LISA 2.0: Enhancing the land information system of Austria (LISA) with temporal information form SENTINEL-2 data

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INSPIRE & COPERNICUS Conference
24.11.2015, Bratislava

LISA land information system austria

overview

- **LISA – Land Information System Austria**

- **LISA concept and data model**
- **LISA roll out in Austria**
- **LISA future developement**
  - Integration of Copernicus/Sentinel-2

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LISA Evolution

Concept Phase
Jan. 2009 – Oct 2010
Catalogue & Proof of Concepts
LISA-1 (ASAP)

Completion of CMS
Nov. 2010 – June 2012
Completing Mapping Services
LISA-2 (ASAP)

Roll-out Phase
Oct. 2012 – June 2015
Production of 10,000 km² of LISA land cover
Production of Change Alert Maps for entire Austria
CadasterENV Austria
ESA (DUE)
cadasterenv austria
Integration of Pléiades satellite images

LISA 1.0

Advancement Phase
Aug. 2015 – July 2017
HR Land cover for entire Austria & Enrichment of LISA land cover
End-to-end processing system
Highly detailed Land Monitoring using Sentinel-2
GSE CadasterENV
ESA (GSE)
Use of Sentinel-2 time series data

LISA 2.0

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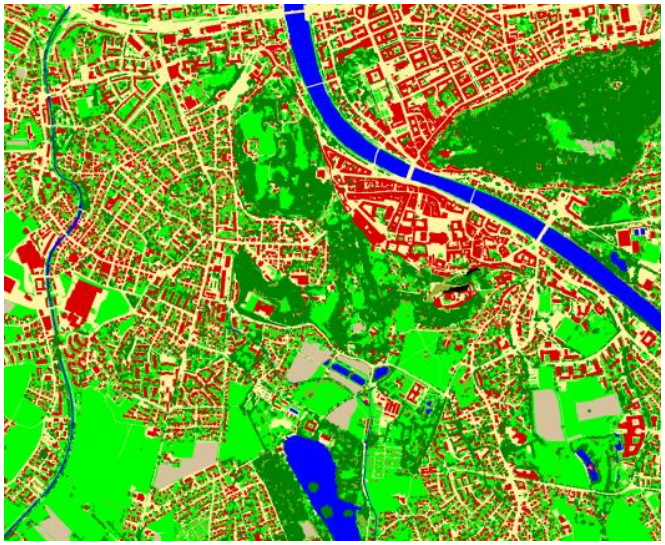
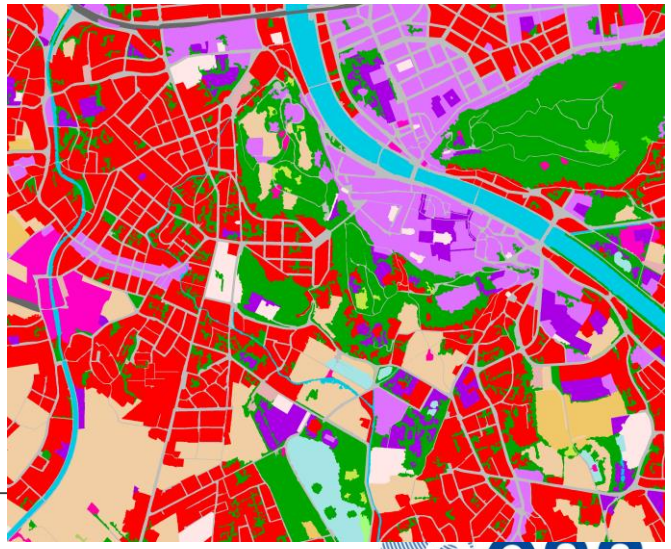
LISA Data Models:

- **Land Cover data model**
  - 13 classes + 12 attributes
  - MMU: starting from 25 m^2
  - 95% overall accuracy
  - directly and independently derived from EO data
  - Buildings, other built-up areas, bare soil, bare rocks, trees, bushes, herbaceous vegetation, water ….



- **Land Use data model**
  - 25 classes + 72 attributes
  - MMU: starting from 1.000 m^2
  - based on land cover maps, orthophotos, DSMs, ancillary and in-situ data
  - settlements, roads, railways, arable lands, grasslands, forests, alpine pastures, …



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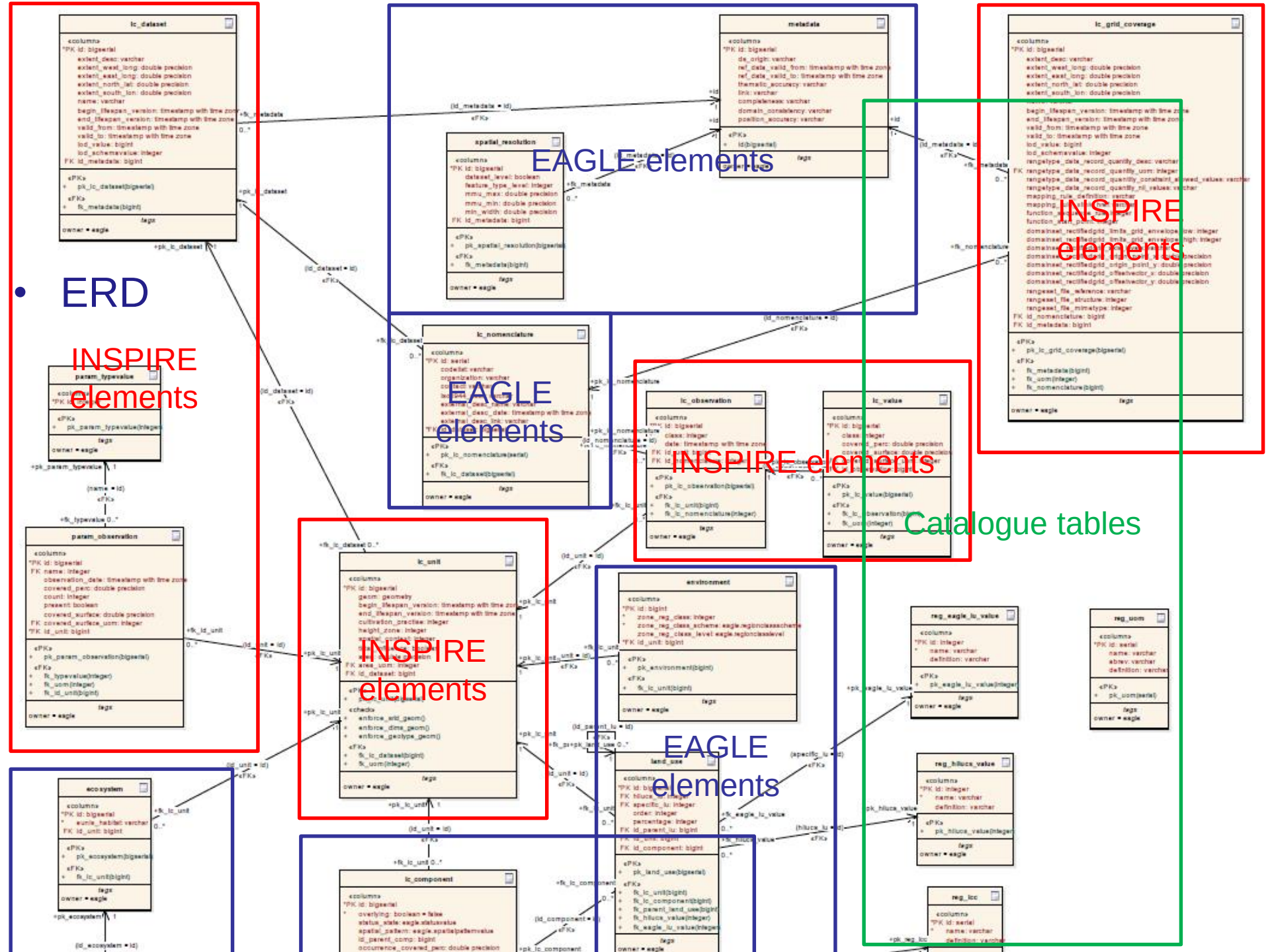
LISA Land cover – Data model

	Classes	MMU	Description
1	Buildings	25 m²	Buildings with all types of use
2	Other constructed areas	25 m²	Sealed areas except buildings, gravelled streets and parking zones
3	Bare soil	50 m²	Non-vegetated, bare soil
4	Screes	50 m²	Unconsolidated sediments as debris, scree slopes, crushed stones and sandy sections
5	Bare rock	50 m²	Rocks and (solid) bedrock
6	Surface water	50 m²	Open surfaces standing water bodies and watercourses
7	Snow	50 m²	Temporarily snow-covered areas
8	Ice	50 m²	Glaciers and ice fields
9	Trees	25 m²	Single trees and groups of trees
10	Bushes	50 m²	Bushes, hedges in settlements, dwarf pines and afforestation areas with low tree heights
11	Dwarf shrubs	50 m²	Outspread dense population of dwarf-shrubs
12	Herbaceous vegetation	50 m²	Artificial green areas (gardens and fields) and natural grassland
13	Reeds	50 m²	Reed belts
14	Shadow	500 m²	Non-interpretable shaded areas due to topographic conditions
15	Clouds	500 m²	Non-interpretable areas due to clouds

LISA, INSPIRE+EAGLE

- **EAGLE – European Action Group on Land Monitoring in Europe**
  - Extension to INSPIRE data model on land cover
- **LISA**
  - compatible with INSPIRE & EAGLE
- **EAGLE**
  - Solid base for future development
  - European harmonisation
  - Conceptual Model: UML + EA; logical model: ERD
  - physical implementation: PostgreSQL PostGIS, ESRI Geodatabase
- **Key issue**
  - Description of objects, and not primary a classification of objects
  - Objects are characterized by a range of attributes
  - Remote sensing, in-situ data, crowd-sourcing, ….
- http://sia.eionet.europa.eu/EAGLE
- http://land.copernicus.eu/
- http://www.perger.net/EAGLE/

- ERD


INSPIRE elements
EAGLE elements
INSPIRE elements
INSPIRE elements
Catalogue tables
INSPIRE elements
EAGLE elements

LISA roll out

- **Orthofoto campaigns, 3-yearly base**
  - Cooperation
    - National mapping agency (BEV)
    - Ministry for environment, agriculture, forestry and water
    - 9 federal states
  - operational cycles:
    - 2013-2015
    - 2016-2018
  - 0,25 cm resolution, RBG+NIR
  - 80/50 overlap of flight tracks

Derived products

- **Digital surface model**
  - Derived from aerial images
  - using dense image matching methods
  - In combination with ALS-derived DTM
    - nDSM…object heights

- **LISA-light**
  - BEV: operational production (pending decision Nov. 2015)
  - slightly reduced LISA classes
  - First implementation:
    - Starting 2016 with orthofotos 2013-2015
    - from 2017 onwards: first monitoring cycle with orthofotos 2016-2018
    - production timeline: orthofoto aquisition +1,5 years

