
- 126 bands (450-2500nm)
- Length: 7.5 km
- Swath width: 3330 m

Field data

Data collection planned in **wheat crop.** Due to a delay in image acquisition a **full grown maize crop** was sampled

DTM 5m resolution

Calculated from the VLM 1point/20m^2 elevation data using TIN interpolation

Field data (Maize and Soil)

Plant characteristics

- -Height
- -Cob number
- -Leaf number
- -Moisture content leaves

Soil characteristics

- -Texture
- -N-content (NH4+ and NO3-)
- -pH
- -Profile description

Cob characteristics

- -Weight
- -Moisture content

Top leafs

- -N% (Variomax)
- -C%
- -Moisture content

- •37 Sample sites
- •9 Fields
- •2-7 samples per field

Geometric corrections

Technical problems during over flight

⇒ GPS data missing for some scan lines

DLR images ⇒ UTM

DTM ⇒ Belgian Lambert

Conversion did not provide a correct result: errors >> m

Only solution ⇒ Warping images

-No warping of DTM to preserve topographic integrity

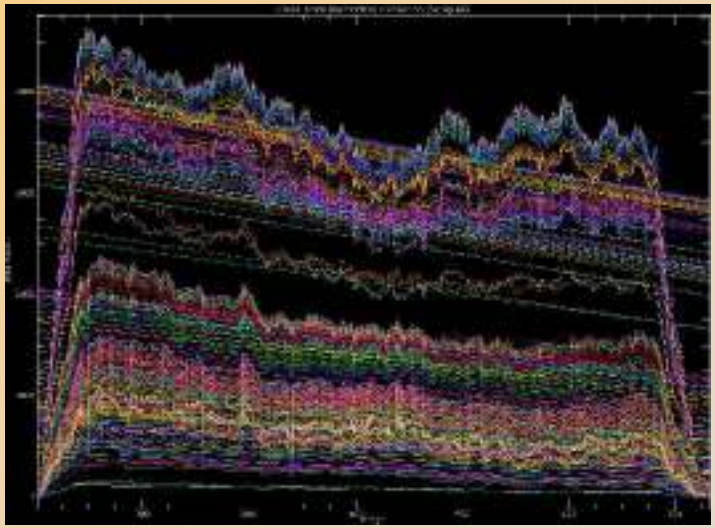
-Warping images after classification to preserve spectral integrity

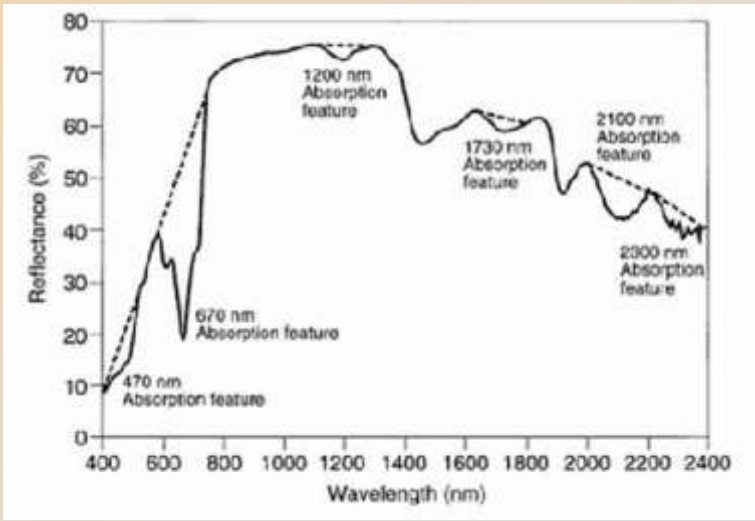
Warping RMS error: ± 1.0

Data preparation

Considerable variation in reflectance across the image

- Edges clipped
- Trend removed using ENVI's Cross Track Illumination Correction option
- 2nd data set created with continuum removed spectra





Mapping crop response

Correlation of field variables to identify covariance

Correlation of Image variables (bands and indices) with:
- All field data
- Individual fields (very few observations per field)

