Assessing a river floodplain status using airborne imaging spectrometer data and ground validation – the HyEco'04 project

L. Kooistra, O. Batelaan, J. Clevers, K. Sykora, L. Bertels, J. Bogaert, J. Holtland, W. Debruyn, M. Schaepman, H. van Dobben, W. Wamelink

WAGENINGEN UNIVERSITY
WAGENINGEN UR

Centre for Geo-information

Contents

- Introduction
- Material and methods
  - Test site Millingerwaard
  - Imaging spectrometer data HyMap
  - Ground measurements
- Results
  - Classification of vegetation types
  - Analysis of soil moisture gradients
  - Deriving LAI for softwood forest stands
  - Comparison of IS and model derived NPP and biomass
  - Using RTF-models to derive vegetation species maps
- Conclusions

Multifunctional use of river floodplains

Possibilities for RS in river management

Monitoring

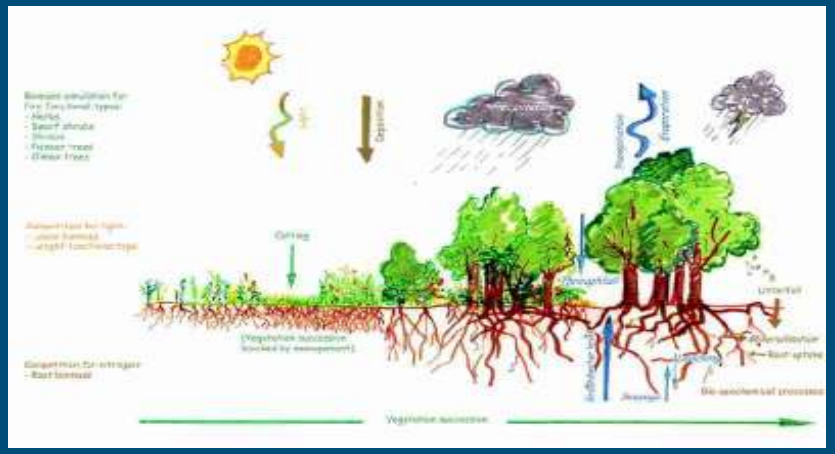
- Actual situation
- Land-use, natural succession
- Robust method
- Qualitative: e.g., vegetation types

Millingerwaard (the Netherlands)

CASI (2001)

HyMap (2004)

AHS (2005)



Modelling

- future developments and processes
- Input for calibration, initialization, validation
- More quantitative: biomass, LAI, N
- Example: SMART-SUMO: natural succession

Objectives of HyEco'04 project

- explore the use of hyperspectral sensors to retrieve biochemical and biophysical variables as input for ecological models
- combination of expertise* to assess biodiversity on an explicit spatially distributed scale (thematic groups)

* ecological modeling, quantitative imaging spectroscopy, hydrology, habitat fragmentation, vegetation succession mapping and assessment of the spatial integrity of landscapes

Test site Millingerwaard

Dauco-Melilotion

Artemisio-Salicetum
Agrostiestosum stoloniferae

Different succession stages

Bromo inermis-Eryngietum campestris

Echio-Melilotetum typicum

Natural management by grazing

WAGENINGEN UNIVERSITY
WAGENINGEN UR

Centre for Geo-information

Imaging spectrometer data HyMap

July 28th, 2004
13:38 hrs

strip 1

strip 2

Aug 2nd, 2004
10:30 hrs

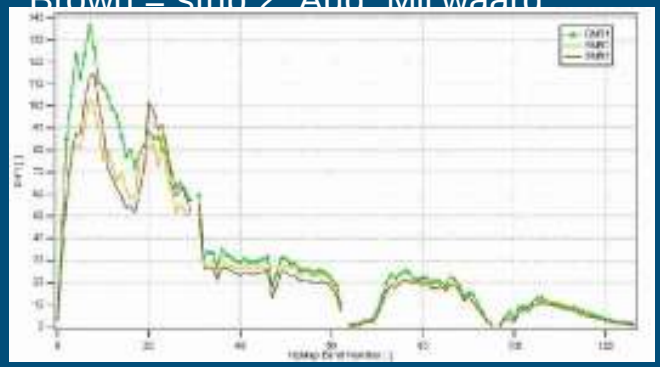
strip 1

strip 2

images geo-atmospherically corrected: PARGE & ATCOR4 (DLR & VITO)