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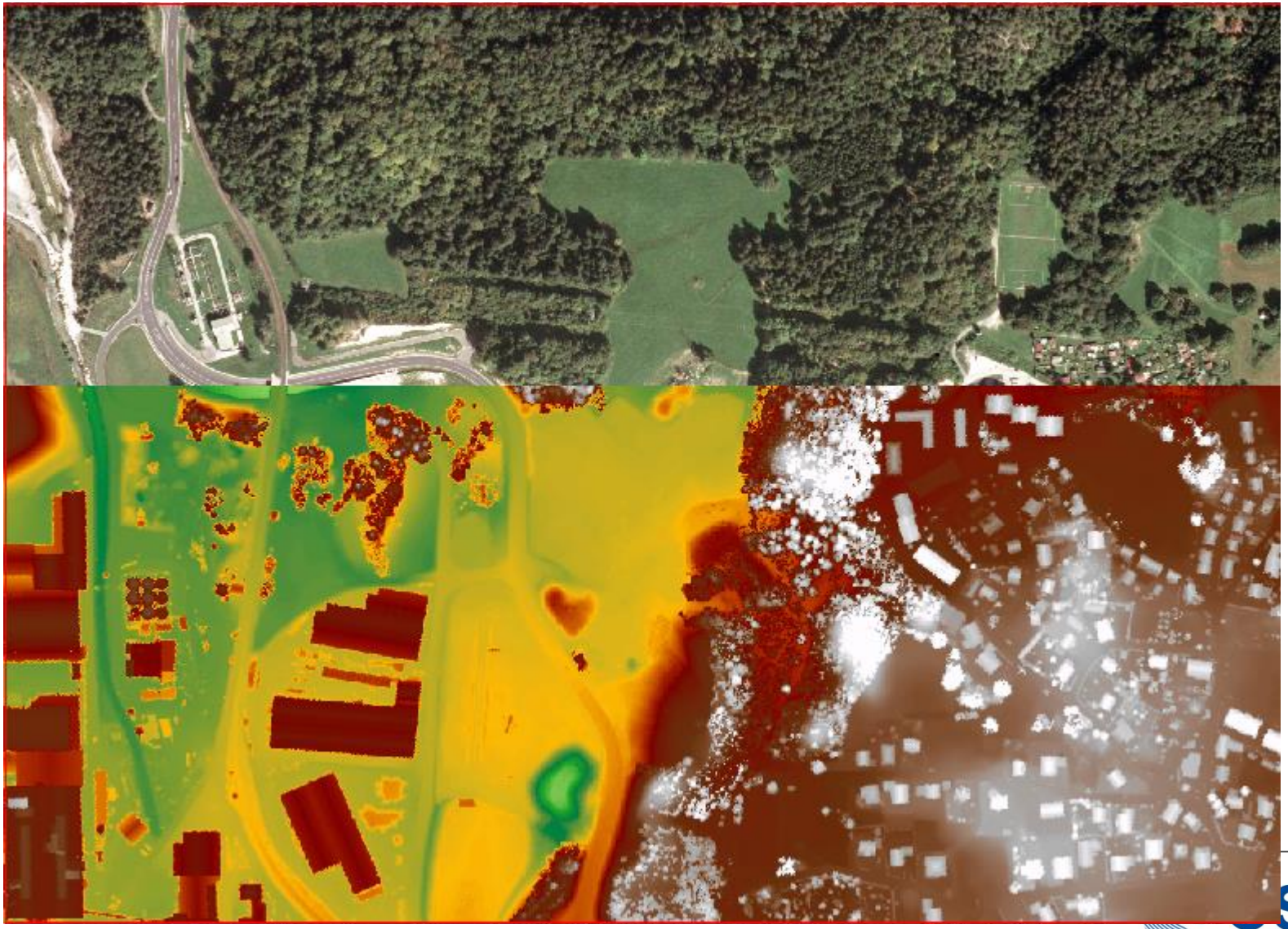
Orthofoto (resampled from 25 to 50 cm)

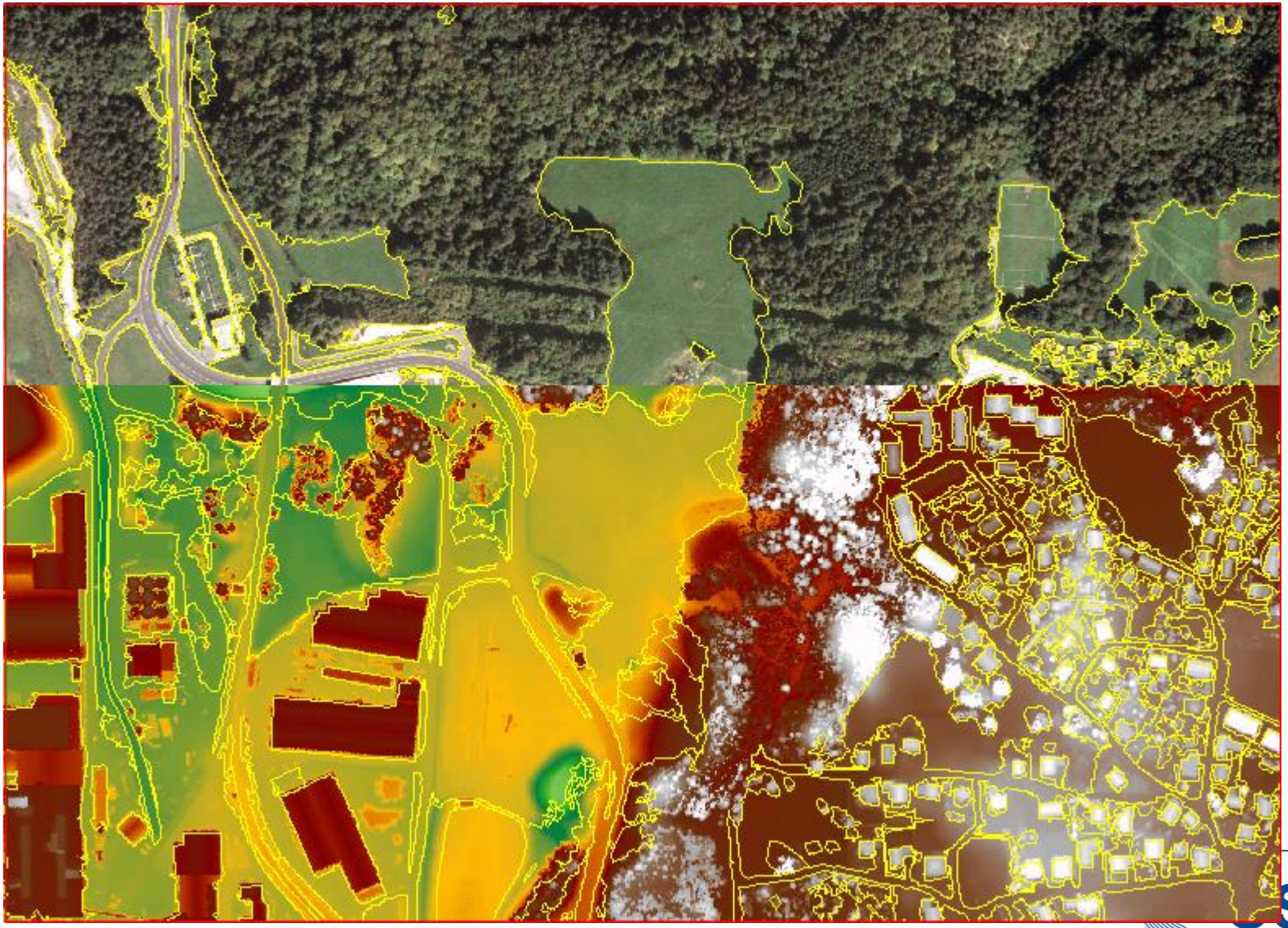
LISA land information system austria

Ortho + ALS (DGM+DOM, 1m)



LiSA land information system austria

Ortho + ALS + Segementation



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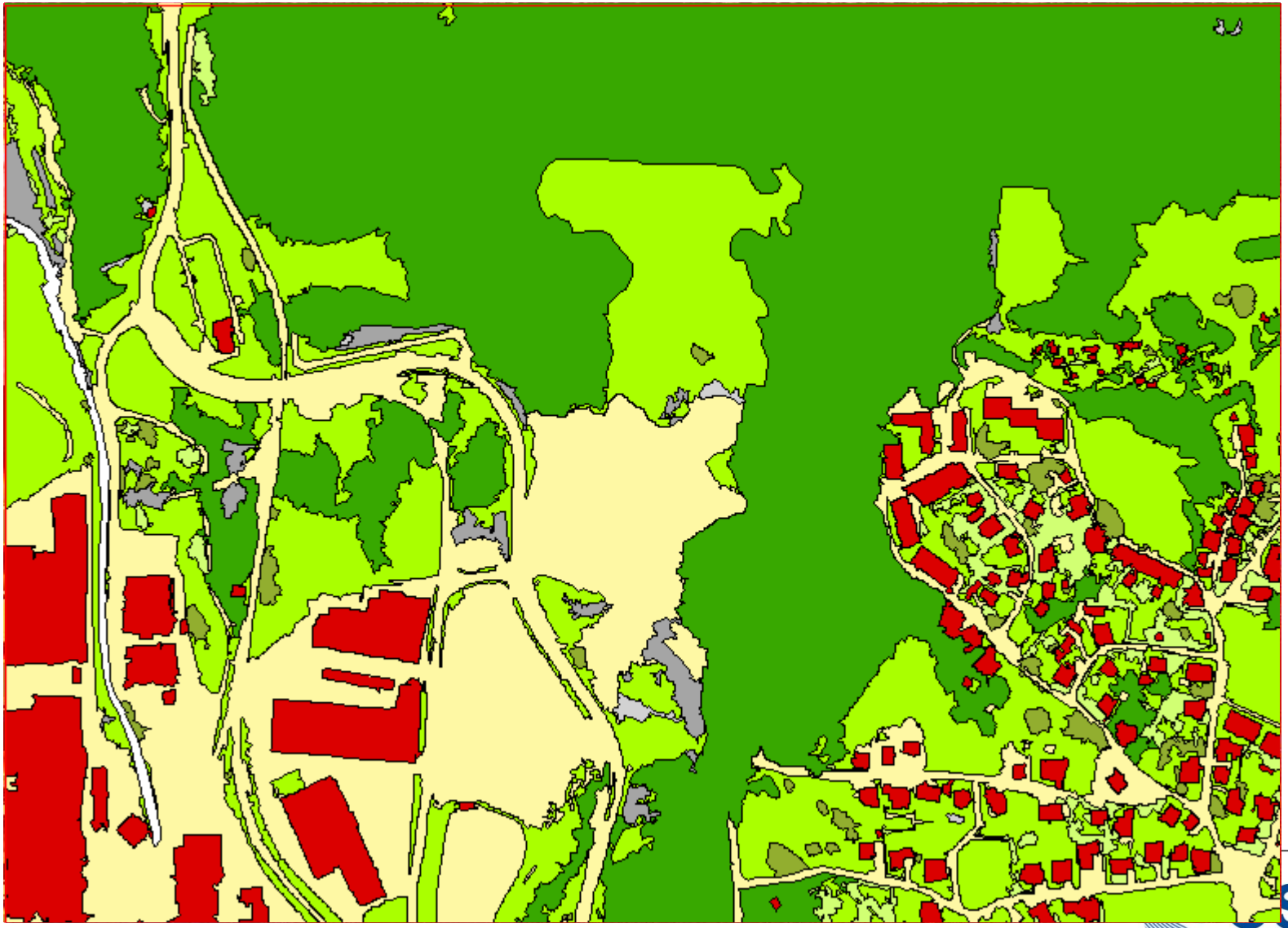
LISA land cover classification



