



# CASI-SWIR WORKSHOP

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## Hyperspectral textural parameters and LAI from remote sensing images

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# RESEARCH GOAL

LAI

Extraction of Leaf Area Index (LAI) from remote sensing imagery of forests

## Why LAI?

LAI: half the total leaf area per unit ground surface

- Quantitative measure of canopy structure
- Leaf surface is primary interface for matter and energy exchange
- Plays prominent role in ecosystem modeling applications



# RESEARCH GOAL

LAI

Problem	3D clumping of forest structure
Solution	Texture of images

## This research

Texture parameters from hyperspectral images and relation to ground parameters of forest stands (as LAI)



# STUDY AREA

Pijnven

Pijnven	
Location	Hechtel Eksel, Limburg, Belgium
Stands	-Homogeneous stands -Different age -Different managing techniques
Species	-Scots pine ( <i>Pinus sylvestris</i> ) -Corsican pine ( <i>Pinus nigra</i> )





# AIRBORNE CASI IMAGERY

CASI

4 flight lines

Oriented in N-S direction

Acquisition time : 17h00 (orig.  $\pm 13h00$ )

Elevation aircraft	1500 m
Speed aircraft	185 km/h
resolution	2,44 x 2,44 m <sup>2</sup>
96 Spectral bands	400 – 950 nm



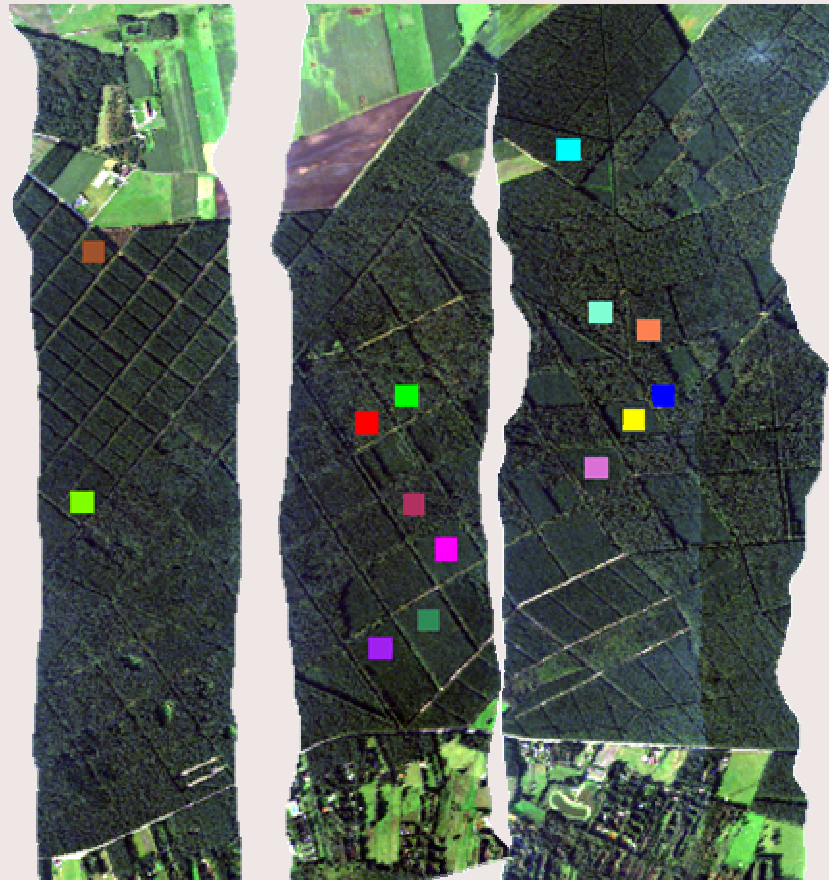




# FIELD MEASUREMENTS

Field measurements

14 plots selected, to cover a wide range of:



- Density
- Tree height
- LAI



3 km





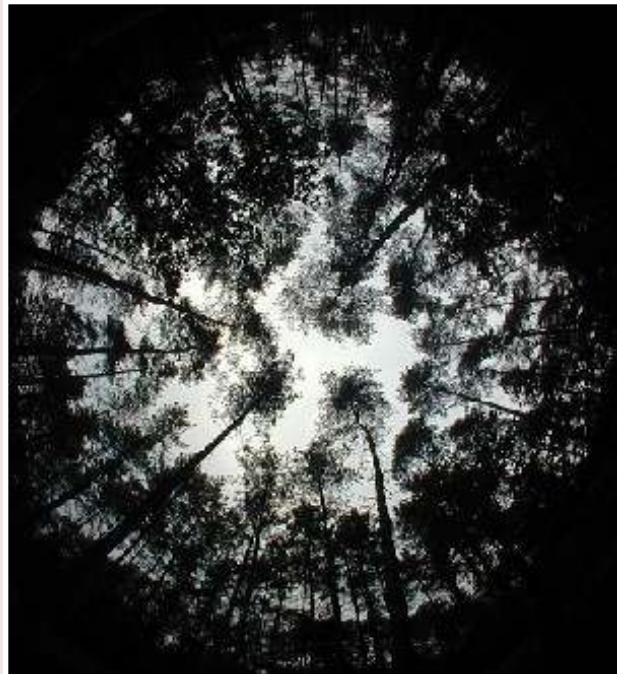
# HEMISPHERICAL PHOTOGRAPHY

## Field measurements

Digital camera + fish-eye lens

16 measurements per plot

8 parameters extracted



Gap fraction ring 1

Gap fraction ring 2

Gap fraction ring 3

Gap fraction ring 4

Gap fraction ring 5

LAI using 4 rings

LAI using 5 rings

Fractal dimension



# TEXTURE PROCESSING

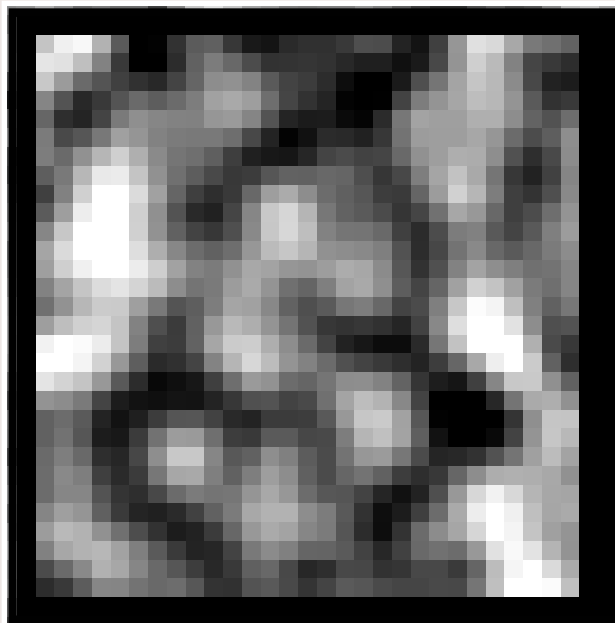
Digital image data

14 plots

Subsets of 32 x 32 pixels (64 x 64 m<sup>2</sup>)

For all 96 channels:

Grey level co-occurrence matrix  
8 Haralick parameters :



