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

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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

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

Millingerwaard (the Netherlands)

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

Different succession stages

Bromo inermis-Eryngietum campestris

Echio-Melilotetum typicum

Artemisio-Salicetum Agrostiestosum stoloniferae

Natural management by grazing

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Imaging spectrometer data HyMap

July 28th, 2004 13:38 hrs

Aug 2nd, 2004 10:30 hrs

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

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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 relevées)
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

R²=0.2
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)
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 relevée plots.

\[ y = 0.2303x + 1.1599 \]

\[ R^2 = 0.4871 \]
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
Publications