Image variables:
- Single band reflectance
- MNF bands
- Continuum removed spectra
- Red-edge-index
- NDVI / SAVI
- 605/760
- 695/420
- 695/760
- 710/760…

Mapping crop response using significant variables

Mapping soil erosion with WaTEM/SEDEM

Input requirements:

- DEM
- Parcel map
  - Forest
  - Pasture
  - Roads and built-up area
  - Arable land

Classification procedure:

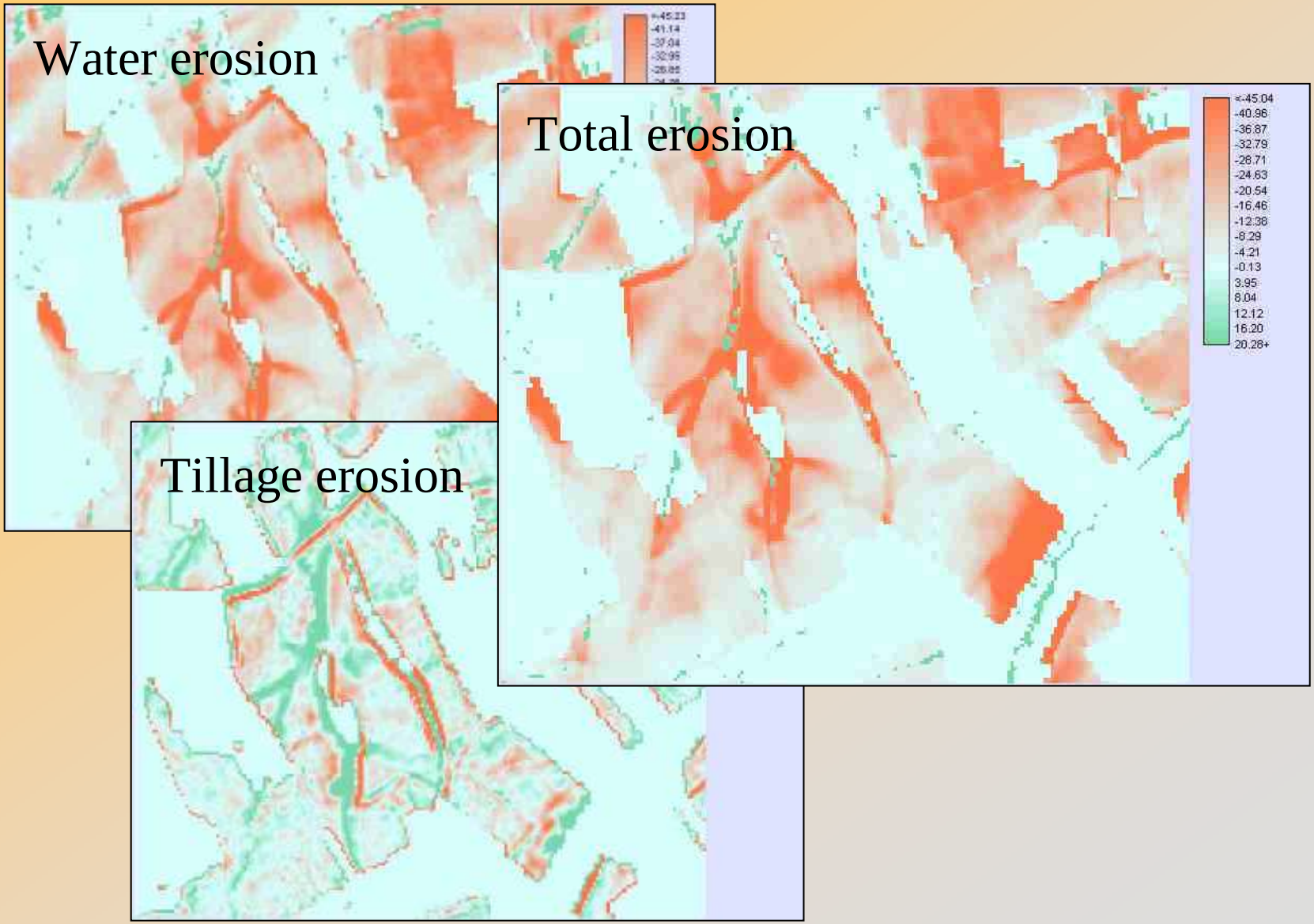
- MNF
- ROI created from locantions with known cover
- SAM