Image based signal to noise ratio

Green = strip 1, July, Mil'waard
Yellow = Aug, Wageningen
Brown = strip 2, Aug, Mil'waard



WAGENINGEN UNIVERSITY
WAGENINGEN UR

Centre for Geo-information

Ground measurements

	Instrument	# locations	date	variables
atmospheric conditions	sunphotometer	1	2/8 2004	aerosol optical thickness
radiometric correction	Fieldspec FR	19 (5x5 m)	28/7 and 2/8 2004	VNIR spectra (sand, clay, asphalt, water)
radiometric vegetation	Fieldspec FR	21 (5x5 m)	28/7 2004	top-of-canopy and leaf spectra (VNIR)
vegetation description	Braun-Blanquet method	21 (2x2 m)	13-16/8 2004	structure, species composition
sampling vegetation	lab analysis	21 (0.5x0.5 m)	13-16/8 2004	biomass, N and P concentration
canopy structure	hemispherical camera	13 (20x20 m)	28/7 – 6/8 2004	LAI, gap fraction
surface characteristics	theta probe, temperature gun	86	28/7 2004	Soil moisture and temperature

Results (VITO): Classification of vegetation types

Method

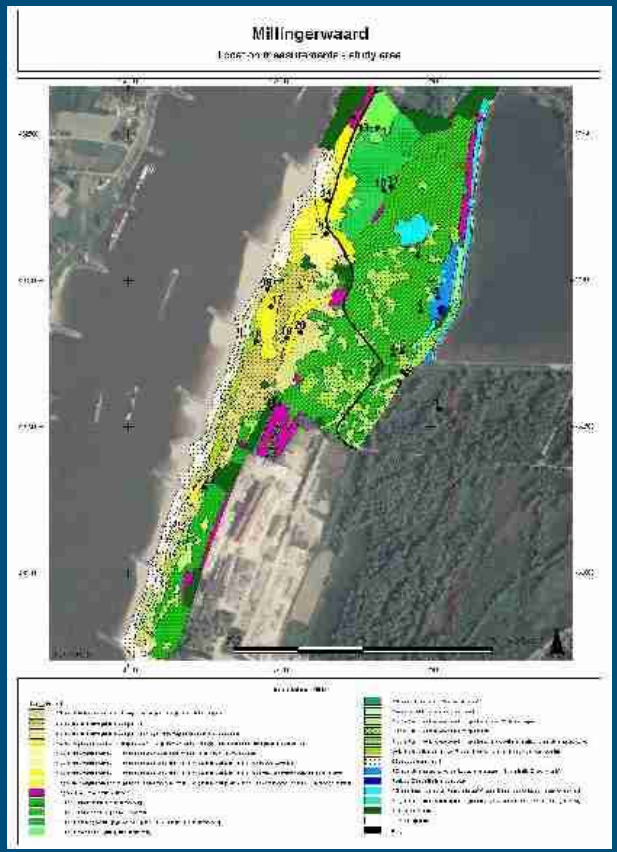
- Pre-processing (vegetation mask, MNF)
- Spectral Angle Mapping
- 21 training points: 14 classes
- 3x3 majority filter

Next step (ULB):

- Landscape ecology
- Pattern analysis: patch & pixel based approach
- Spatial pattern and ecological processes are linked

HyMap derived vegetation classes 2004

Vegetation map 2002 (aerial photographs and relevees)



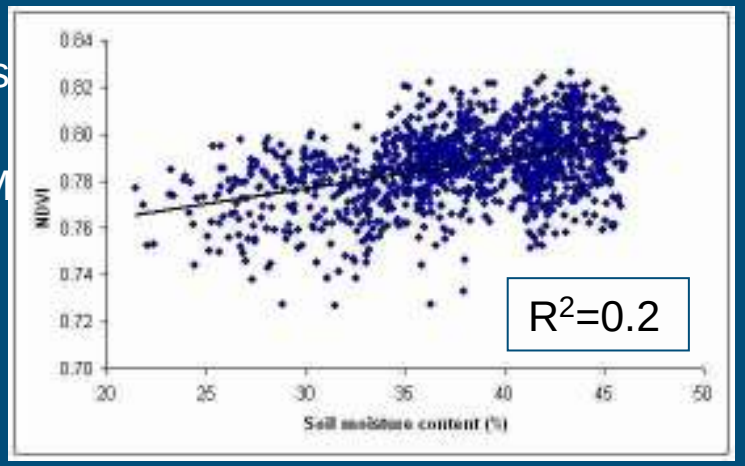
Results (VUB&ULB): analysis of soil moisture gradients

