DLM-Update
Integration of earth observation technologies in IT-structures of national mapping authorities

Update of the ATKIS®-DLM of the State Bureau of Surveying and Geoinformation Schleswig-Holstein

EFTAS Fernerkundung Technologietransfer GmbH

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Landesamt für Vermessung und Geoinformation Schleswig-Holstein

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Agenda

1. Objectives and technical concept

2. Implementation of the change detection system 'DLM-Update'

3. Evaluation

4. Work in progress and future prospects
1. Objectives and technical concept

**ATKIS**
- Official German Topographic-Cartographic Information System

**ATKIS Basis-DLM**
- Digital Landscape Model (1:10.000 - 1:25.000)
- including topographic information as well as information on „real land use“ („Tatsächliche Nutzung“)
1. Objectives and technical concept
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**Major objective**

- Integration of *earth observation data* into the IT-structures of national authorities (preparation of SENTINEL data integration)

**Specific objective**

- Can the combination of satellite images and ortho images in a customized change detection software optimize and speed up the current manual workflow of updating topographic land use data (ATKIS Basis-DLM) by using (semi-) automatic approaches?
1. Objectives and technical concept

**Focussing the level of detail**

**Reason for an update action**
Automatic hint, *which* topographic object needs an update

**Change indicator**
Automatic hint, *where within* a topographic object the change did happen and *thematic suggestion* of the change reason

**Final update object geometry**
Automatic generation of a map-like object geometry for the direct integration into the official data set
1. Objectives and technical concept

**User requirement analysis**

- Analysis of the current update process for topographic data (ATKIS) and its potential for optimization
- Integration of external users

**Module development**

Raw concept → Detailed concept

What to develop? → How to implement it?

- Definition of the future update process
- Specification of the prototype system
1. Objectives and technical concept

**Module and workflow overview**

<table>
<thead>
<tr>
<th>User Interface 1</th>
<th>Remote Sensing Module</th>
<th>User Interface 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Data import, metadata management, project administration)</td>
<td>Automatic Image Analysis</td>
<td>(ArcGIS Add-In)</td>
</tr>
<tr>
<td>Topographic data (ATKIS) (t_0)</td>
<td>Change Detection</td>
<td>Manual control of change indicators and update of topographic objects</td>
</tr>
</tbody>
</table>
2. Implementation of the change detection system 'DLM-Update'

User Interface 1: Project administration

Four functional areas:

• Import
• Data view
• Batch processing (Classification & Change Detection)
• Export of change indicators
1. Objectives and technical concept

Image data:

Aerial images of the surveying authority
- Digital ortho images (RGB and CIR)
- 20 cm / px, cycle of 3 years

Preparation of Sentinel-2 data integration
- Copernicus space component
- Swath: 290 km
- Resolution: 10 m, 20 m, 60 m
- 13 optical bands
- Free of cost!
- During the project time: Mostly usage of Landsat
2. Implementation of the change detection system 'DLM-Update'

**Sentinel Loader: Direct integration of Sentinel-2 image data**

- **Automatic download and archiving** of all available data for a defined area of interest
- **Automatic pre-processing** of the images (layer stacking, tiling, atmospheric correction)
1. Objectives and technical concept

Remote Sensing Module

Process of the image analysis:

1. **Automatic training data preparation**  
   Needs ATKIS data \((t_0)\) for the automatic derivation of training data  
   (import of manually acquired training data is also possible)

2. **Classification process**  
   Uses training data, digital ortho images and satellite images

3. **Change Detection**  
   Uses the land cover classification and the topographic data (ATKIS)
2. Implementation of the change detection system 'DLM-Update'

**Land Cover Classes:**
- Sealed
- Grassland
- Cropland
- Forest / Shrubs
- Water
- Wetland
- Open soil / Sand
- Shadow (no LC class)

**Time frames image data:**
- March - May
- June - July
- August - October (Minimum)
2. Implementation of the change detection system 'DLM Update'
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Topographic Data (ATKIS)
2. Implementation of the change detection system 'DLM-Update'

Training Data
Land Cover Classification
Change Indicator
2. Implementation of the change detection system 'DLM-Update'

Batch processing and transferability of the trained classifier

- For tiles with the same data combination (image acquisition day of ortho images and used satellite images)
- Prioritize training data usage vs. available classifier
2. Implementation of the change detection system 'DLM-Update'