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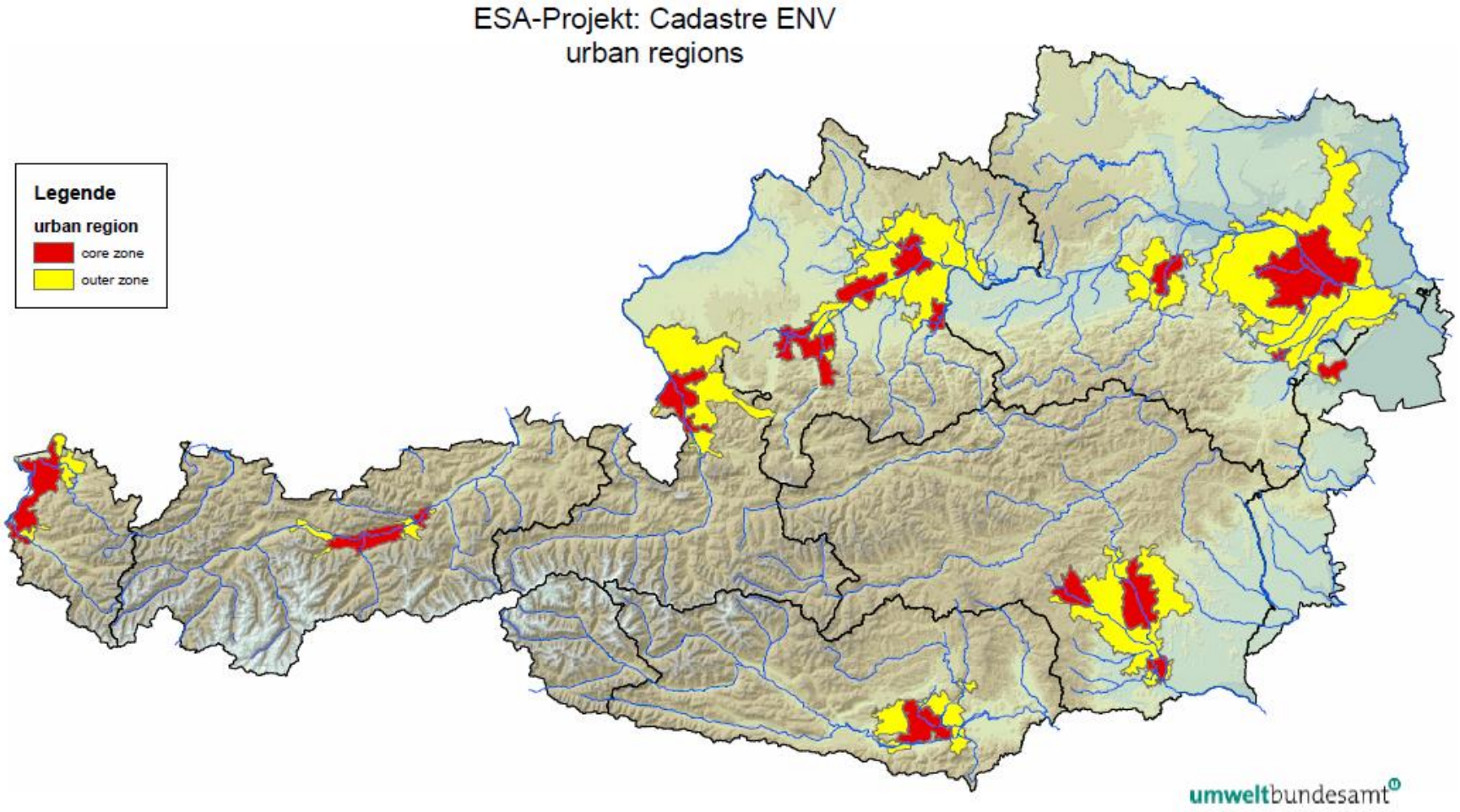
Production: 10.000 km² around cities



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Future developments

- **Integration of COPERNICUS data**
  - SENTINEL-2 data
  - Partly SENTINEL-1 data (radar)
  - GSE Cadaster evironment (ESA financed)
- **Main goals**
  - Characterization of land cover objects
  - Moving towards multi-temporal analysis and multi-annual time lines
  - Differentiation and identification of different types of changes
    - State change
    - Cyclic change
    - Condition change
      - Link to biodiversity
      - MAES…mapping and assessment of ecosystems and their services

Paradigm shift: change in land monitoring

- Change occurs all the time
  - Variable rates and magnitudes
- What matters is then the *process* change
  - Create and label vectors

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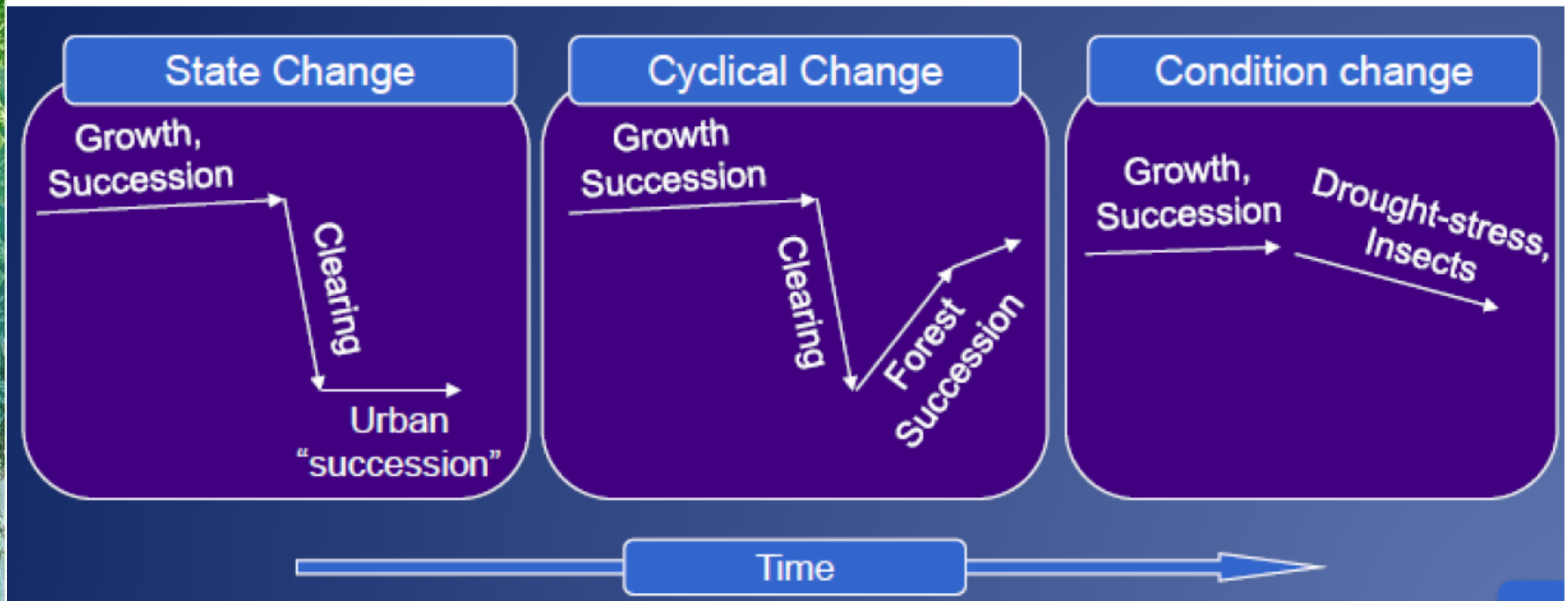

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LISA 1.0: low differentiation in agricultural areas

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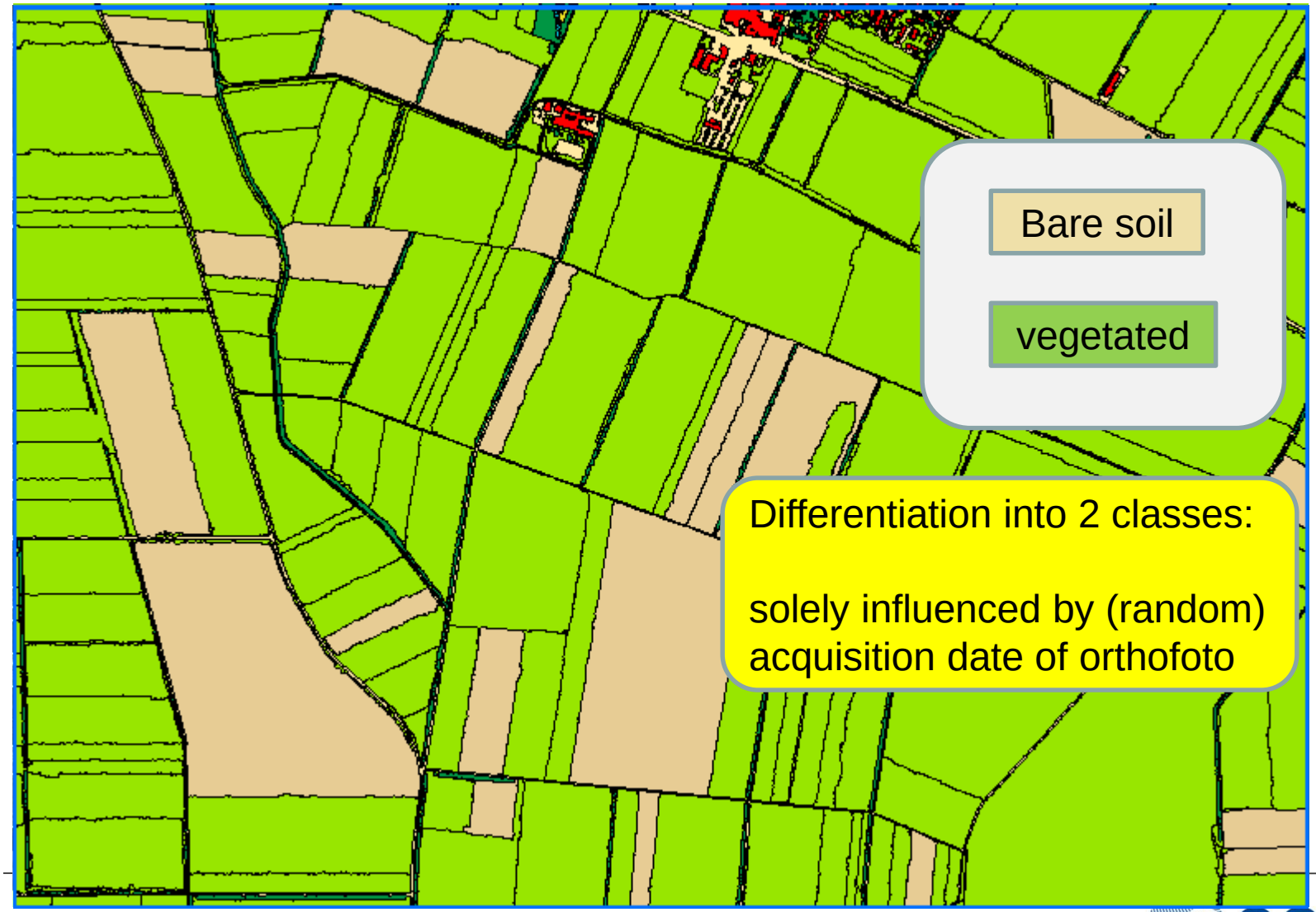
Only 2 classes



How to integrate information on crop roation ?