Method

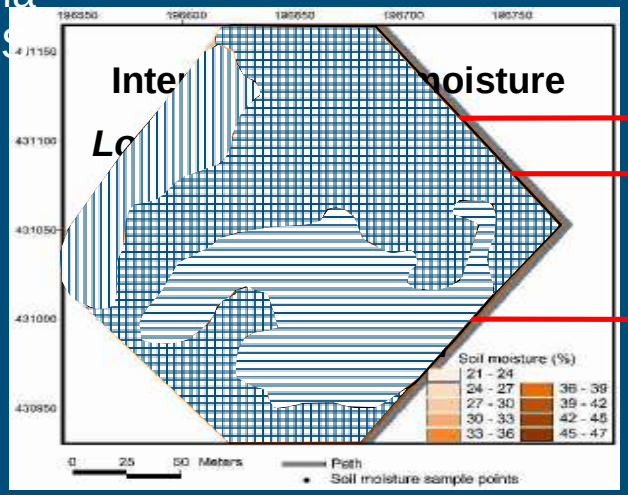
- Location Millingerwaard
- 88 locations SM: thetaprobe
- Interpolated SM maps (kriging)
- VIs derived from HyMap: SAVI, WDVI, PCA

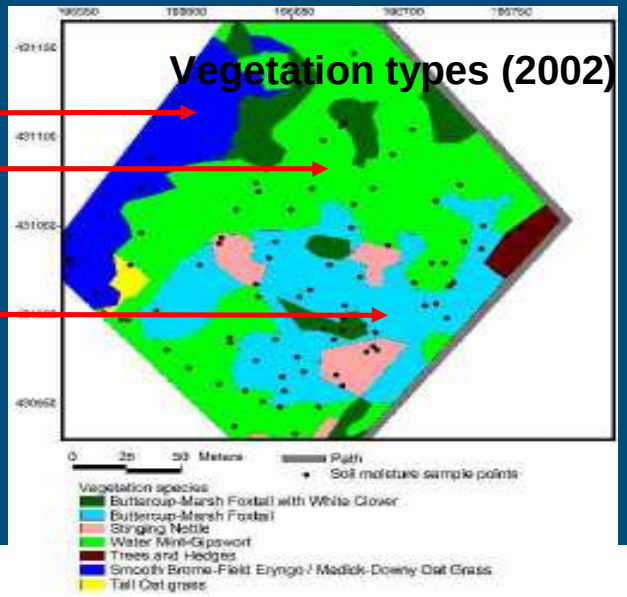
Conclusion: mapping SM via vegetation types using IS