Mean

Variance

Homogeneity

Contrast

Dissimilarity

Entropy

Second moment

correlation

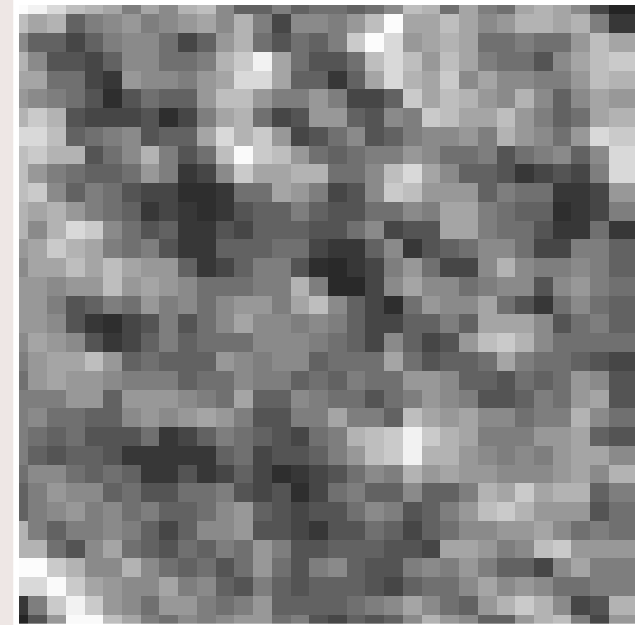
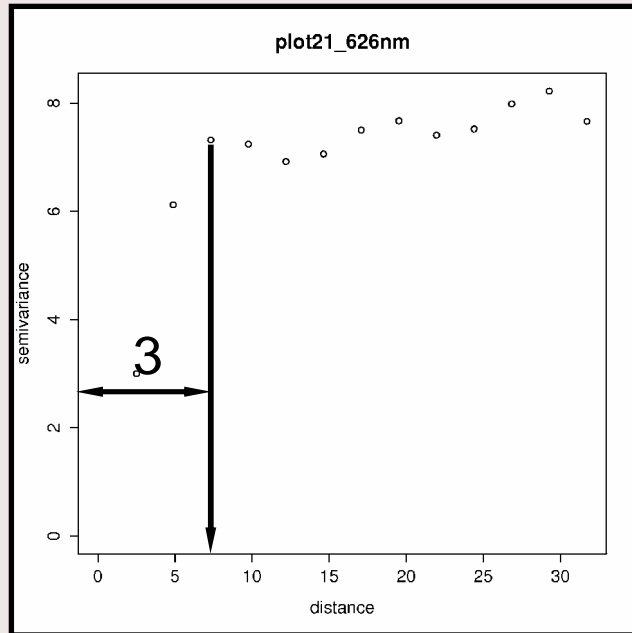