13. April

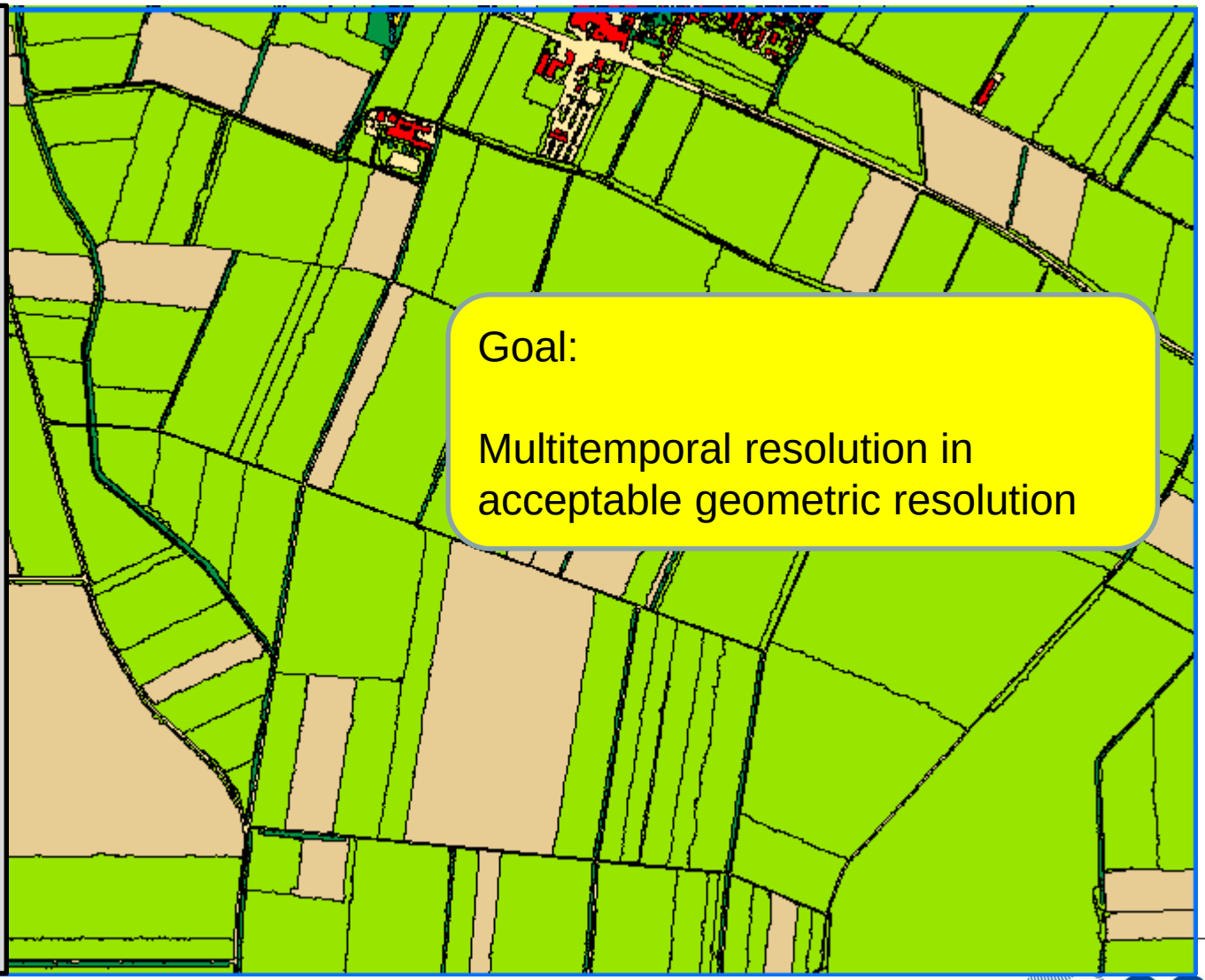
8. May

12. June

7. July

6. August

10. September



Goal:

Multitemporal resolution in acceptable geometric resolution

Multitemporal SPOT 5 data 2015

13. April

8. May

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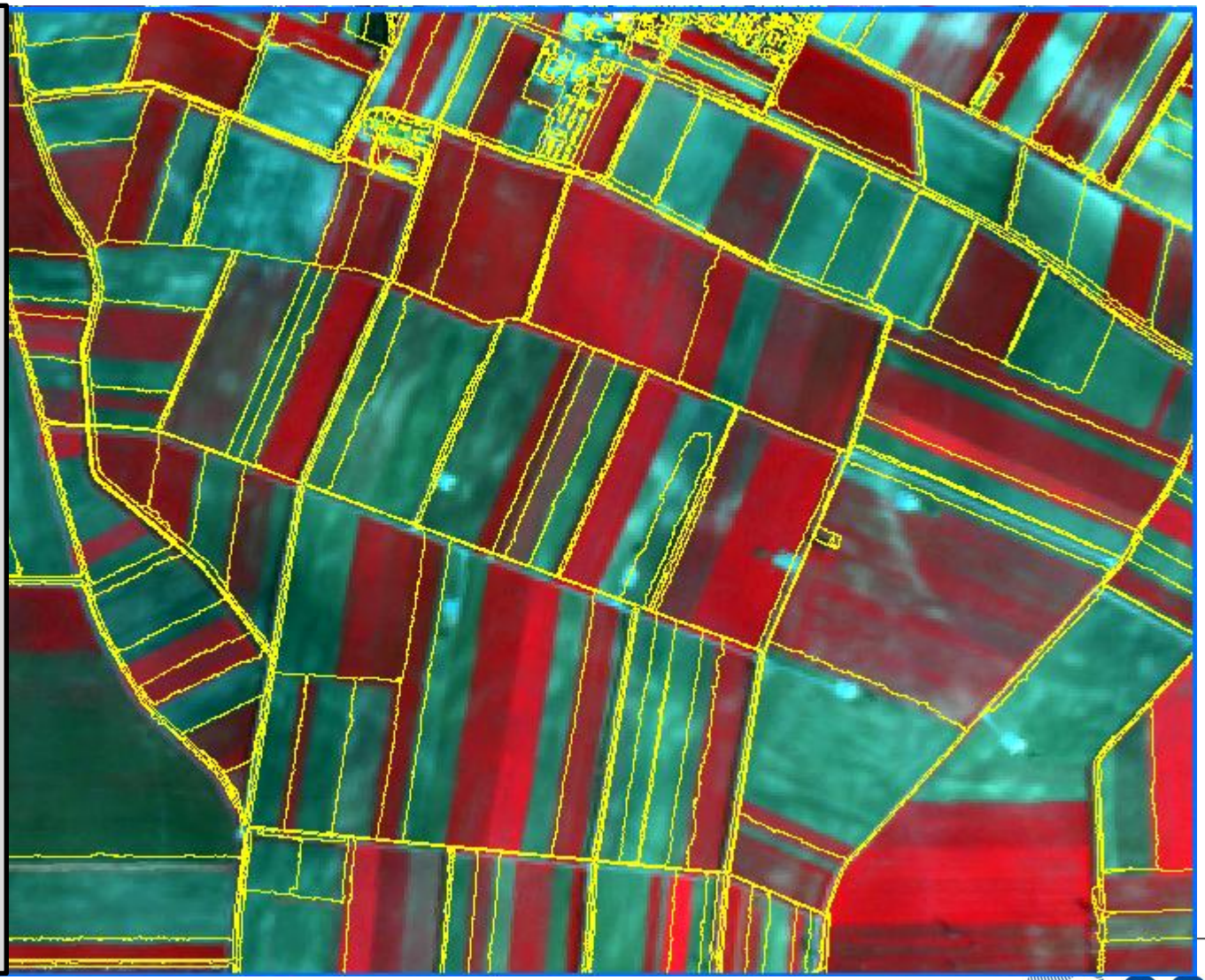
10. September



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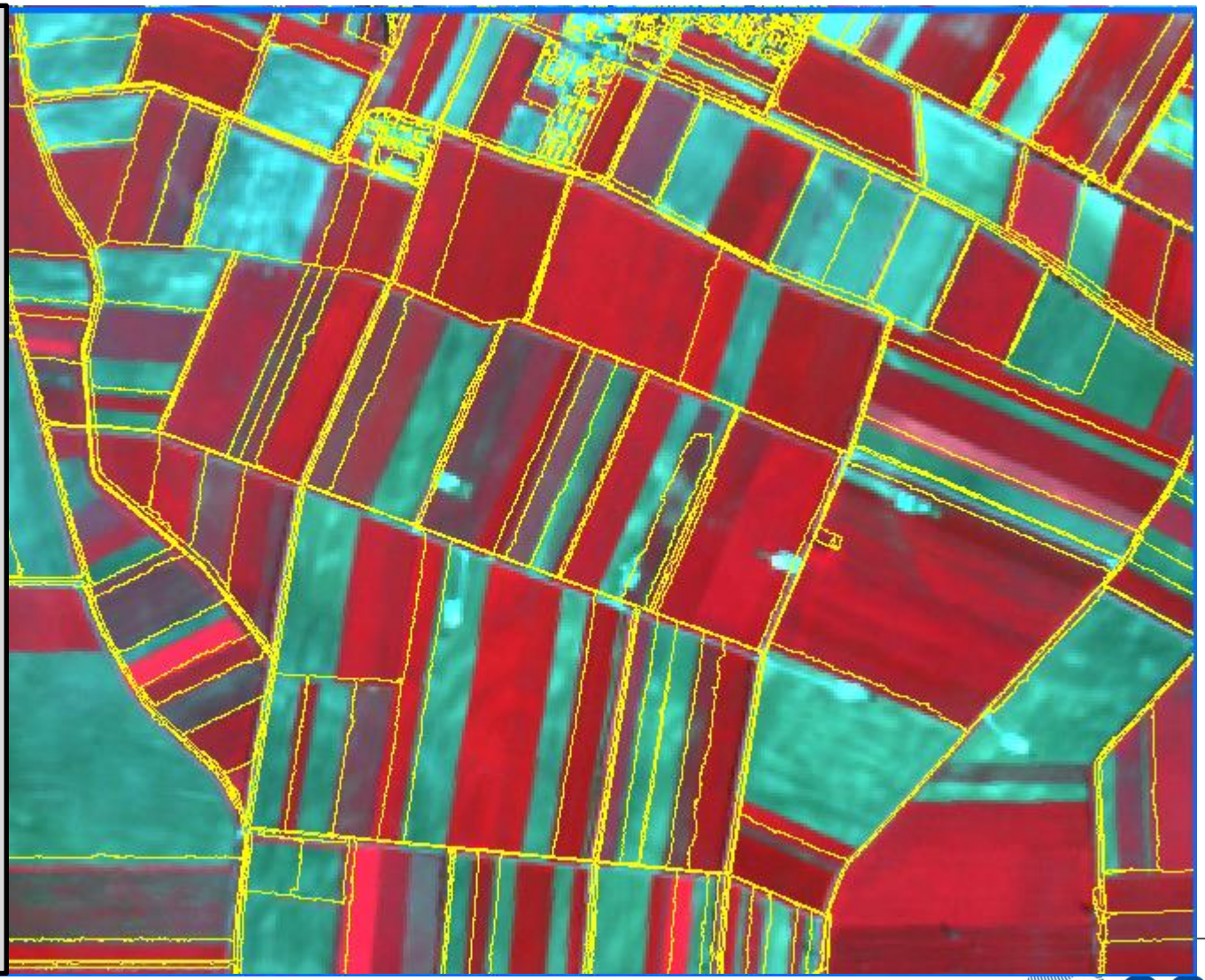