Post classification:

- Changing treshold value in rule image classifier tool
- Clump

Mapping soil erosion with WaTEM/SEDEM

WaTEM/SEDEM Results



Comparing patterns…

(RGB of first 3 MNF-bands)

(Total erosion)

Analysis steps

Correlation of crop response maps and image variables with the modeling results and topographic variables:

- Slope
- Aspect
- Minimum curvature
- Maximum curvature

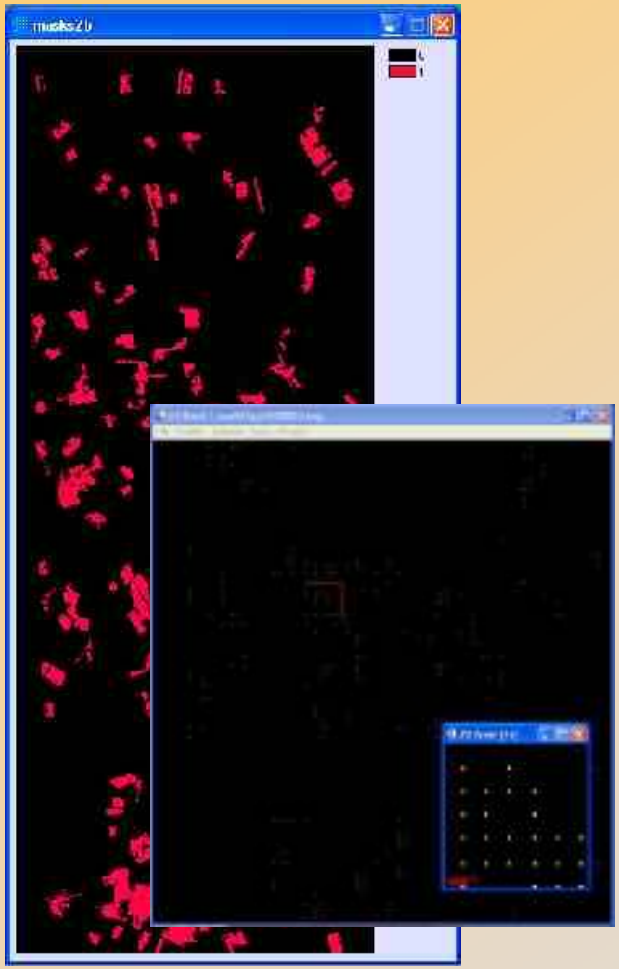
Two scales:

- Grid covering all maize fields
- Grid covering four of the sampled fields.

- ‘Normalization’ of the response maps, using averages per field.

Analysis steps

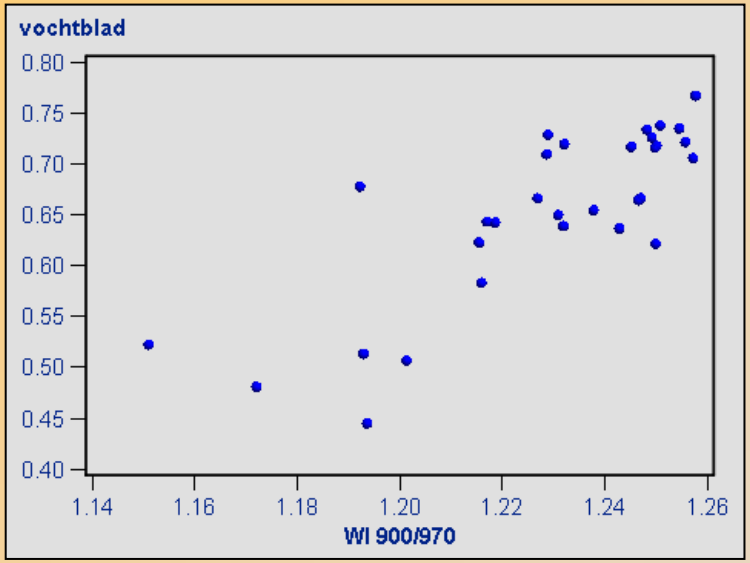
(2000 point grid covering all maize fields)