**Change Detection:**

- Topographic Data (ATKIS Basis-DLM) \( t_0 \)
- Land Cover \( t_1 \)
- Change Indicators

**Processing the change indicator data set:**

**Object-based comparison and translation of**

- **land use** (27 polygonal object classes („Tatsächliche Nutzung“) and
- **land cover** (8 land cover classes (7+1) from the supervised classification)
2. Implementation of the change detection system 'DLM-Update'

Change Detection:

- **Translation** of land use to land cover in an object-based evaluation catalogue matrix

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<th>Versiegelung</th>
<th>Grünland</th>
<th>Acker</th>
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<th>Wasser</th>
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- **Comparing** ATKIS polygons with the land cover classification via an xml-based rule set
- **Rule set**: Relative proportion of area & absolute minimum mapping unit
2. Implementation of the change detection system 'DLM-Update'

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2. Implementation of the change detection system 'DLM-Update'

User Interface 2 (as Add-In for ArcGIS 10)
2. Implementation of the change detection system 'DLM-Update'

User Interface 2 (as Add-In for ArcGIS 10)

Change Indicators
4. Work in progress and future prospects

Some more features I couldn’t show:

- Reduction of change indicators by integration of ATKIS polyline vegetation information (t0)
- Verification of streets and paths (ATKIS polyline objects)
- Shadow regions: Classification and rule set integration
- Border masking for minimizing mixed pixel influences
First conclusion of the State Bureau of Surveying and Geoinformation Schleswig-Holstein (LVermGeo SH)

- First Evaluation: February to May 2015

- „The usage of the DLM-Update led to an approx. 10 % speed-up of updating ATKIS data."

- „More optimization could be achieved […] especially via a geometric sorting of the change indicators as well as a customized zoom level after selecting the change indicator objects“ [in the ArcGIS-AddIn].
3. Evaluation

→ Implementation of geometrical sorting of change indicators and zoom customization
First conclusion of the State Bureau of Surveying and Geoinformation Schleswig-Holstein (LVermGeo SH)

Strategy for the further development:

• A strict rule set, producing more change indicators (even false positives)

  → Less changes are overlooked

• Assumption: The more structured workflow can speed-up the update of land use information (ATKIS)
3. Evaluation

## Final evaluation I - Accuracy

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- Six areas from “real life projects” with a total area of ~ 216 km²
- 3986 ATKIS objects
3. Evaluation

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- 36.5 % (1453) of all objects (3986) get a change indicator
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- 36.5 % (1453) of all objects (3986) get a change indicator
- Correctness: 55.1 % (801) of these change indicators are real changes
3. Evaluation

Final evaluation I - Accuracy

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- 27.3% (301) of all changed objects (1102) were not detected
3. Evaluation

Final evaluation I - Accuracy

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- Sensitivity $\rightarrow$ 72,7 % (801) of all real changes (1102) were detected
3. Evaluation

**Final evaluation I - Accuracy**

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- 92,4 % (3685) of all objects (3986) were treated strategically correct
3. Evaluation

Final evaluation II - Workflow Integration

- Cost-benefit analysis in a standard update project (9 km², rural area)
- ArcGIS add-in (User Interface 2) enables optimized and structured screening of change indicators
- Precision: 53.5% of all change indicators are correct
- Sensitivity: 99.3% of all changes were found
- Slight acceleration, compared to the regular update process: Approx. 10%
4. Work in progress and future prospects

**Current developments for detecting “the missing ones”**

- Multi-temporal Sentinel-2 data (first full season!)
- Adjusting the automatic training data generation for Sentinel-2 data
- Integration of height information (DTM and DSM)
- Object recognition in urban areas (e.g. cars, …) for a direct derivation of land use information

**Further To-Dos**

- Refining the processes for more detailed cadastral information (ALKIS)
- Integration into other workflow environments and use cases
- Interface to the future German COPERNICUS platform „CODE-DE“
- …
Take away from DLM-Update

• Satellite image data can be integrated into existing workflows of survey authorities and improve current update processes!

• The developed automatic change detection system speeds up the current manual update of topographic geo data (ATKIS Basis-DLM) and supports securing the quality of the updated data set!

• The customized software solution enables users from survey authorities to process change detection results on their own, close to their everyday processes, in an easy-to-use interface!
Thank you for your interest!

Do you have any questions?

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