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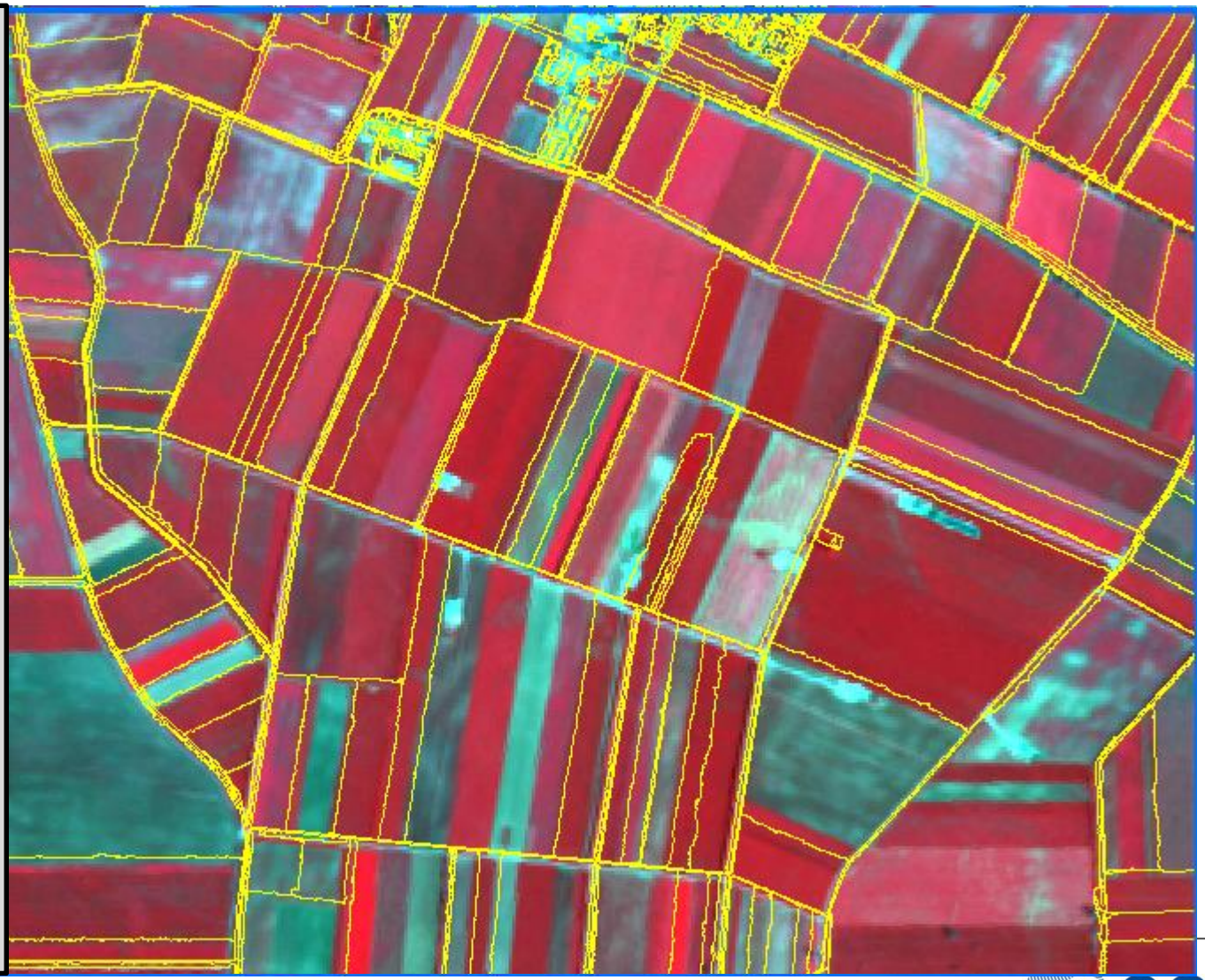

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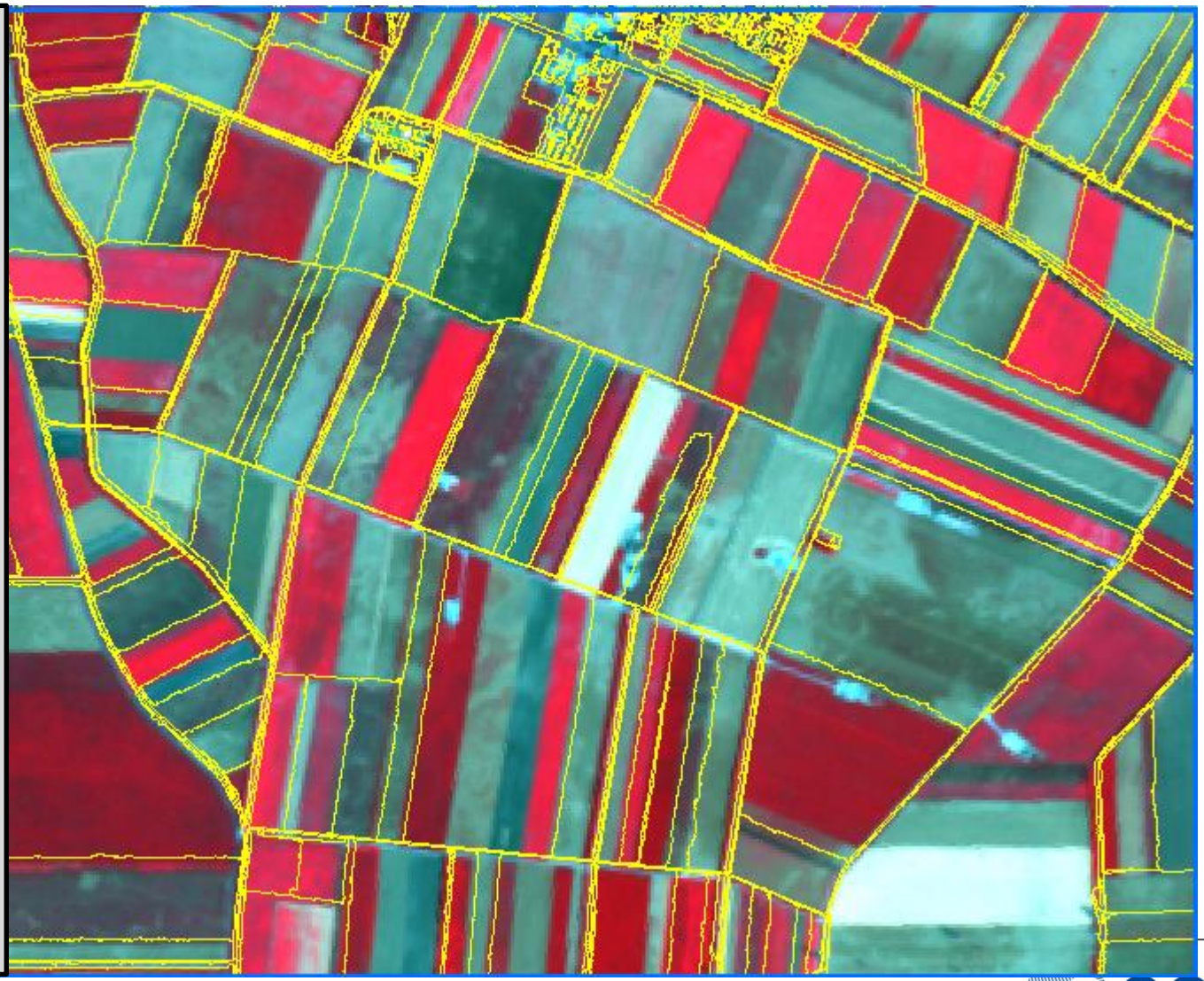

Multitemporal SPOT 5 data 2015

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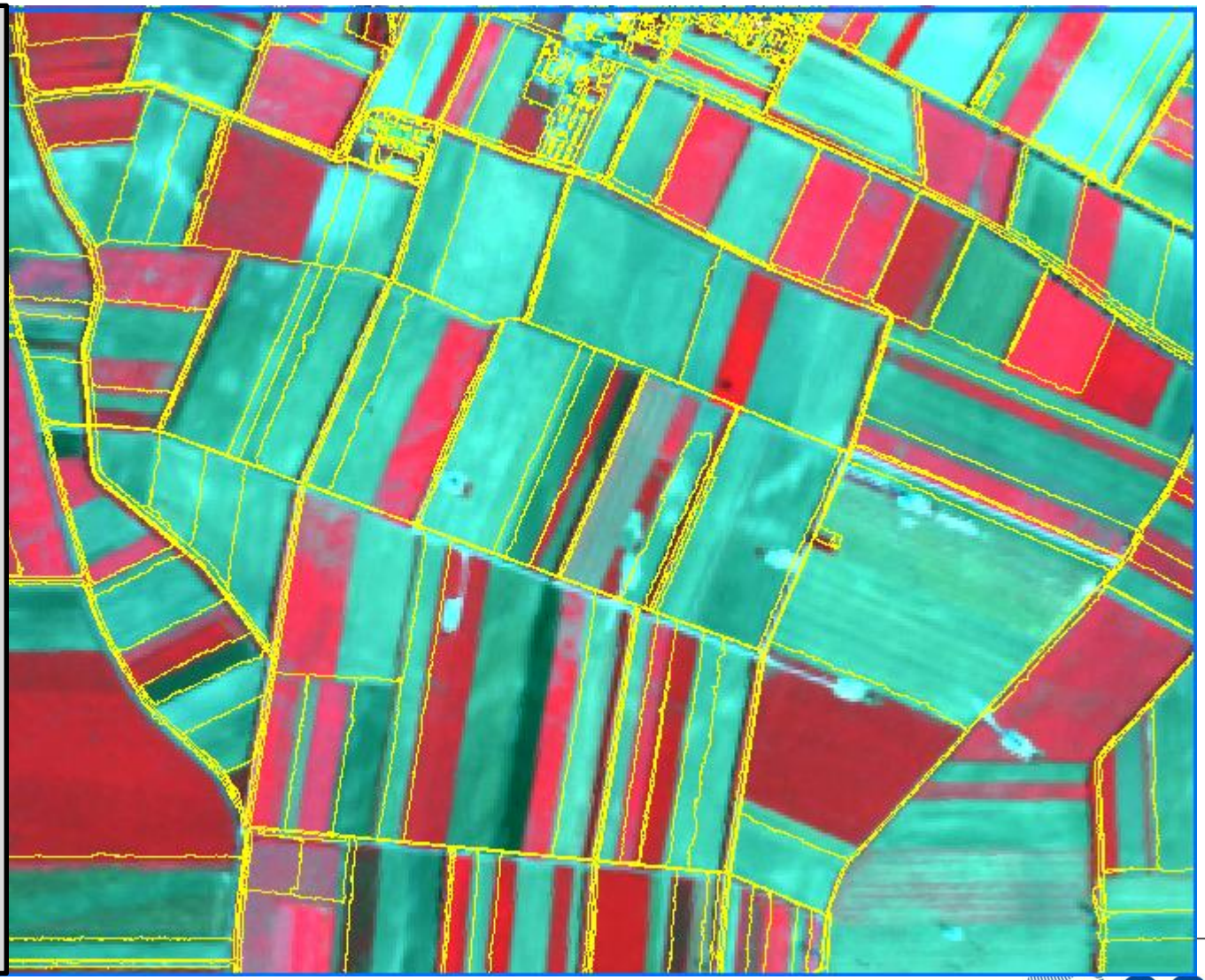