HyMap derived VIs show low correlation with SM



Three major vegetation types differ significantly ($p<0.05$) in SM





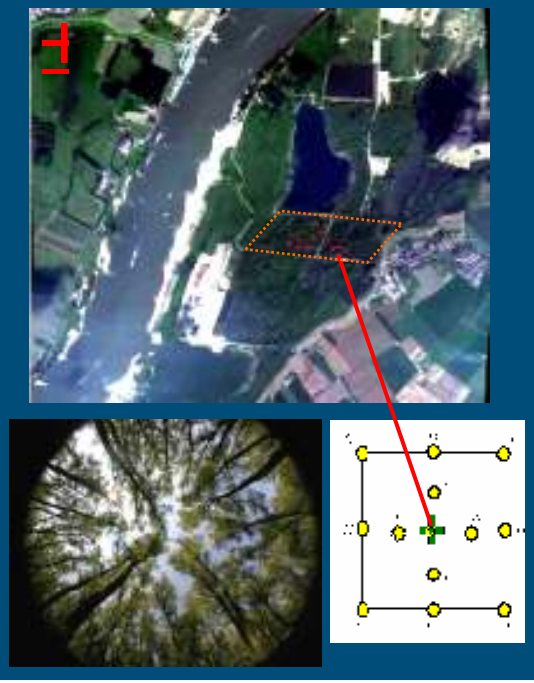
WAGENINGEN UNIVERSITY
WAGENINGEN UR

Centre for Geo-information

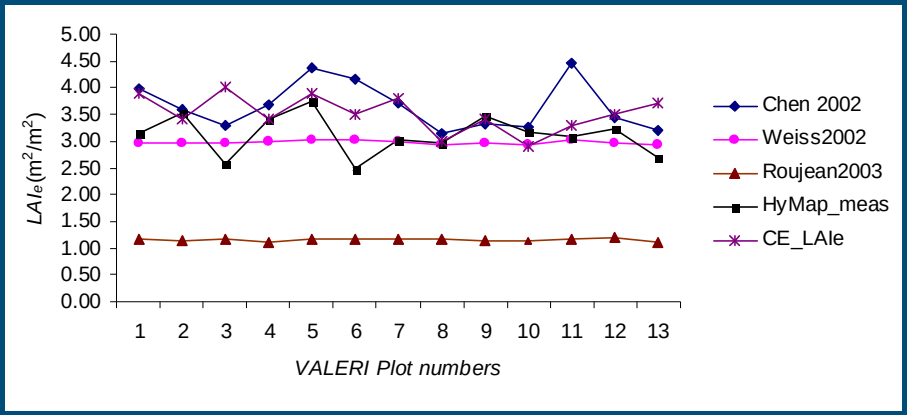
Results (WUR): Deriving LAI for softwood forest stands

Method

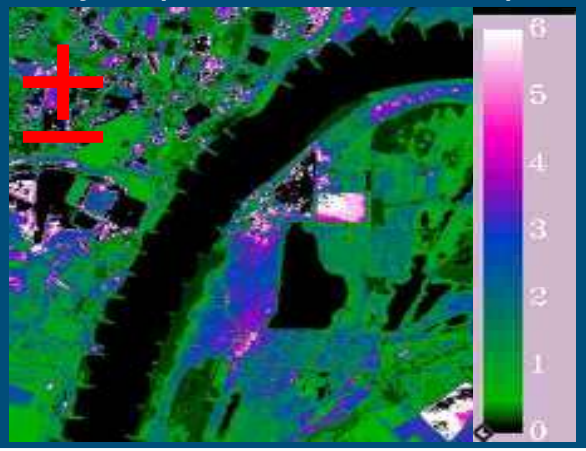
- 13 softwood forest stands
- VALERI-plot sampling
- hemispherical camera: upward and downward
- CAN_EYE software



Ground measured LAI compared to HyMap derived LAI (different methods)



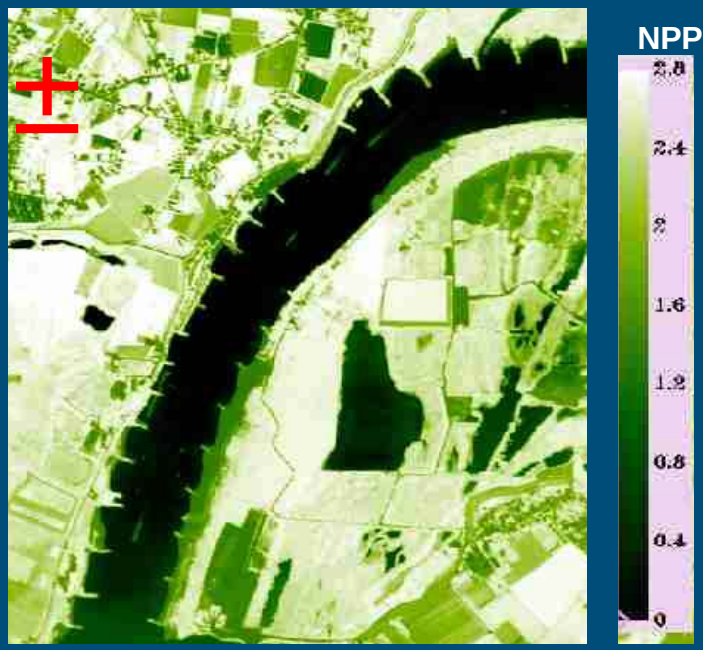
LAI from HyMap based on Chen (2002)



