Integrating remote sensing in Natura 2000 habitat monitoring: the Habistat approach

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and the Habistat-team
(VITO, UA, VUB, INBO, Alterra-WUR)
Outline

- Intro: Natura 2000
- Can remote sensing contribute?
- The Habistat approach
- Some results
- Validation
- Conclusions
Introduction

• Habitats Directive (92/43/EEC) → designation of Natura 2000 sites

• Sites require appropriate management, monitoring of conservation status and reporting to EU → need for data!

• RS as the long-awaited solution?
Can RS contribute?

• Yes,…
  – habitat mapping
  – spatially explicit change detection
  – habitat quality indicators
    *e.g. patch fragmentation, shrub encroachment, soil moisture, biochemical/biophysical vegetation characteristics,…*
  – …

• …, but
  – not at any price: better, cheaper or both (cost vs. benefit)
  – a number of ‘issues’ to be resolved:
    *standardisation of approaches, focus on available imagery, integration into GIS-systems,…*
The Habistat project

- **Goal:** develop operation-oriented method to map, monitor and evaluate habitats in Natura 2000 sites in W-Europe
- **Focus:** heathland habitats in BE & NL
- **Project consortium:** 5 partners (BE, NL)
  - product developers: VITO, UA, VUB, Alterra
  - research institutes involved in N2000: INBO, Alterra
- **2007-2011**
- **Funded by the Belgian Science Policy Office (BELSPO)**
Habistat: general approach

Ecological knowledge:
- Habitat definitions (2310, 2330, 4010, 4030, 9190,...)
- Tools for local CS assessment

Heathland classification scheme:
(habitat/land cover) components that user wants to discern

Field reference data

Classification algorithm
<table>
<thead>
<tr>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>Heathland</td>
<td><strong>2310/4030</strong></td>
<td><em>Hdc</em> Calluna vulgaris dominated heathland</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>4010</strong></td>
<td><em>Hdca</em> Calluna-stand of predominantly adult age</td>
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<tr>
<td></td>
<td></td>
<td><strong>2310/2330</strong></td>
<td><em>Hgm</em> Molinia caerulea dominated heathland</td>
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<td></td>
<td></td>
<td><strong>4010/4030</strong></td>
<td><em>Hgd</em> Deschampsia flexuosa dominated heathland</td>
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<td></td>
<td></td>
<td><em>Hst</em> Tree-encroached heathland</td>
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<tr>
<td></td>
<td></td>
<td><em>Hsr</em> Rubus spp. encroached heathland</td>
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</tr>
<tr>
<td><strong>H</strong></td>
<td>Heathland</td>
<td><strong>2310/4030</strong></td>
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</tr>
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<td><strong>4010</strong></td>
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<td><em>Hsr</em> Rubus spp. encroached heathland</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Grassland</td>
<td><em>Gp</em> Permanent grassland</td>
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<td></td>
<td></td>
<td><em>Gpa</em> Permanent grassland in intensive agricultural use</td>
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<td></td>
<td></td>
<td><em>Gpar</em> Species-rich permanent agricultural grassland</td>
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<td></td>
<td></td>
<td><em>Gpn</em> Permanent grassland with semi-natural vegetation</td>
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<td></td>
<td><em>Gpnd</em> Dry semi-natural permanent grassland</td>
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<tr>
<td></td>
<td></td>
<td><em>Gpj</em> Juncus effusus dominated grassland</td>
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<tr>
<td></td>
<td></td>
<td><em>Gpj</em> Juncus effusus dominated grassland</td>
<td></td>
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<tr>
<td><strong>F</strong></td>
<td>Forest</td>
<td><em>Fc</em> Coniferous forest</td>
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<td></td>
<td></td>
<td><em>Fcp</em> Pine forest/plantation</td>
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<td></td>
<td></td>
<td><em>Fcpc</em> Corsican pine (<em>Pinus nigra laricio</em>)</td>
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<td><em>Fcps</em> Scots pine (<em>Pinus sylvestris</em>)</td>
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<td></td>
<td></td>
<td><em>Fdb</em> Birch forest</td>
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<tr>
<td></td>
<td></td>
<td><em>Fdb</em> Birch forest (<em>Betula pendula &amp; B. pubescens</em>)</td>
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<tr>
<td></td>
<td></td>
<td><em>Fdq</em> Oak forest</td>
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<td></td>
<td></td>
<td><em>Fdqz</em> Pedunculate oak (<em>Quercus robur</em>)</td>
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<tr>
<td><strong>S</strong></td>
<td>Sand dune</td>
<td><em>Sb-</em> Bare sand</td>
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<tr>
<td></td>
<td></td>
<td><em>Sb-</em> Bare sand</td>
<td></td>
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<td></td>
<td></td>
<td><em>Sfg</em> Sand dune with important fraction of fixating grasses</td>
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<td></td>
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<td><em>Sfgm</em> Sand dune fixated by grasses and mosses</td>
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<td></td>
<td></td>
<td><em>Sfm</em> Sand dune with mosses as dominant fixators</td>
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<tr>
<td></td>
<td></td>
<td><em>Stmc</em> Fixated sand dune with predominantly Campylopus introflexus</td>
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<td></td>
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<td><em>Stmp</em> Fixated sand dune with predominantly Polytrichum piliferum</td>
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</tr>
<tr>
<td><strong>W</strong></td>
<td>Water body</td>
<td><em>Wdv</em> Oligoalgal dominated heathland</td>
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<tr>
<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td><em>Wlv</em> Shallow, vegetated oligotrophic water body</td>
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<td></td>
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<td><em>Wou</em> Unvegetated oligotrophic water</td>
<td></td>
</tr>
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Heathland classification scheme:
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Typical composition of habitat patches in terms of components from the classification scheme

