Land Cover Classification using remote sensing data

The Austrian Approach

Reinfried MANSBERGER

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Content

- Definitions, Definitions, Definitions ….
- Why Land Administration
- Principles and Tools of LA
- Concepts of LAS
- Trends

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Remote Sensing
Definition

Traditionally:

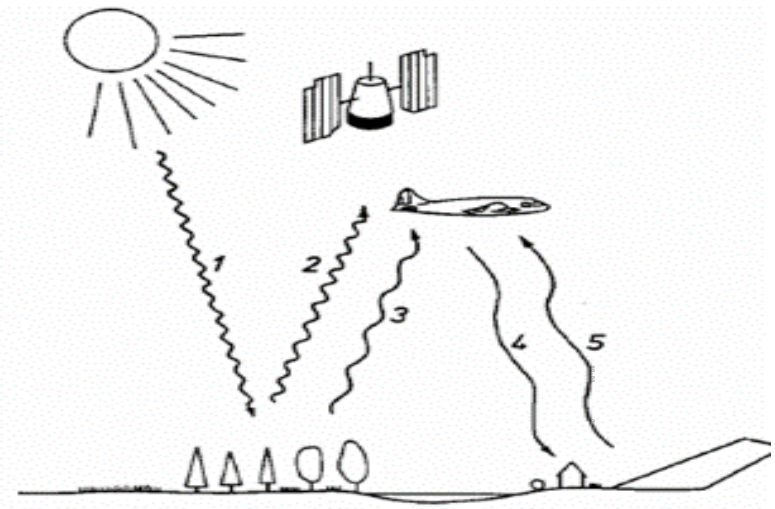
"Remote sensing is the acquisition of information about an object by a recording device that is not in physical contact with it."

Today:

"…the process of collecting, viewing, interpreting, and analyzing aerial or satellite-based images and geodata."

Distinction of methods of Remote Sensing:

- radiation path (passive & active)
- platform (satellite, plane, UAV, terrestrial)
- sensor



Remote Sensing Applications

in general:

- Environment Analysis
- Civil Engineering
- Disaster Management / Risk analysis
- Urban Planning / Growth
- Rural Planning
- ...

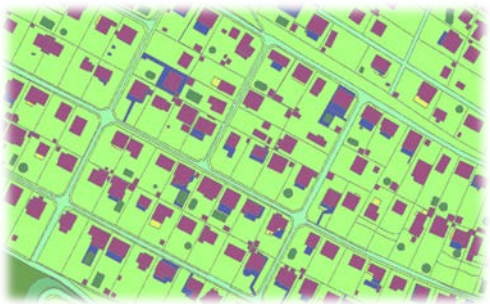
Need for…

…Remote Sensing Data

in different scales / resolutions

for Sustainable Land Management:

- Monitoring of spatial and temporal environment changes (Land Cover, Land Use)



Remote Sensing
Platforms

- Satellites (commercial)

  AVHRR *(1100 m resolution)*
  - ASTER *(15 m resolution)*
  - RapidEye *(6.5 m resolution)*
  - Pleiades *(0.7 m resolution)*
  - Worldview-3 *(0.31 m resolution)*
  - *…*