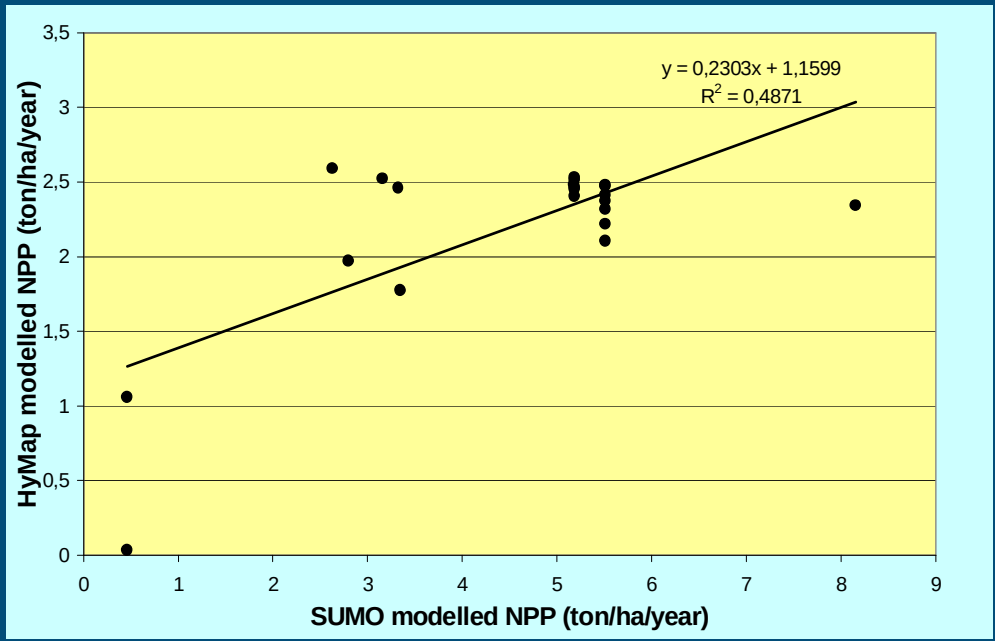
WAGENINGEN UNIVERSITY
WAGENINGEN UR

Centre for Geo-information

Results (WUR): comparison of IS and model derived NPP

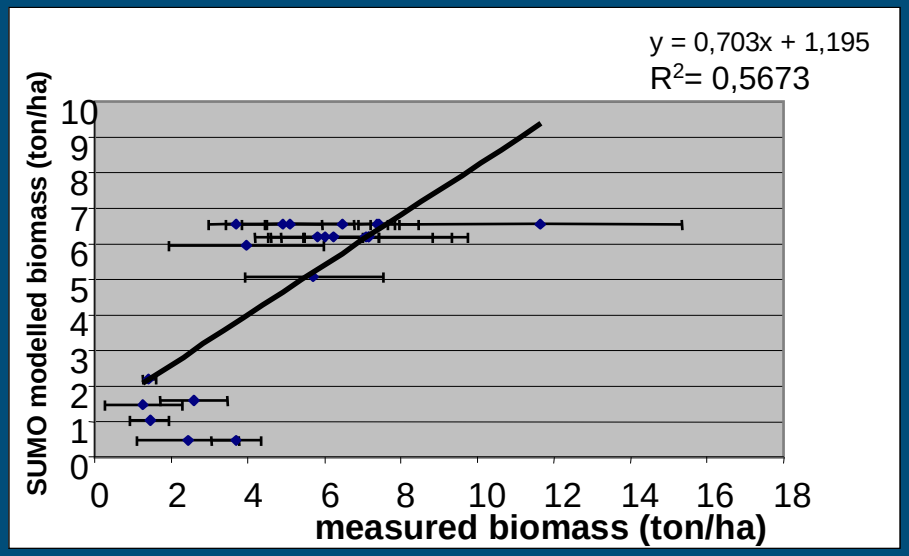


Net Primary Production (NPP) derived from HyMap using Ruimy et al. (1994)