Field reference data

RS experts' input

Classification algorithm

Spatial structuring algorithm
• Study area: Boundary Park De Zoom – Kalmthout Heathland (Belgian-Dutch transboundary nature reserve)
• Image: Airborne Hyperspectral Scanner (AHS), 2 June 2007, 2.4 m pixel size
- Pixel-based, classified map at level 4 (spectral classification, SVM)
- Overall accuracy level 4: 82%
• Next step: recombine into habitat patches (ongoing)
Habistat: general approach

- Habitat definitions (2310, 2330, 4010, 4030, 9190,...)
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Composition of habitat patches
Components of components from the classification scheme

- Existing field maps
- Field data
- Other relevant information (e.g. costs)

Validation
Validation

• Different definitions:
  – Often referred to as thematic accuracy assessment of classification results (map), a narrow definition
  – A broader definition (ISO): confirmation that requirements of specific intended use have been fulfilled

• Different perspectives: user’s and producer’s
  – Producer: validate the mapping methodology (the process) (e.g. interpretation, classification)
  – User: validate the mapping results (the product)
Validation framework

1. What is the intended use of the product (map)?
   assessing area (ha) and CS (good, moderate, bad) of habitats on Natura 2000 site level

2. What are the requirements?
   - quality (in terms of thematic & geometric accuracy, completeness, consistency, spatial scale, etc.) of the product (map)?
   - costs, repeatability, transferability,… of the process?

3. How to examine and provide evidence that these requirements are fulfilled?
   e.g. thematic accuracy assessment : different measures, such as overall accuracy, user’s and producer’s accuracy
Validation approach in Habistat

- User cannot provide unambiguous threshold values for e.g. accuracy, costs, … → comparative analysis
- Scope:
  - Comparison of a ‘traditional’ map (based on aerial photograph interpretation & field work) with ‘innovative’ maps (based on remote sensing)
  - Comparison of different classifiers & methods (performance)
- Starting with thematic accuracy assessment of maps (ongoing)
- Including calculation of the costs for the production (incl. material) of these maps

- Outlook: validation/comparison at the level of the real use of the product? (i.e. area estimates and CS assessments per site)
Conclusions & discussion

• Habistat aims at mapping habitats and their conservation status in Natura 2000 sites:
  – ‘Indirect’ mapping of the habitats
  – Much attention is paid to indicators of habitat condition

• Need for cooperation and dialogue between RS experts and the future users
  – User requirements: define the intended use of the product
  – Work together during the entire process
  – Validation

• Validation should be fair and equilibrated
  – both the process and product
  – dare to compare with existing products, incl. field based maps
Website:
http://habistat.vgt.vito.be

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