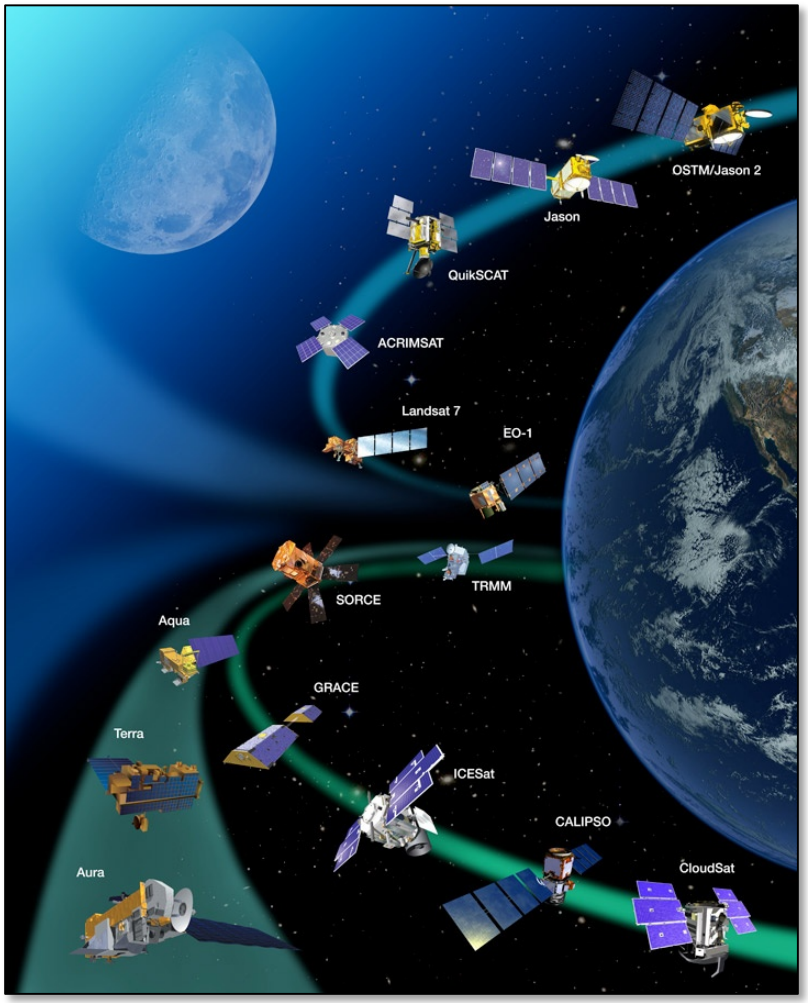
- Satellites (free access)
  - Landsat *(30 m resolution)*
  - Sentinel-2 *(10 m resolution)*

- Aircrafts *(up to 5 cm resolution)*
  - Planes
  - Helicopters

- UAVs (Unmanned Aerial Vehicles)

  (up to sub-millimeter resolution)
  - Fixed-wing
  - Rotary-wing
  - Balloons
  - Kites

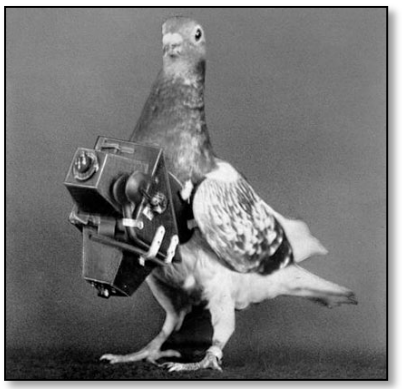
Remote Sensing
Platforms



http://www.luftbild-salzburg.com/img/remos1.jpg

http://www.luftbild-salzburg.com/img/trike.jpg

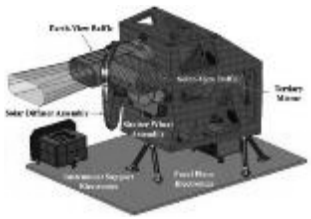
IVFL/IAN

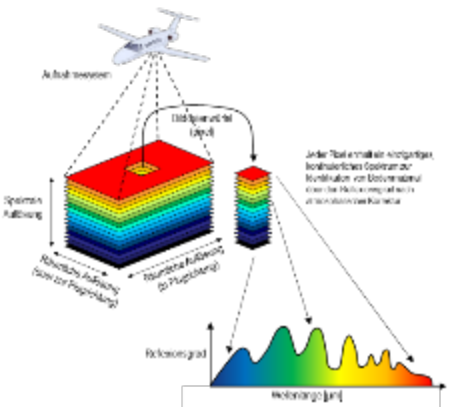


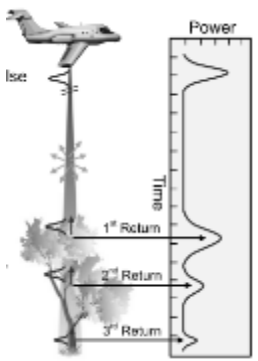
Remote Sensing
Sensors

Sensors are distinguished by the inner geometry, as well as the geometric, spectral and radiometric resolution. (Note: the temporal resolution is defined by the platform)