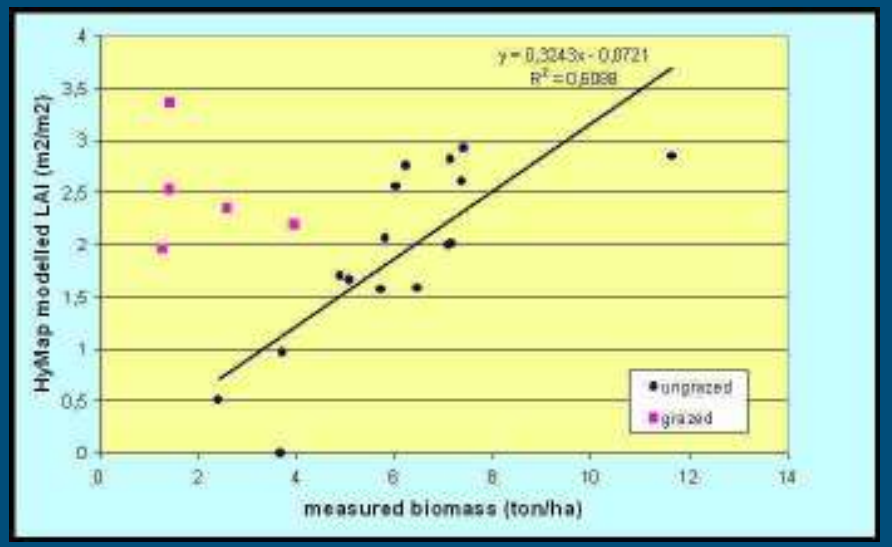


NPP derived from the ecological model SUMO (natural succession scenario) compared to HyMap derived NPP for 21 relevee plots

Results (WUR): comparison for biomass and influence of management



Field measured vegetation biomass compared to biomass derived from SUMO model (scenario natural succession)

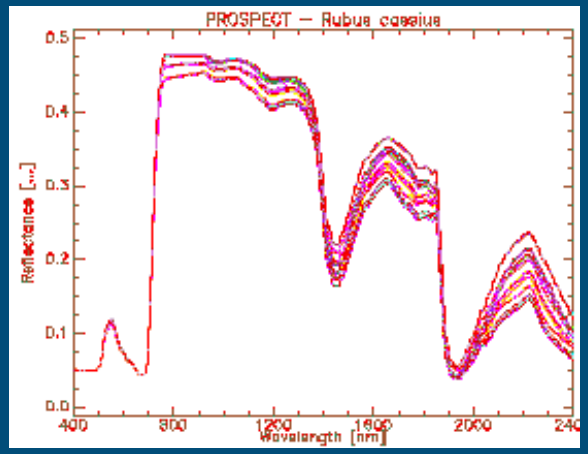


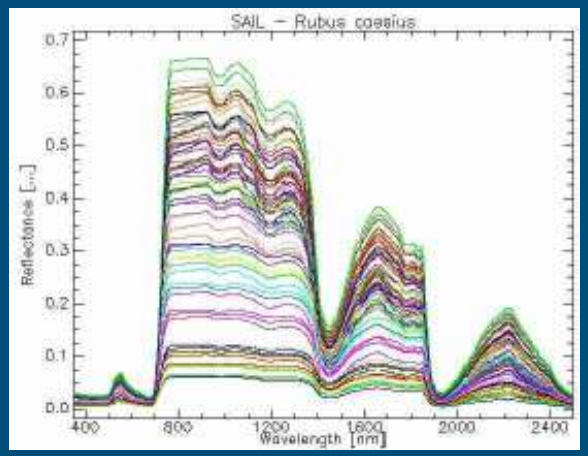
Influence of grazing on relation between HyMap derived LAI and field measured biomass