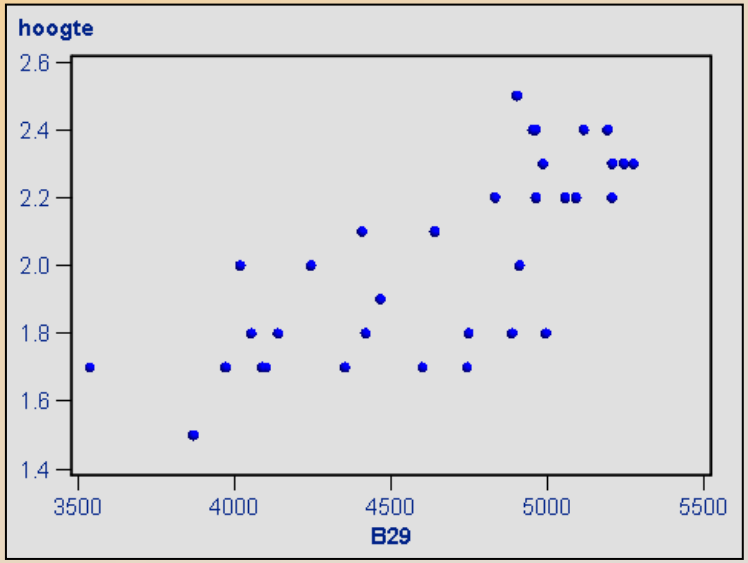


(200 point grid covering 4 fields)