# TEXTURE PROCESSING

Digital image data

Haralick parameter window size  
Semi-variogram



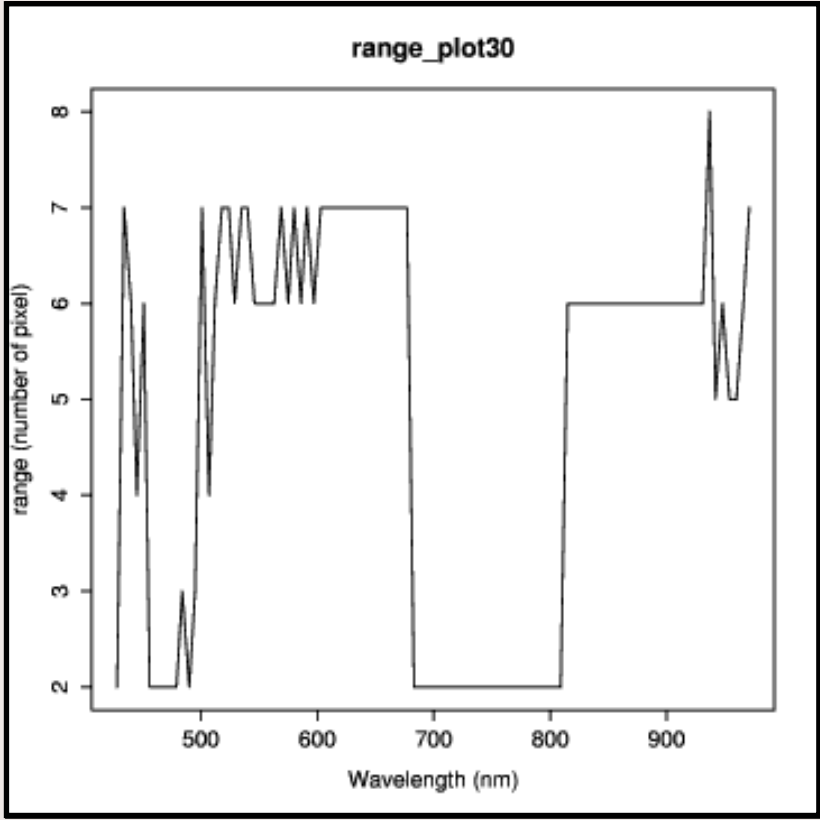


# TEXTURE PROCESSING

Digital image data

Window size changes with	-Plot
	-Wavelength

Textural parameters calculated for :		
3x3	5x5	7x7

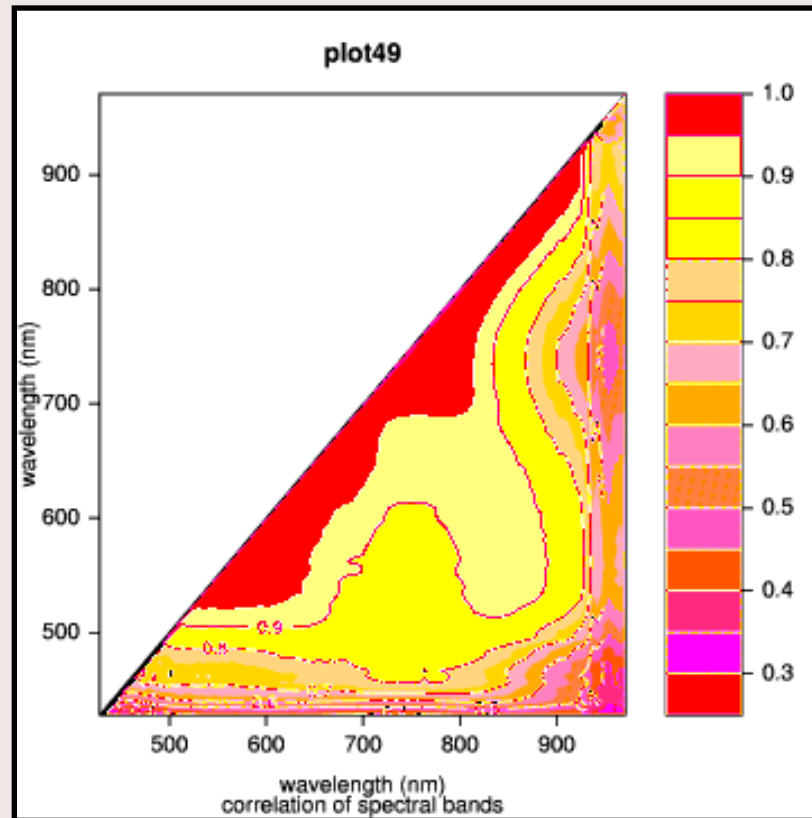




# STATISTICAL ANALYSIS

Statistics

Correlation between 96 spectral channels

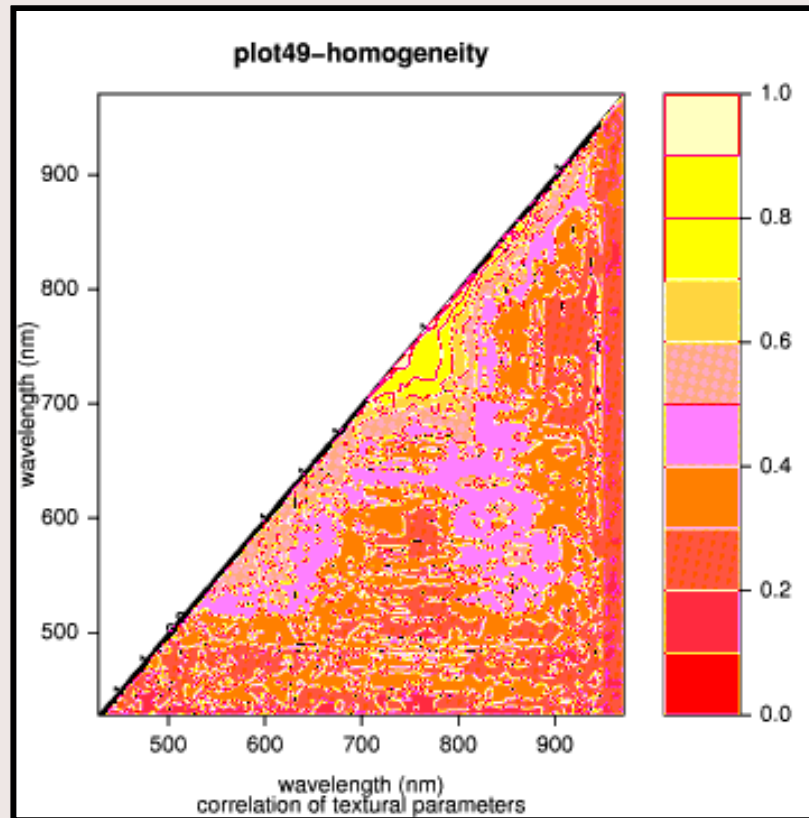




# STATISTICAL ANALYSIS

Statistics

## Correlation of Haralick parameters





# STATISTICAL ANALYSIS

## Statistics

- 8 ground parameters
- 8 remote sensing parameters
- 64 combinations (x 4) (x96)

	GROUND
1	Gap fraction ring1
2	Gap fraction ring2
3	Gap fraction ring3
4	Gap fraction ring4
