Modular Classification and Change Analysis of Vegetation Encroachment using Object-based Image Analysis

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ICC Dresden, 28.08.2013
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**Interpretation / Digitizing**
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**GIS-Consulting**
- Project management
- Consulting for GIS-Systems
- GIS & Migration
- Quality assurance
Content

- Study Area and Motivation
- Data
- Classification Technology „on three pillars“
- Classification Results
- Quality Assurance
- Summary
Study Area

- Hohenfels, Germany
- Military training area under use (~ 160 km²)
- Karst/ limestone soils and semi-natural grasslands and pastures
- Biodiversity in the need of ecological protection
- Endangered by spread of invasive plants/ scrub encroachment - including Blackthorn (*Prunus spinosa*)
Situation in the Study Area
Background – Why Remote Sensing?

- Area under focus (excluding forest) ~ 58 km²

- Reduction costs:
  - LOW STATUS (NEW)
    - grazing animals & mowing
    - ca. 200€/ha*
  - MEDIUM STATUS
    - mowing, mulching, renaturation
    - 400 – 5000 €/ha*
  - HIGH STATUS
    - mulching, manual internshop renaturation
    - 3000 – 8000€/ha*

- Early action is much more cost effective
- Control measures are necessary for reduction of encroachment
- Efficient instrument to map the entire area


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Data

Aerial Imagery 2007

LiDAR Optech ALTM 3100
DSM/DTM 2007

WorldView-2 2012

LiDAR Trimble Harrier 56
DSM/DTM 2012

Reference mappings
Classification Technology – Spectral Pillar
Classification Technology – Spectral Analysis

Grassland

Blackthorn (young)

Forest

Blackthorn
Classification Technology – Height Pillar

Exclusion criteria

Spectral Signatures
Aerial img./ WorldView-2

LiDAR
height differences
Classification Technology – LiDAR Data

2007/03/15 (Optech ALTM 3100 (1m))

2012/03/23 Trimble Harrier 56 (0.5m)

trees

shrub

grassland

situation

DSM 2007
Optech ALTM 3100 (1m)

DSM 2012
Trimble Harrier 56 (0.5m)

DTM

(DSM-DTM)
Classification Technology – LiDAR Data

- Object-based Image Analysis
- Rule set technology
- Using contextual information (neighbourhood), relations and changes
Classification Technology – Texture Pillar

- Texture WorldView-2 pan
- Spectral Signatures Aerial img./ WorldView-2
- LiDAR height differences
- Variance, Neighbourhood relationship

Exclusion criteria
Classification Technology – Texture Analysis

- Homogeneous texture, no elevation (shadow)
- Texture, no elevation (vegetation)
- Texture, elevation (forest-shrub)
Classification Technology – Feature Space

Exclusion criteria

Variance, Neighbourhood relations

Combination

Texture WorldView-2 pan

Spectral Aerial image

LiDAR height differences

Variance, Neighbourhood relations

defined Class
Classification Technology – Feature Space

Object-based Image Analysis
- logic expansion of classification via
  - Reference knowledge
  - Neighbourhood relationships
  - Plausibilities & Valuing of changes 2007/2012
  - Minimum values / Similarities
Classification Result – Status and Change Analysis

2007

2007/12

2012

<table>
<thead>
<tr>
<th>2007</th>
<th>2012</th>
<th>flat</th>
<th>medium</th>
<th>high</th>
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<tbody>
<tr>
<td>flat</td>
<td>grassland, open</td>
<td>new Shrub</td>
<td>Forest/ no real effect</td>
<td>LIDAR effect/ resolution</td>
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<tr>
<td>medium</td>
<td>LIDAR effect mulched area</td>
<td>Shrub</td>
<td>Forest</td>
<td>Forest</td>
</tr>
<tr>
<td>high</td>
<td>LIDAR effect resolution clearing</td>
<td>LIDAR effect Shrub</td>
<td>Forest</td>
<td>Forest</td>
</tr>
</tbody>
</table>

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28.08.2013
Classification Result

LIDAR height differences
Spectral signature aerial img./WorldView-2
Texture + eCognition (rule set)

aggregated classification
secure classes: class.matrix

Generalisation1: Similarity, Neighborhood, Size/ location

Generalisation2: Class!, rel. difference, location/ plausibility

Mask (Change elements)
Quality Assurance – Field Check

Visual control with result and experts: complete matching
Quality Assurance – Reference Mapping

- Numeric control with reference data - “Monitoring of Vegetation Control Areas” (NRI) using 84 2x2m plots: correlation of 94%

<table>
<thead>
<tr>
<th>Correlation</th>
<th>Total</th>
<th>%</th>
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<tr>
<td>Class difference = 0</td>
<td>79</td>
<td>94.0%</td>
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<tr>
<td>Class difference = 1</td>
<td>4</td>
<td>4.8%</td>
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<tr>
<td>Class difference &gt; 1</td>
<td>1</td>
<td>1.2%</td>
</tr>
<tr>
<td>Sum</td>
<td>84</td>
<td>100.0%</td>
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</table>
Summary

- Control measures for scrub encroachment are essential for military training areas in order to
  - Protect heterogeneous habitats (heterogeneous grassland, etc.) and
  - Enable training activities

- Object-based image analysis and modular classification technology allow high quality status mapping and change analysis

- LiDAR (surface and terrain) in combination with spectral information (WorldView-2 or other) enables a high degree of accuracy

Thank you for your attention!
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