Results

Data individual fields strongly affected by outliers





Leaf moisture - WI 900/970

0.80457

<.0001

n=31

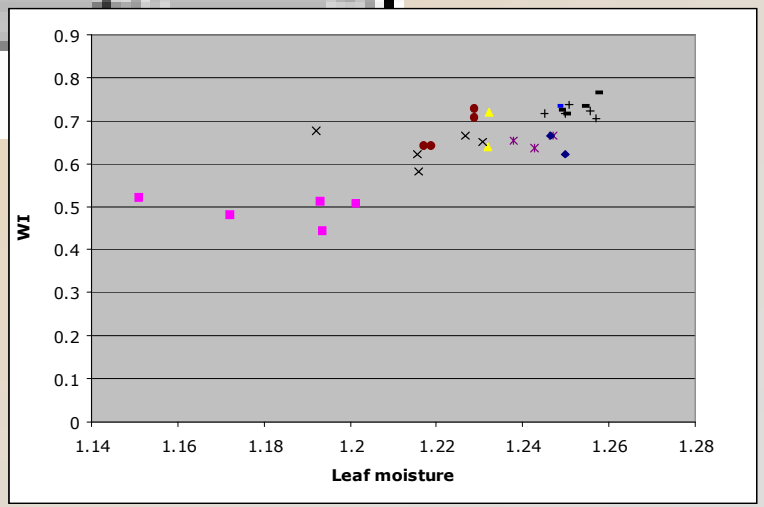
Height - B28

0.73862

<.0001

n=34

Results

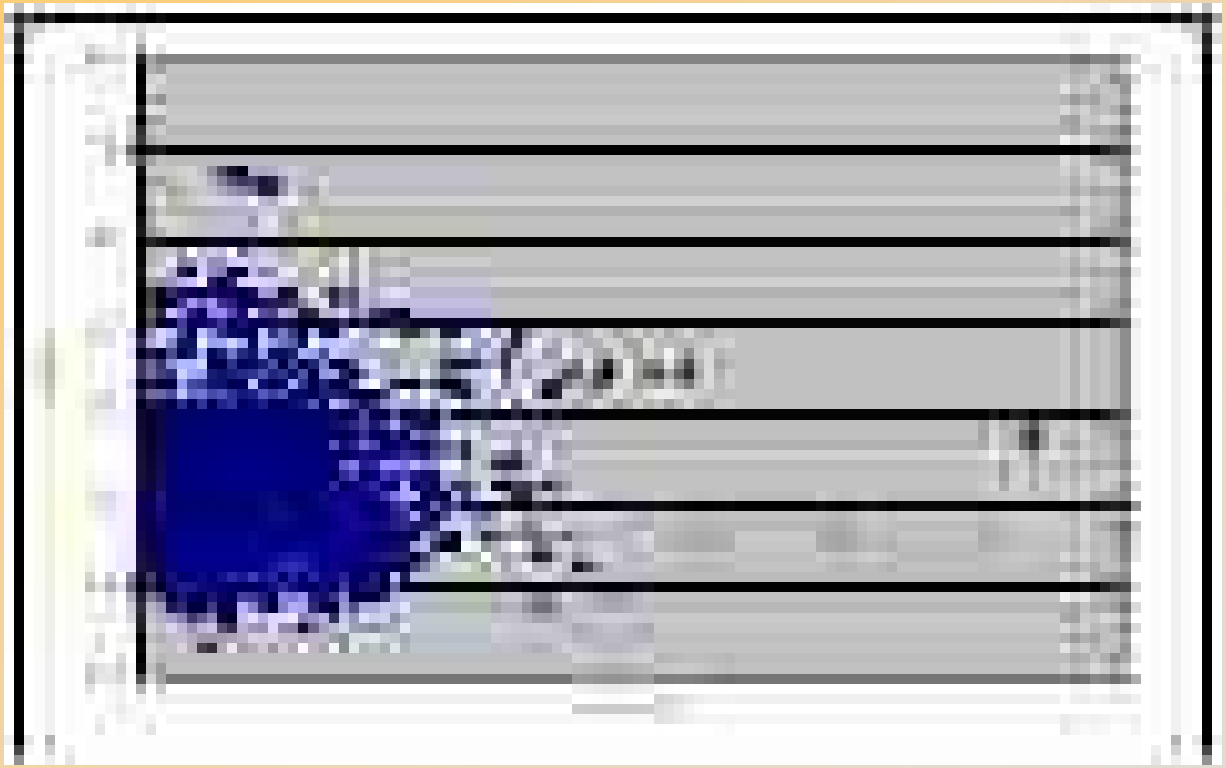


High correlations for all data as a result of crop variation between fields

Results

No relationships with soil erosion observed…

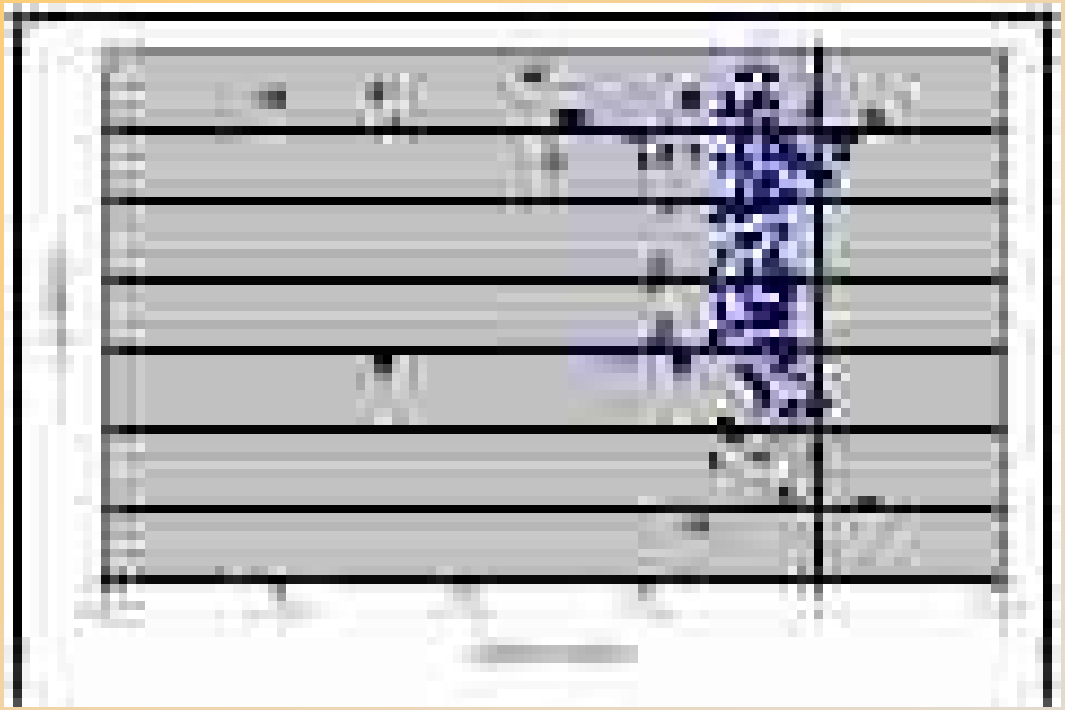