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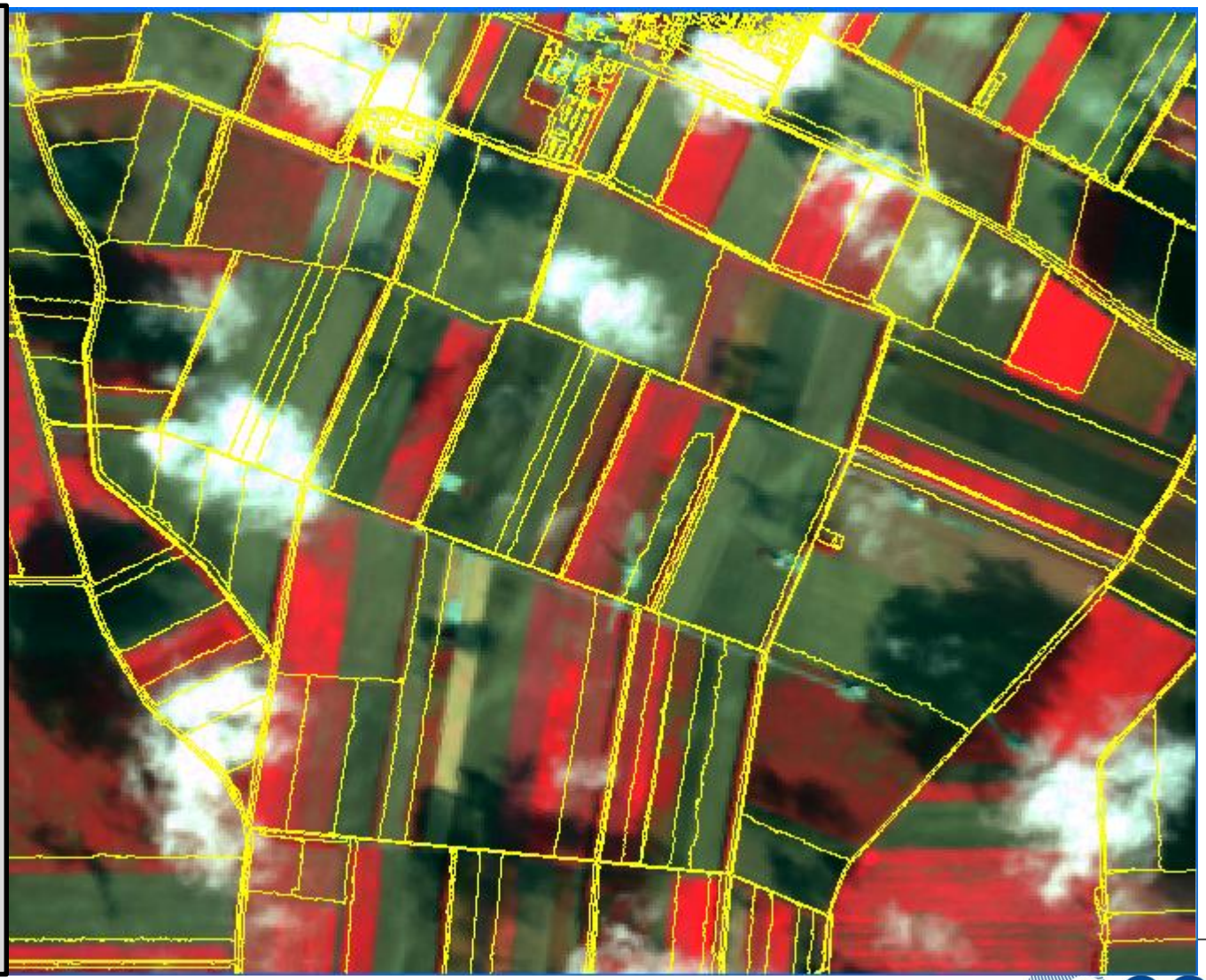
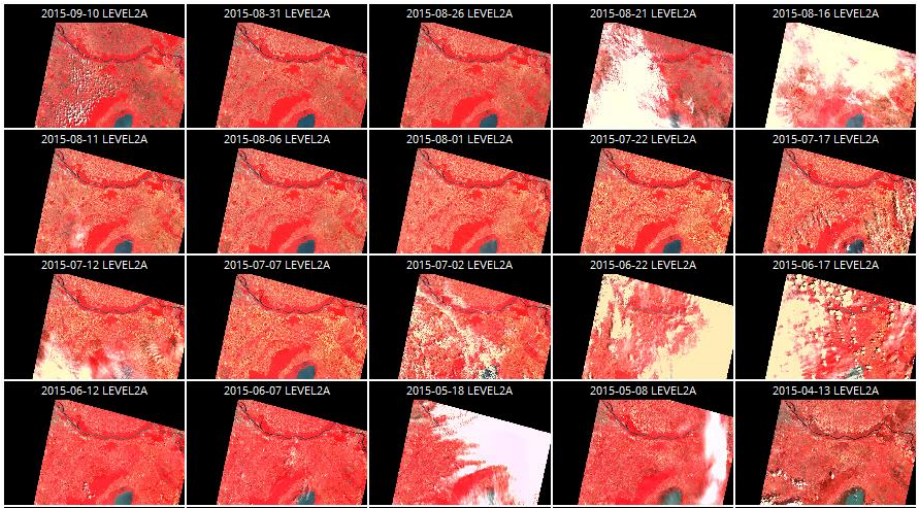


Enhancing temporal information on object level



Analytical unit = object level

- Summary of all valid pixels within one object
- No need for cloud free images
- Robust estimators (e.g. NDVI)
- variance on pixel level is very high, but
- Variance of object MEAN is significant lower

Temporal resolution: 5 days
Geometric resolution: 10*10 m^2

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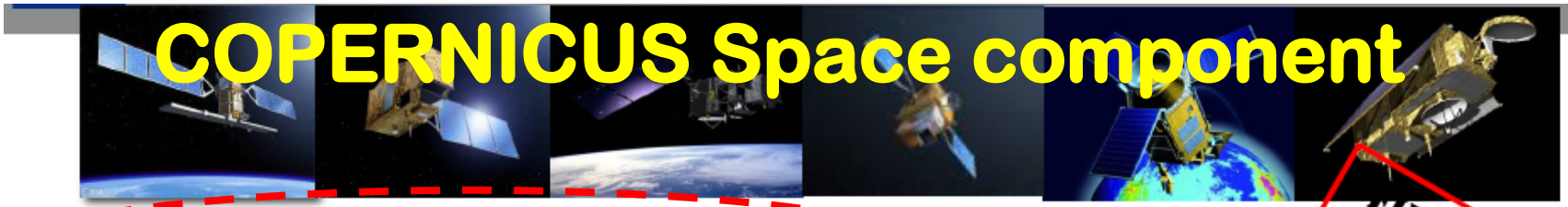
COPERNICUS Space component



S1: Radar Mission

FIRST LAUNCH 3.04.2014

S2: High Resolution Optical Mission

FIRST LAUNCH 23.06.2015

S3: Medium Resolution Imaging and Alti[illegible]ion

S4: Geostationary Atm[illegible]

S5P: Low Earth Orbit A[illegible]rsor Mission

S5: Low Earth Orbit Atmospheric Chemistry Mission

S6 (Jason-CS): Altimetry Mission

Data policy = free and open

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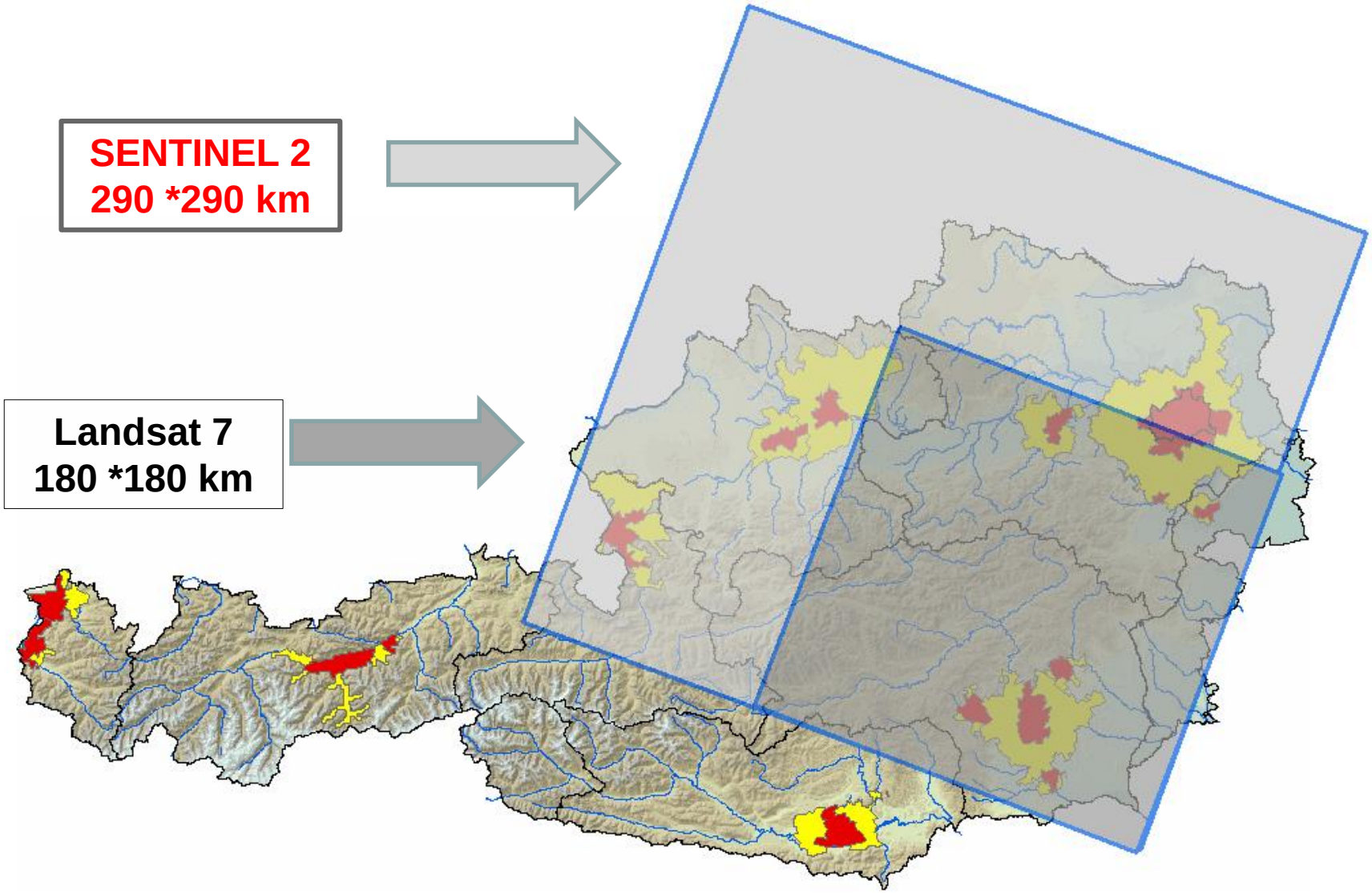
Sentinel -2 Swath Austria