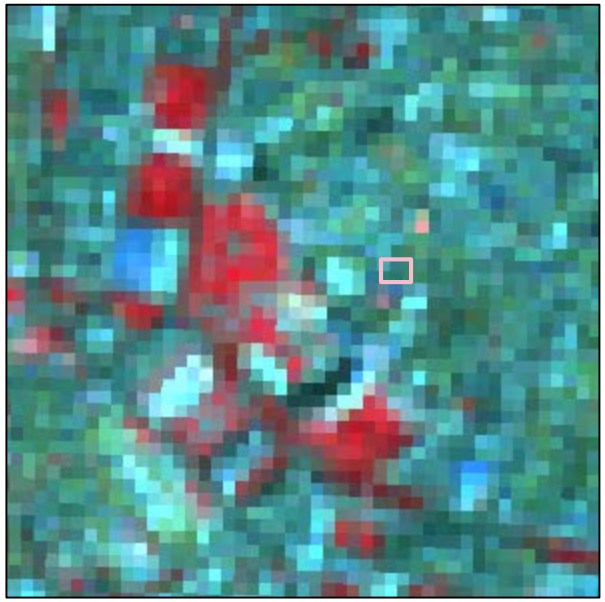
- Photographic camera *(a standard camera)*
- Photogrammetric camera *(for professional photo flights)*
- Airborne Laserscanner (ALS) *(for elevation models)*
- Multispectral-Scanner *(more than 3 channels)*
- Hyperspectralscanner *(a lot more than 3 channels in fine resolution)*
- Thermalscanner *(temperature)*
- Radar *(microwaves, (for elevation models, soil moisture)*