Results



…Or topographic variables

For both 200 and 2000 point grids

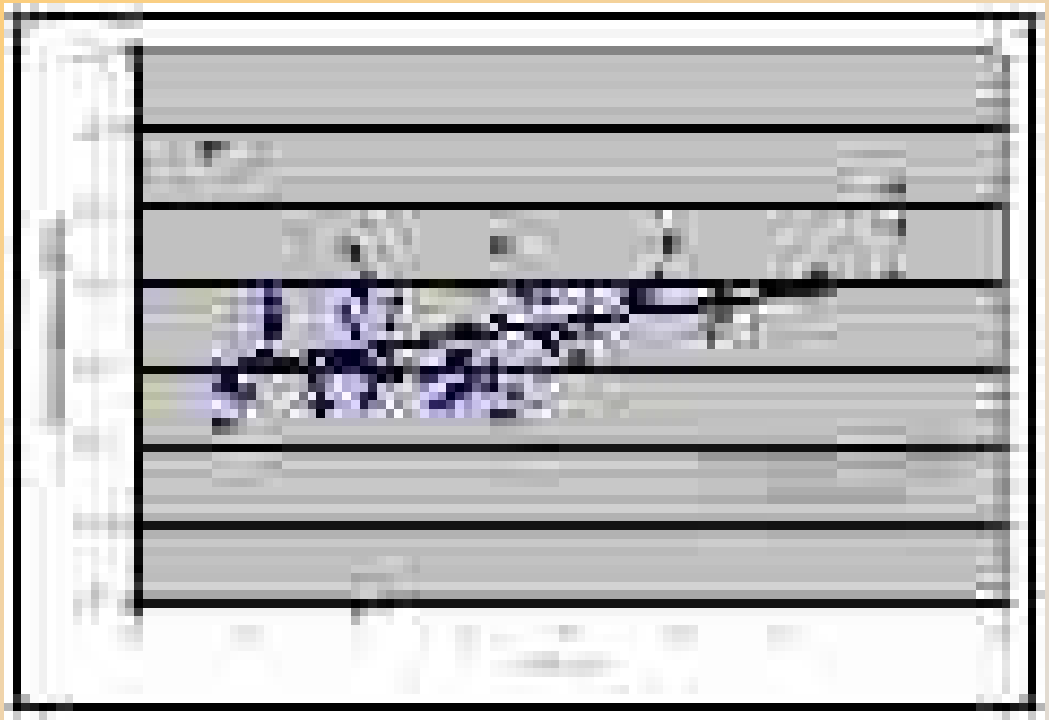
Results



Alternatively data was analysed per field and for 4 fields with ‘normalized’ data, but this did not improve the results

Results

The best we got so far:



Further analysis methods (e.g. path analysis) have not been attempted (yet)

Final comments/questions:

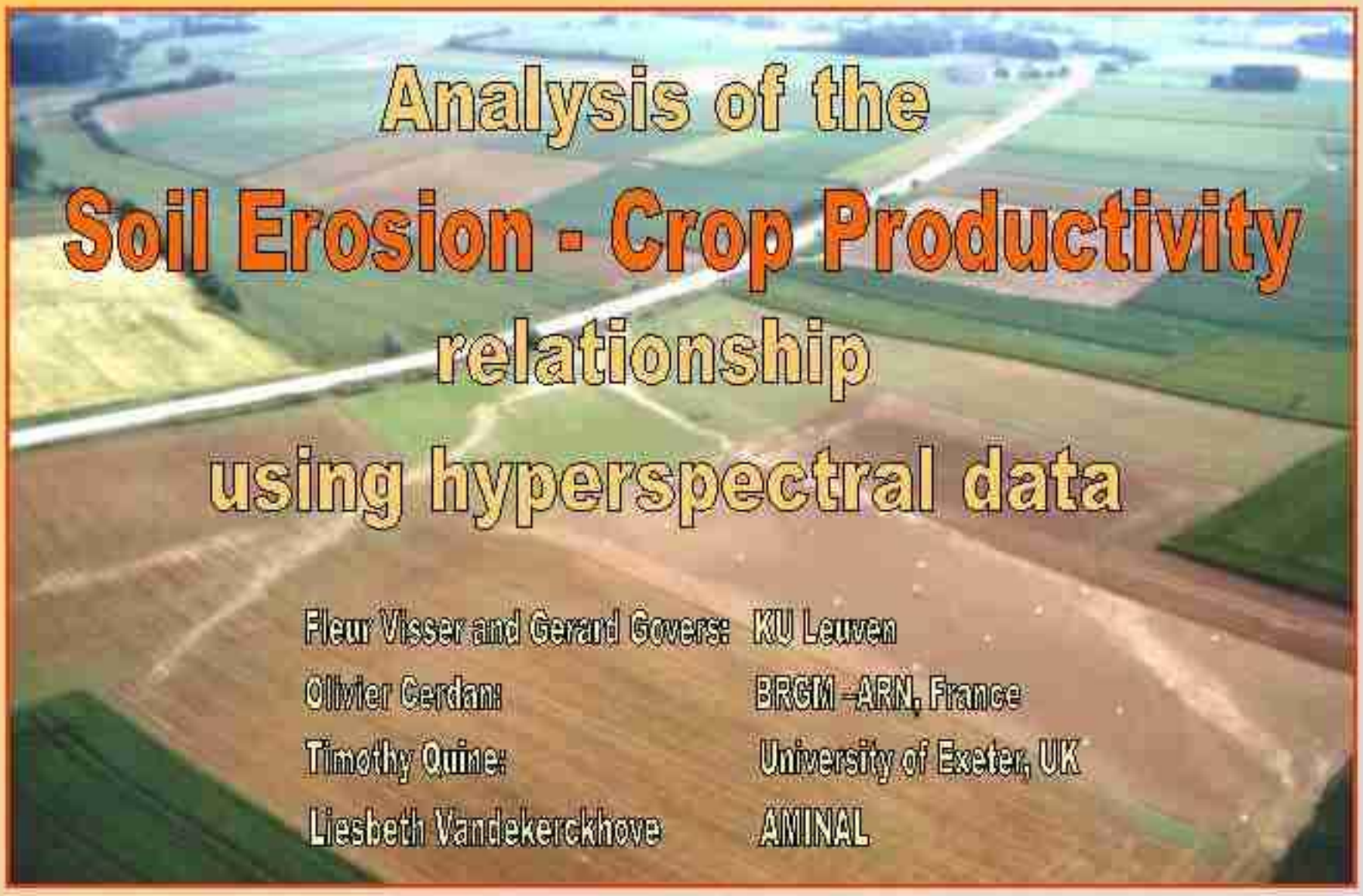
- We have so far not succeeded in clarifying the soil erosion – crop response relationship for the Hageland area
- Identifying reliable crop response indicators from our own data was difficult, particularly since we were relying on natural variation only
- Most reflectance indices are also an integration of various crop variables, which makes it as yet difficult to use them for identifying specific erosion effects
- To map relative response on a regional scale at least detailed information on reflectance of different maize types is required

Final comments/questions:

Suggestions for improvements of this research:

- Images taken earlier in the season
- Different crop type
- Include phosphorus analysis
- Include controlled plots with controlled fertilizer/water applications in the study area