5	Gap fraction ring5
6	LAI from 4 rings
7	LAI from 5 rings
8	Gap fraction

	CASI IMAGE
1	Mean
2	Variance
3	Homogeneity
4	Contrast
5	Dissimilarity
6	Entropy
7	Second moment
8	correlation

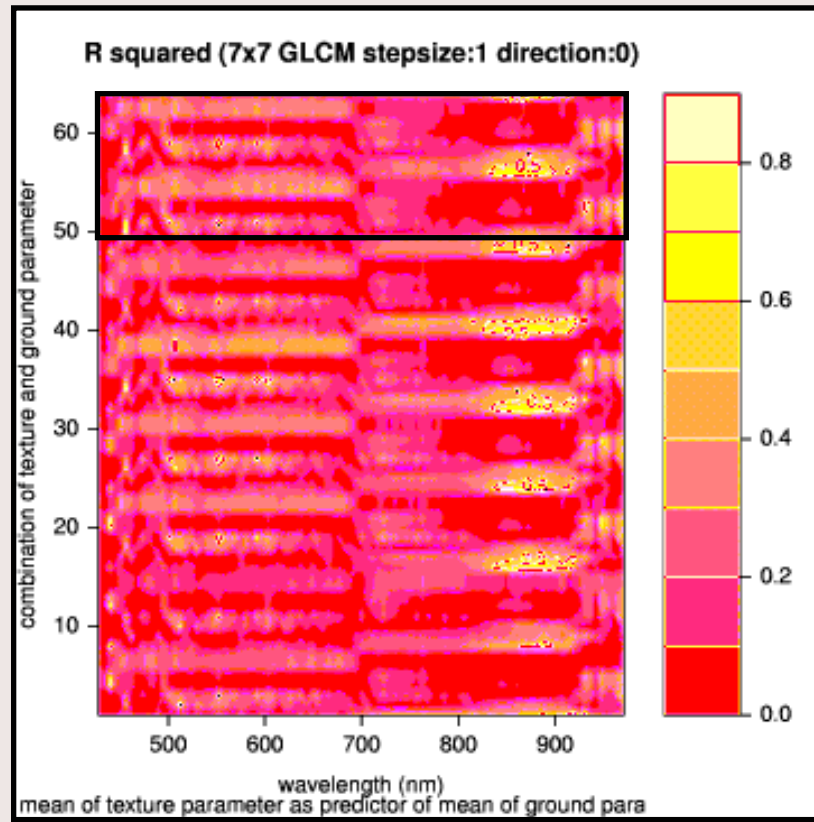




# STATISTICAL ANALYSIS

Statistics

Linear regression model – R squared



Texture parameter  
2nd moment  
Ground parameter  
LAI



# FIRST CONCLUSIONS

## Conclusions

### Which texture parameters to use to predict LAI?

Best fit for Gap fractions estimation with entropy and dissimilarity

For LAI itself...less correlation... model used to calculate LAI from gap fraction???

### More investigation needed

- Which channels to use
- Semi-variogram
- Validation of prediction model

THANK YOU