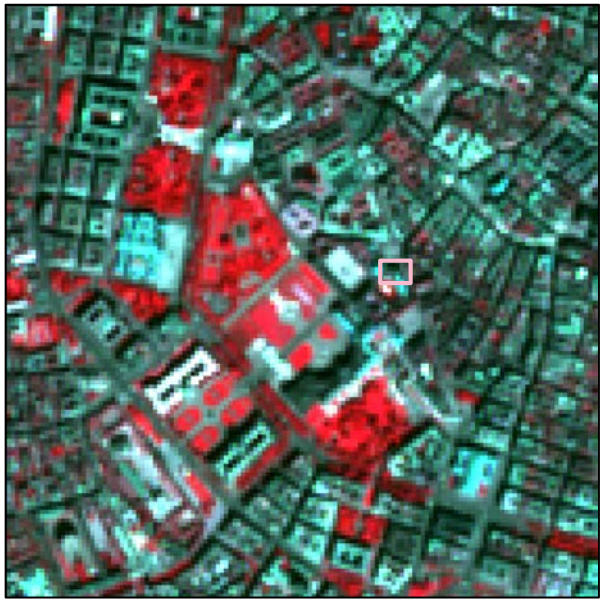






Remote Sensing
Spatial Resolution





Source: ViennaGIS

Satellite Image Landsat 8

Multispectral sensor

Spatial resolution: 30 m

shown channels: NIR, R, B

Acquisition date: 2015

Satellite Image Sentinel-2

Multispectral sensor

Spatial resolution: 10 m

shown channels: NIR, R, B