SENTINEL 2
290 *290 km

Landsat 7
180 *180 km



SENTINEL -2 vs. Landsat 7

- **Higher spatial resolution**
  - 10 m vs. 30 m
- **Larger area extent**
  - 290 km vs. 180 km
- **Higher temporal resolution**
  - 2 to 3 days vs. 16 days
- **More bands**
  - 12 bands vs. 7 bands
- **Improved spectral resolution**
  - red-edge band
- **Improved radiometric resolution**
  - 12 bit vs. 8 bit
- **Data policy**
  - Free ad open vs. prior: app. 5.000.- EURO / scene

Vegetation periode:
April-September
Estimation Austria: every 2. aquisition cloud free

→ appr. 30 aquisition/year

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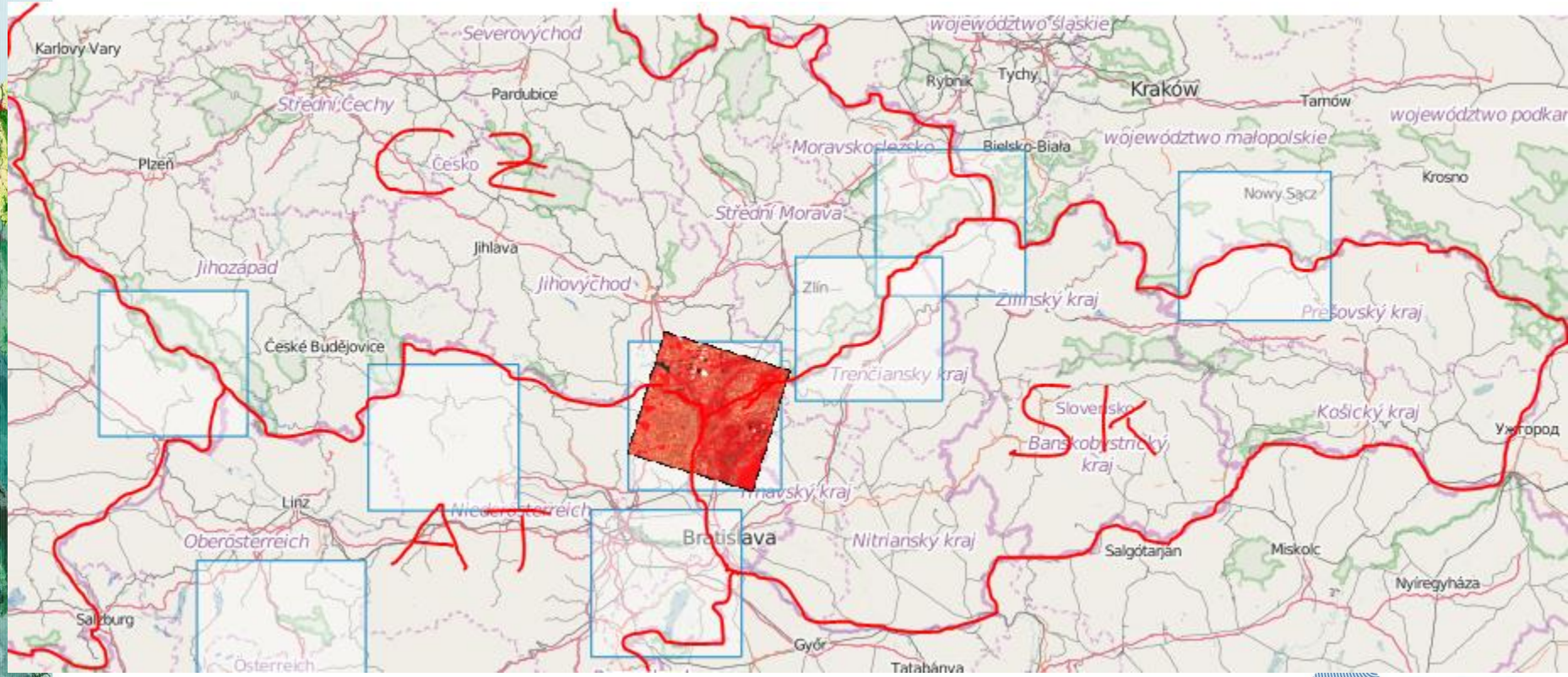
CZ-SK-AT study site

- SENTINEL-2 simulation data: SPOT-5 Take 5 experiment (2015)
- https://spot-take5.org/client/#/products/SPOT5?site=LanzhotCzech
- Free data download

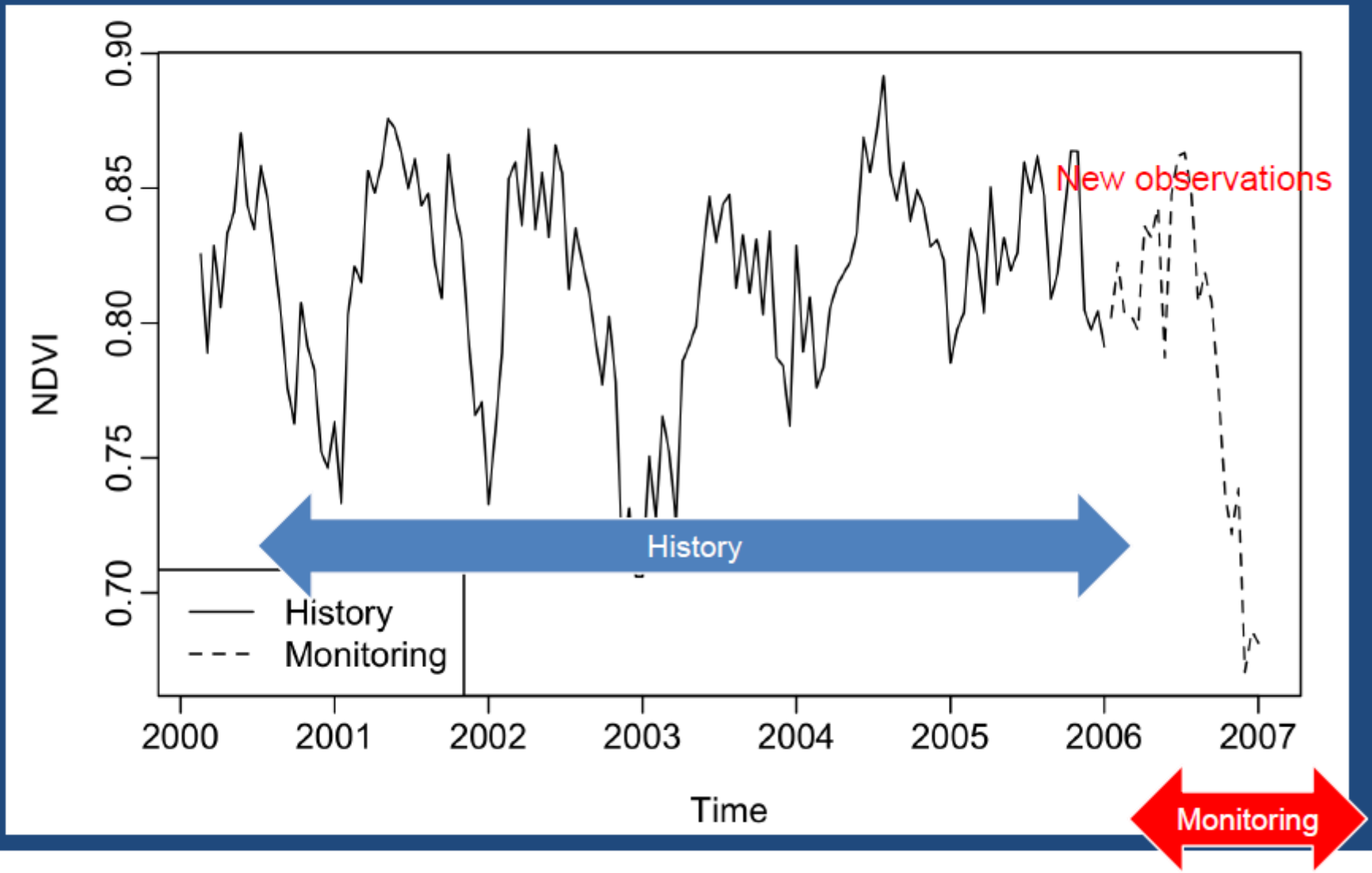


GSE Cadaster Environment (LISA 2.0)

- Consolidate the Austrian **multi-scale** and **multi-purpose** Land Monitoring system, integrating Sentinel 2 data in the Land Information System Austria (LISA)
  - **Multi-scale**: optimised and combined use of EO from static VHR imagery (orthophotos/Pleiades) and multi-temporal HR time series (Sentinel 2).
  - **Multi-purposes**: S2-based land monitoring system for detection of Land Cover/Land Use and ecosystem/habitat change.
- Compliance with the **EAGLE** European land cover harmonisation lead by the European Environment Agency.
- Two **international workshops** to share experiences and build synergies with other national initiatives.

Land Cover Mapping		Land Cover / Land Use Monitoring		
HR Land Cover Mapping	**Enriched VHR LC Mapping**	**LC Change Alert system**	**Land Use monitoring**	**Ecosystem Status monitoring**
Sentinel 2 based Land cover map	VHR LC classification enriched with S2	Detection of hot-spots of changes	Detection of cyclical changes	Detection of land conditional changes
S2A	Pleiades + S2A	L8, SPOT-5, S2A	S2A	L8, SPOT-5, S2A
84,000 km2	10,000 km2	16,800 km2	16,800 km2	3,000 km2
2016	2016	2014-16	2016	2014-2016