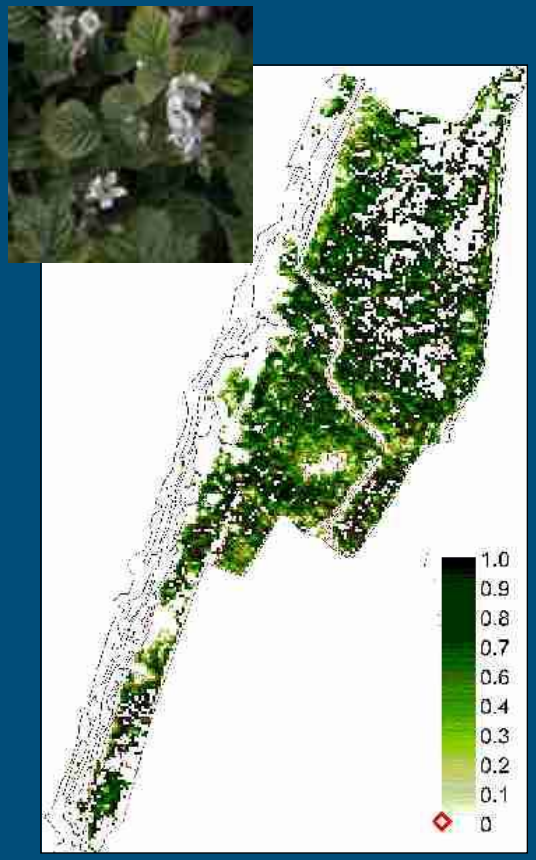
Results (WUR): using RTF-models to derive vegetation species maps

Method

- Radiative Transfer models
- PROSPECT model:
  - Field leaf reflectance spectra
  - Parameters from literature
  - Result: simulated leaf spectra
- SAIL model:
  - PROSPECT leaf spectra
  - Soil background spectra
  - Vegetation parameters
  - Result: canopy reflectance for single species
- Spectral unmixing:
  - HyMap image
  - Simulated SAIL spectra
  - Veg. description per plot
  - Result: species abundance maps







Spatial abundance map for Rubus caesius, derived from HyMap data, Millingerwaard, The Netherlands

Conclusions

- HyMap data and acquired field enable the production of continuous fields for biophysical variables (LAI, NPP, vegetation type) in the Millingerwaard
- Comparison of HyMap derived variables and results from ecological model SUMO show promising relations
- Validation in study area with high spatial variability requires attention: scale of sampling, nr. of samples, influence of management
- From statistical to physical based models (and back)

Thank you for your attention

WAGENINGEN UNIVERSITY
WAGENINGEN UR

Centre for Geo-information

Publications

- Kooistra, L., Clevers, J., Schaepman, M., van Dobben, H., Sykora, K., Holtland, J., Batelaan, O., Debruyn, W., Bogaert, J.,Schmidt, A., Clement, J., Bloemmen, M., Mucher, C.A., van den Hoof, C., de Bruin, S., Stuiver, J., Zurita, R., Malenovsky, Z., Wenting, P., Mengesha, T., van Oort, P.A.J., Liras Laita, E., Wamelink, W., Schaepman-Strub, G., Hung, L.Q., Verbeiren, B., Bertels, L., & Sterckx, S. (2005) Linking Biochemical and Biophysical Variables Derived from Imaging Spectrometers to Ecological Models - The HyEco'04 Group Shoot. In 4th Workshop on Imaging Spectroscopy (eds B. Zagajewski, M. Sobczak & W. Prochnicki), Vol. 1, pp. 61. EARSeL, Warsaw.
- Mengesha, T., Kooistra, L., Zurita Milla, R., De Bruin, S., & Schaepman, M. (2005) Methodol-ogy Comparison of Quantiative LAI Retrieval using Imaging Spectroscopy and Geo-Spatial In-terpolation in a Softwood Forest. In: 4th Workshop on Imaging Spectroscopy edited by B. Za-gajewski, M. Sobczak & W. Prochnicki (EARSeL, Warsaw), pp. 141.
- Schmidt A, L Kooistra, H van Dobben & M Schaepman, 2005. Improved initialisation and vali-dation of ecological models by remote sensing. In: 4th Workshop on Imaging Spectroscopy ed-ited by B. Zagajewski, M. Sobczak & W. Prochnicki (EARSeL, Warsaw), ##-##.
- Mengesha, T., Schaepman, M., De Bruin, S., Zurita Milla, R., & Kooistra, L. (2005b) Ground Validation of Biophysical Products Using Imaging Spectroscopy in Softwood Forests. In VALERI Workshop (eds F. Baret & M. Weiss), pp. CD-ROM. INRA, Avignon (F).