Acquisition date: 2015

Orthophoto

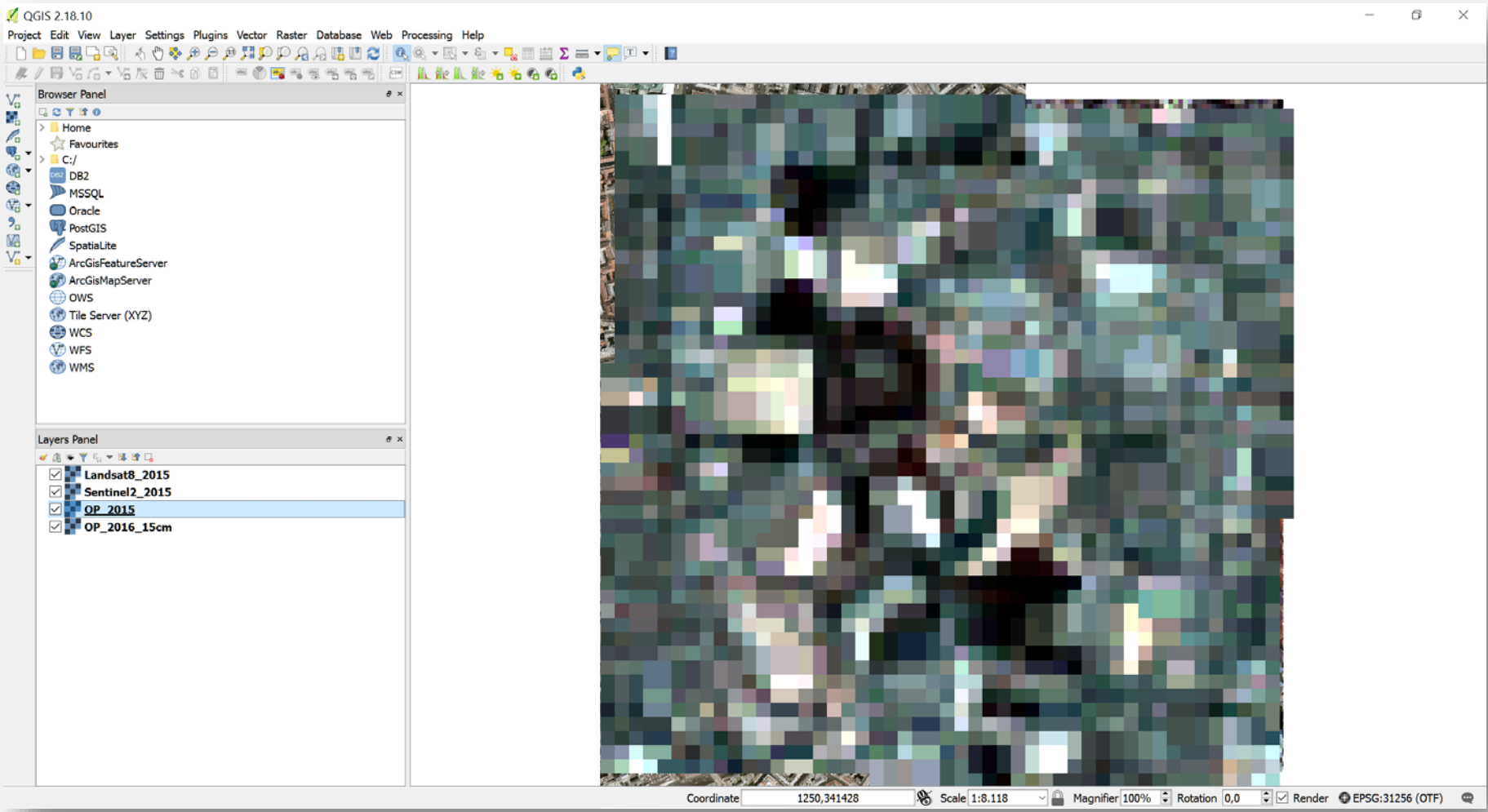
Photogrammetric Camera

Spatial resolution: 15 cm

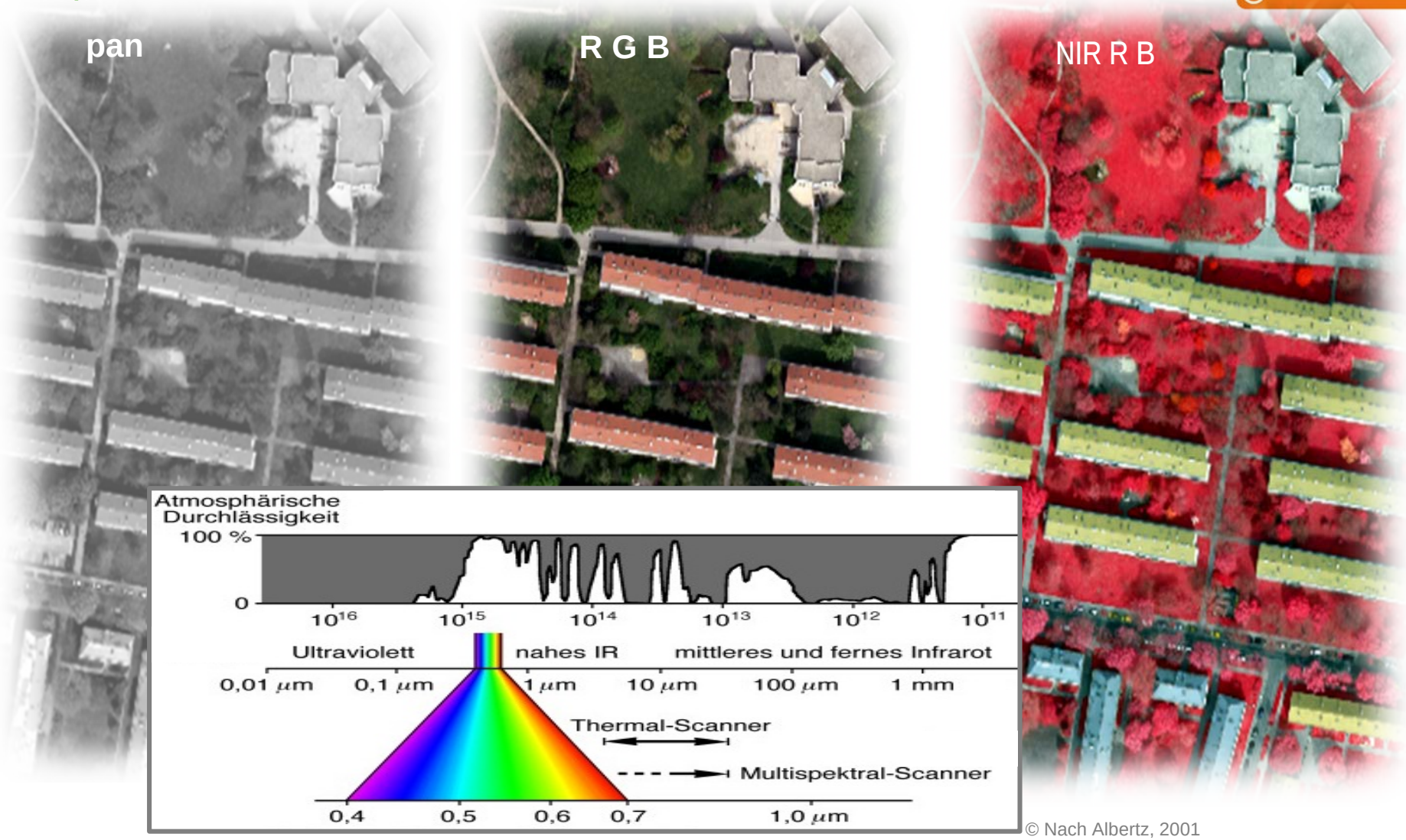
shown channels: NIR, R, B

Acquisition date: 2015

Remote Sensing
Demo 1: Spatial Resolution

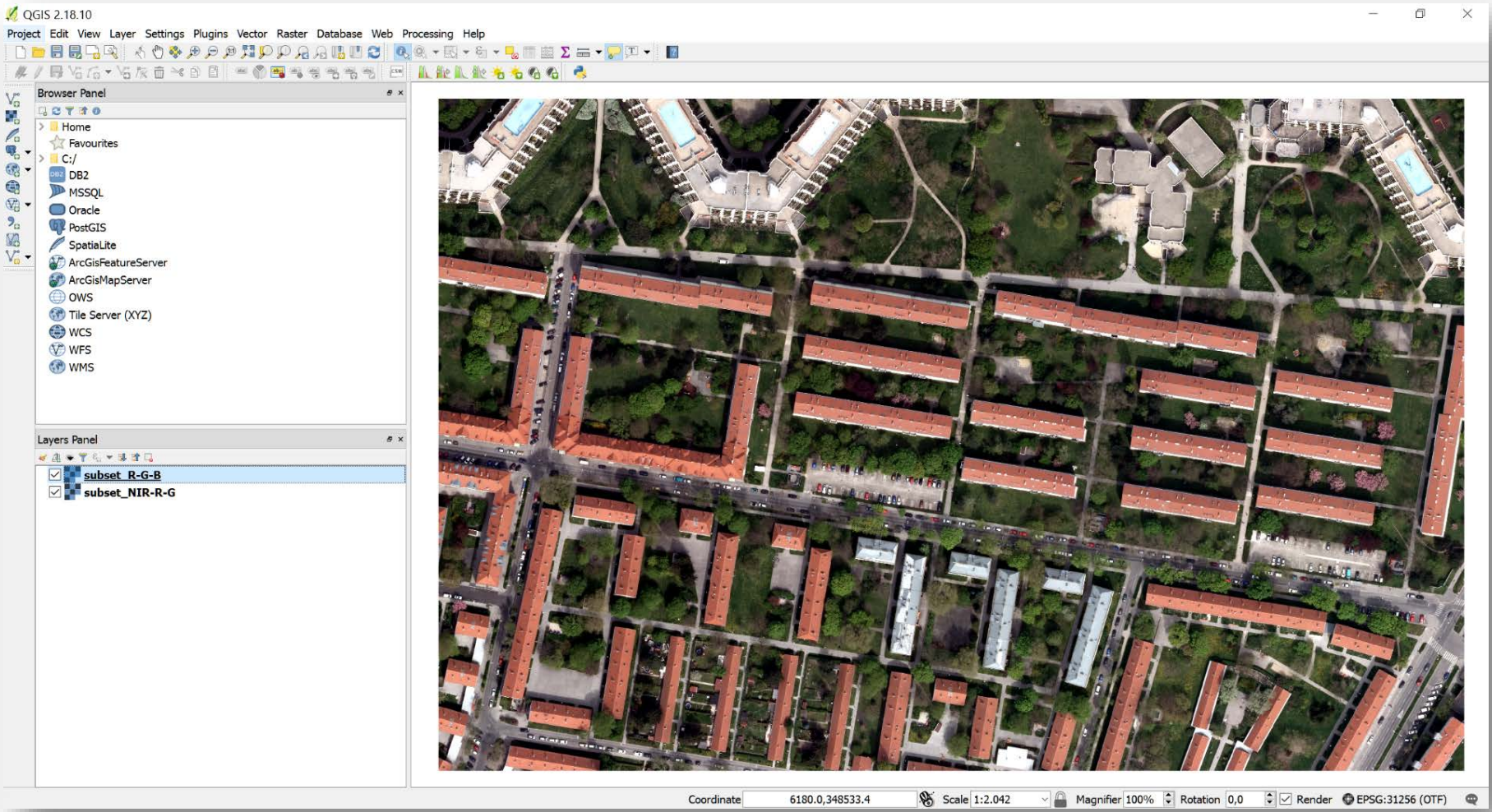


Remote Sensing
Spectral Resolution