Many thanks to:
•BELSPO for financing the Hymap project
•Our project partners for their advice
The End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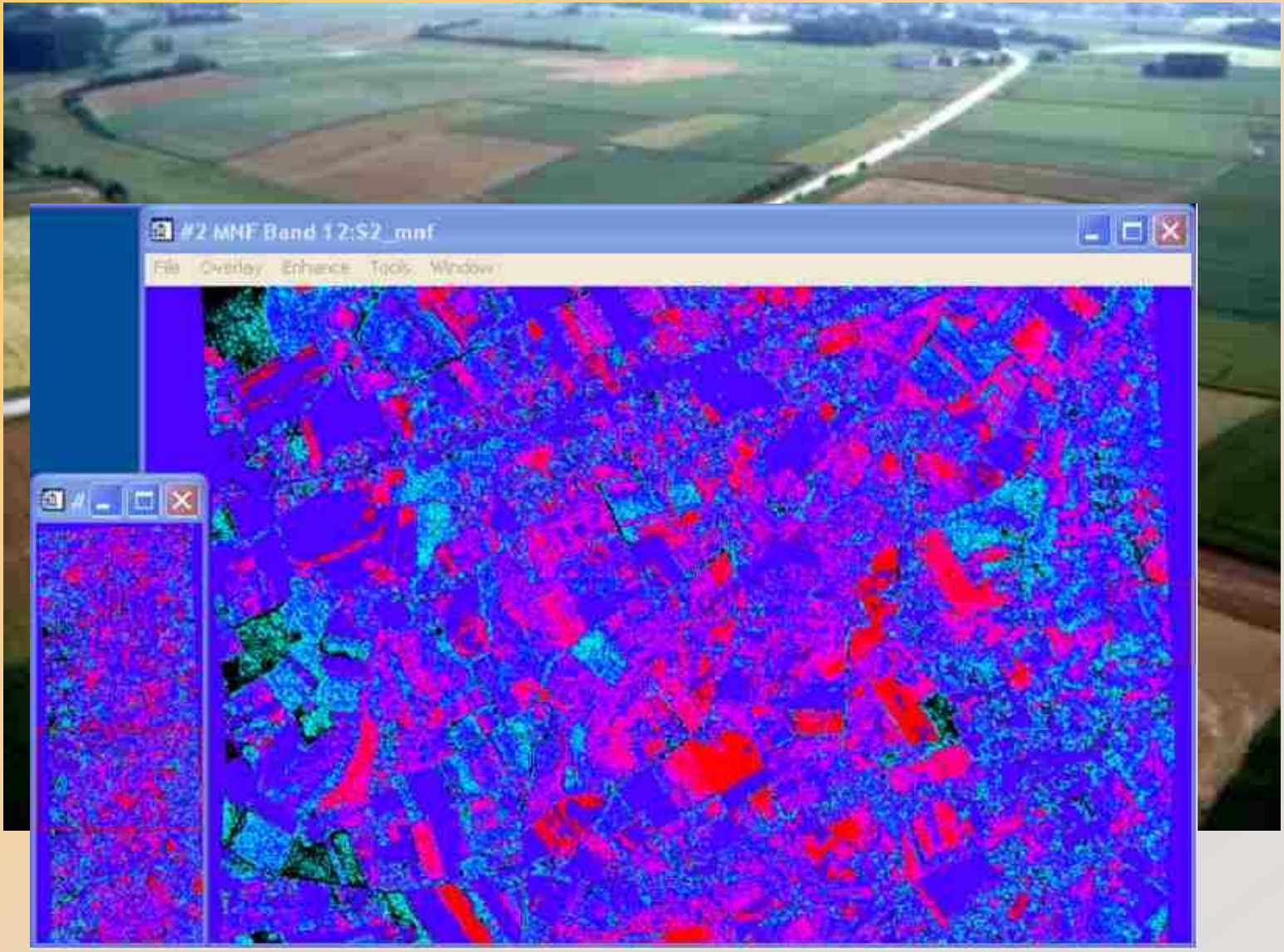
#2 MNF Band 12:S2_mnf
File
Overlay
Enhance
Tools
Window