Methodology



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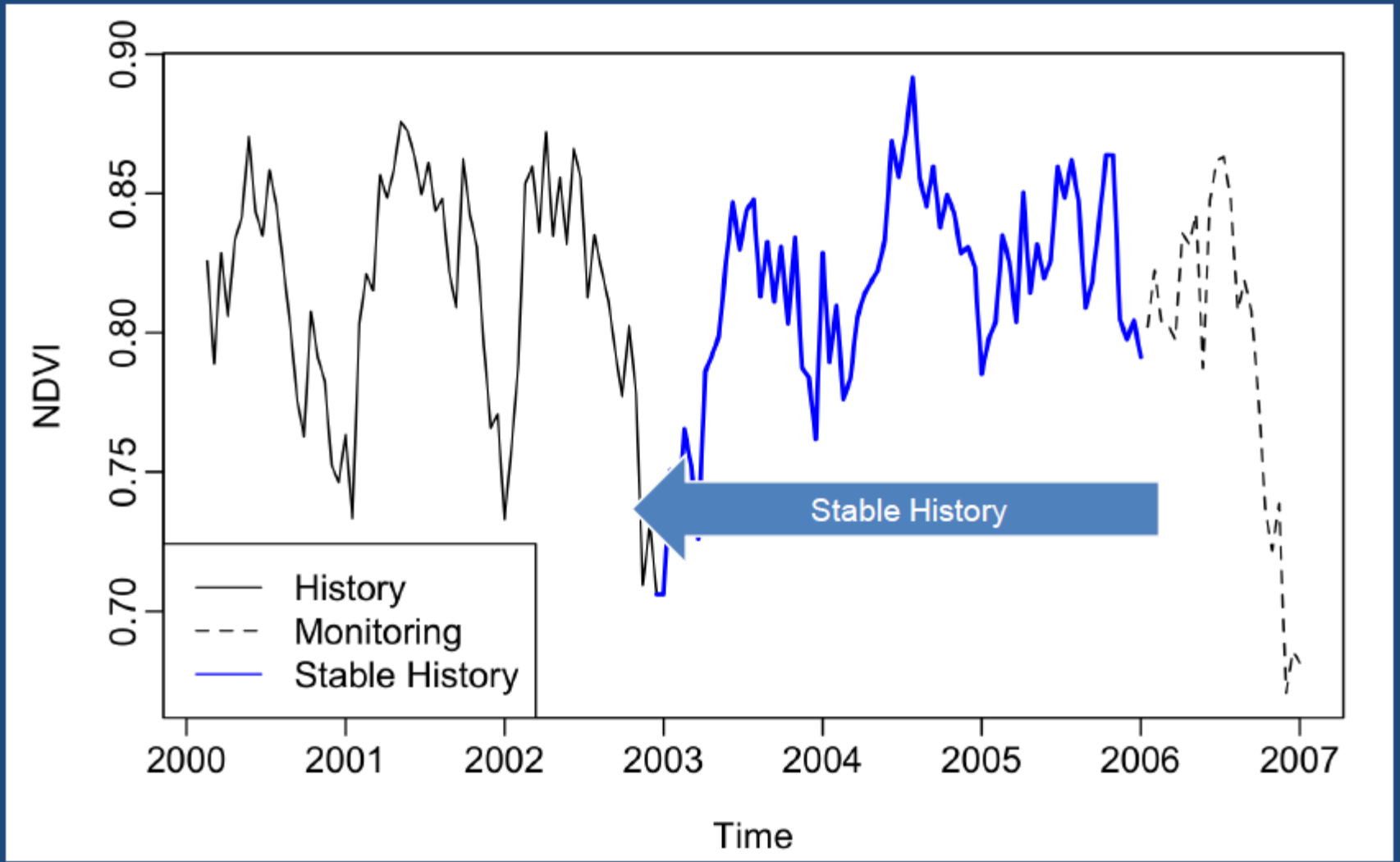
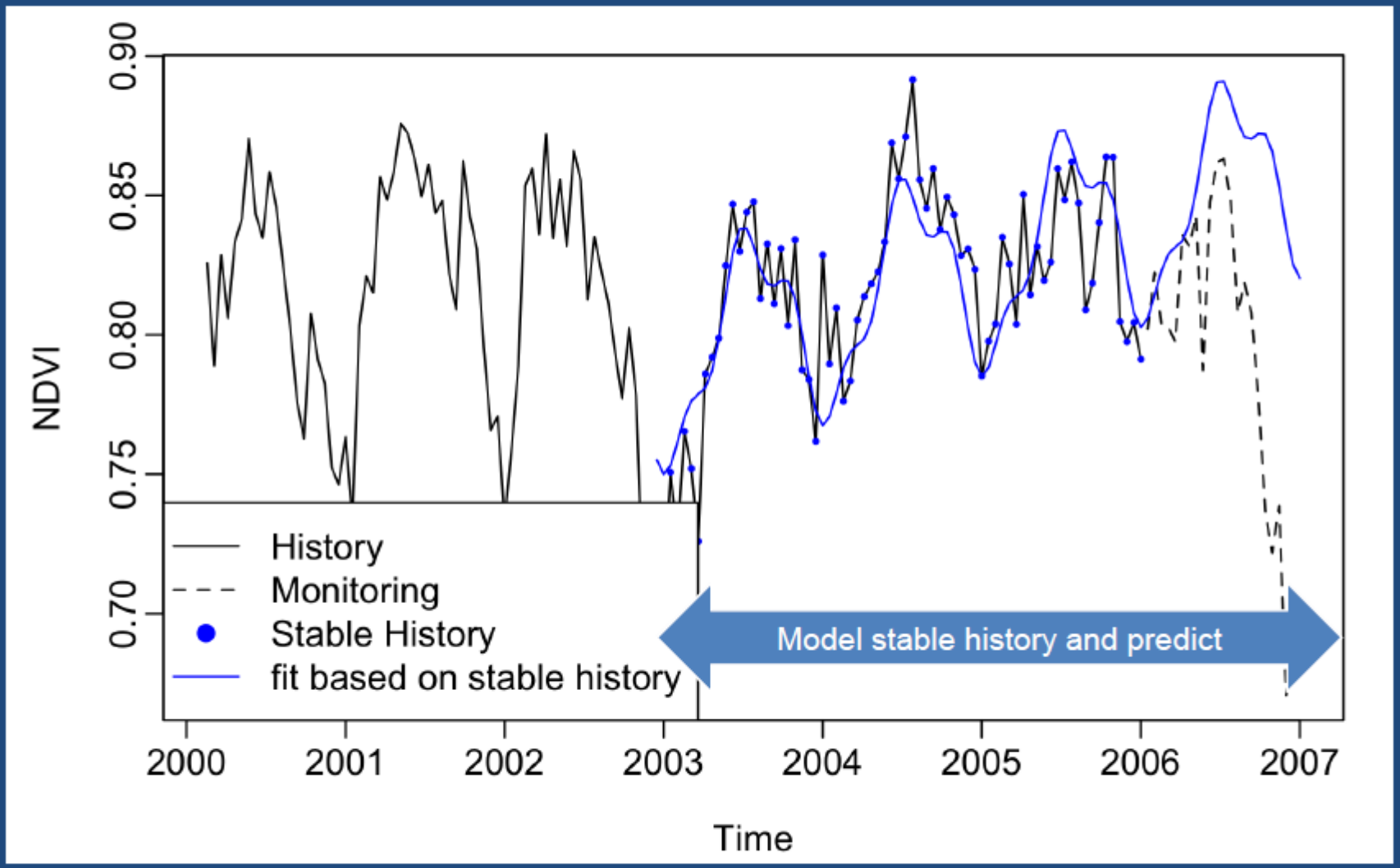


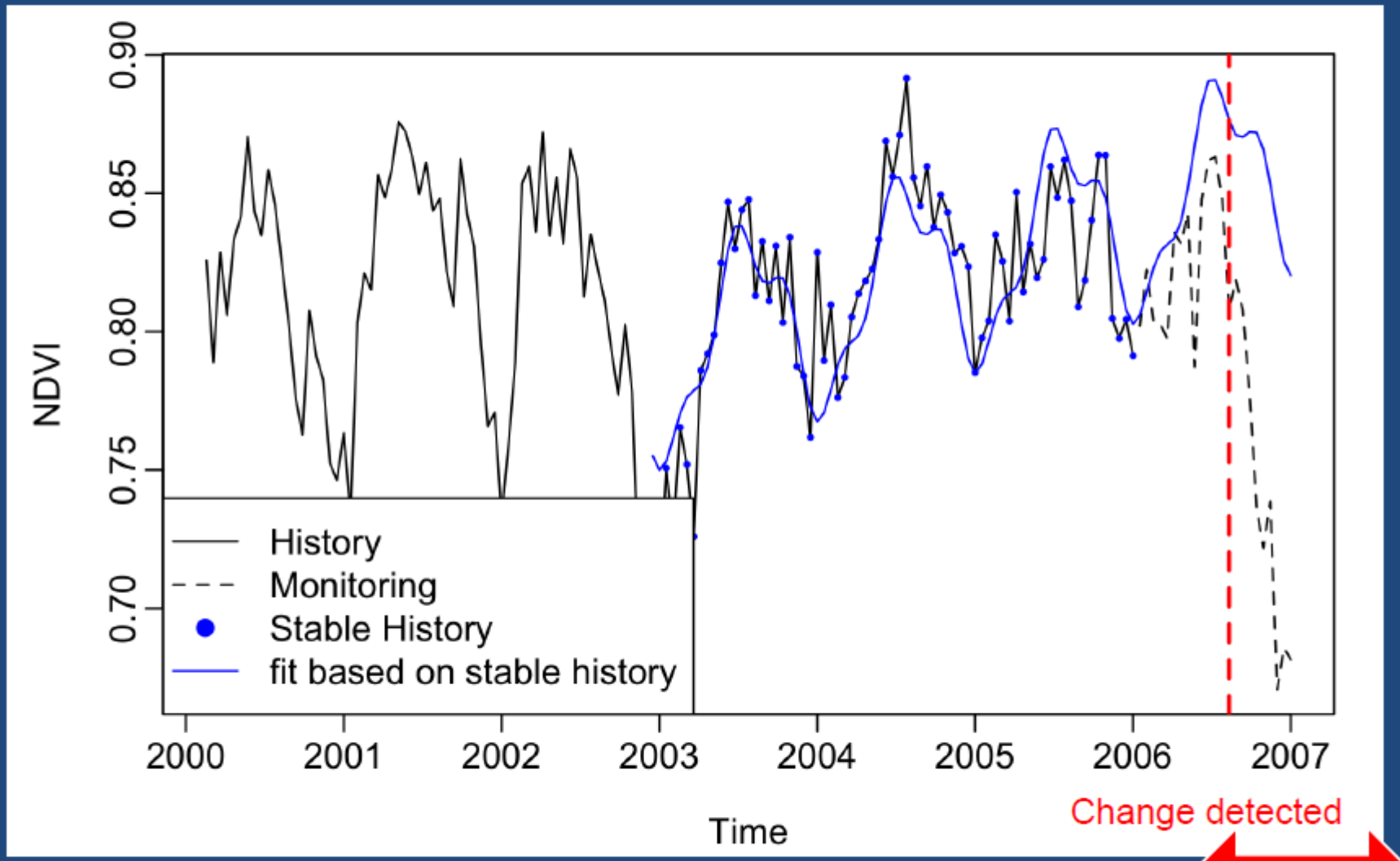
WAGENINGEN UNIVERSITY
WAGENINGEN UR

Verbesselt, A. Zeileis, and M. Herold, Near Real-Time Disturbance Detection using satellite Image Time Series (2012), Remote Sensing of Environment.

Methodology



Methodology



LISA – cooperation project

- **Prime service provider:**
  - GeoVille GmbH, Innsbruck
  - Joanneum, Graz
- **Scientific team:**
  - AIT Austrian Institute of Technology, University of Life Sciences (BOKU), Technical University Vienna
- **Users:**
  - Umweltbundesamt, BEV, ministry for agriculture & environment, statistical office Austria, regional states, …
- **Financing programm**
  - FFG – Austrian Space and application programme
  - ESA – European Space Agency
  - EEA – European Environment Agency (EAGLE)
  - COPERNICUS programme (EAGLE)

Data from
www.landinformationsystem.at
Contribution to

WMTS-Service
www.basemap.at

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Thank you for your attention

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