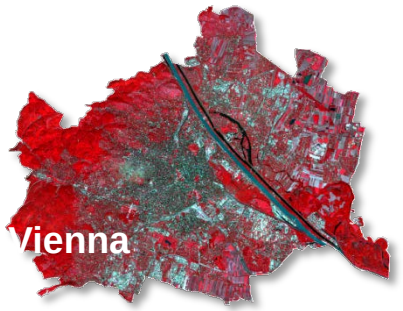
© Nach Albertz, 2001

Remote Sensing
Demo 2: Spectral Resolution

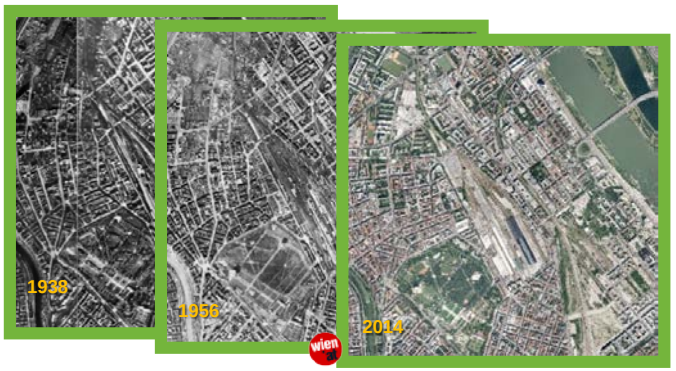


Remote Sensing
Temporal Resolution

- Satellites
  - Geostationary satellites → high temporal resolution, but only limited area
  - orbiting satellites → from days to weeks
  - oldest data from ~1970s

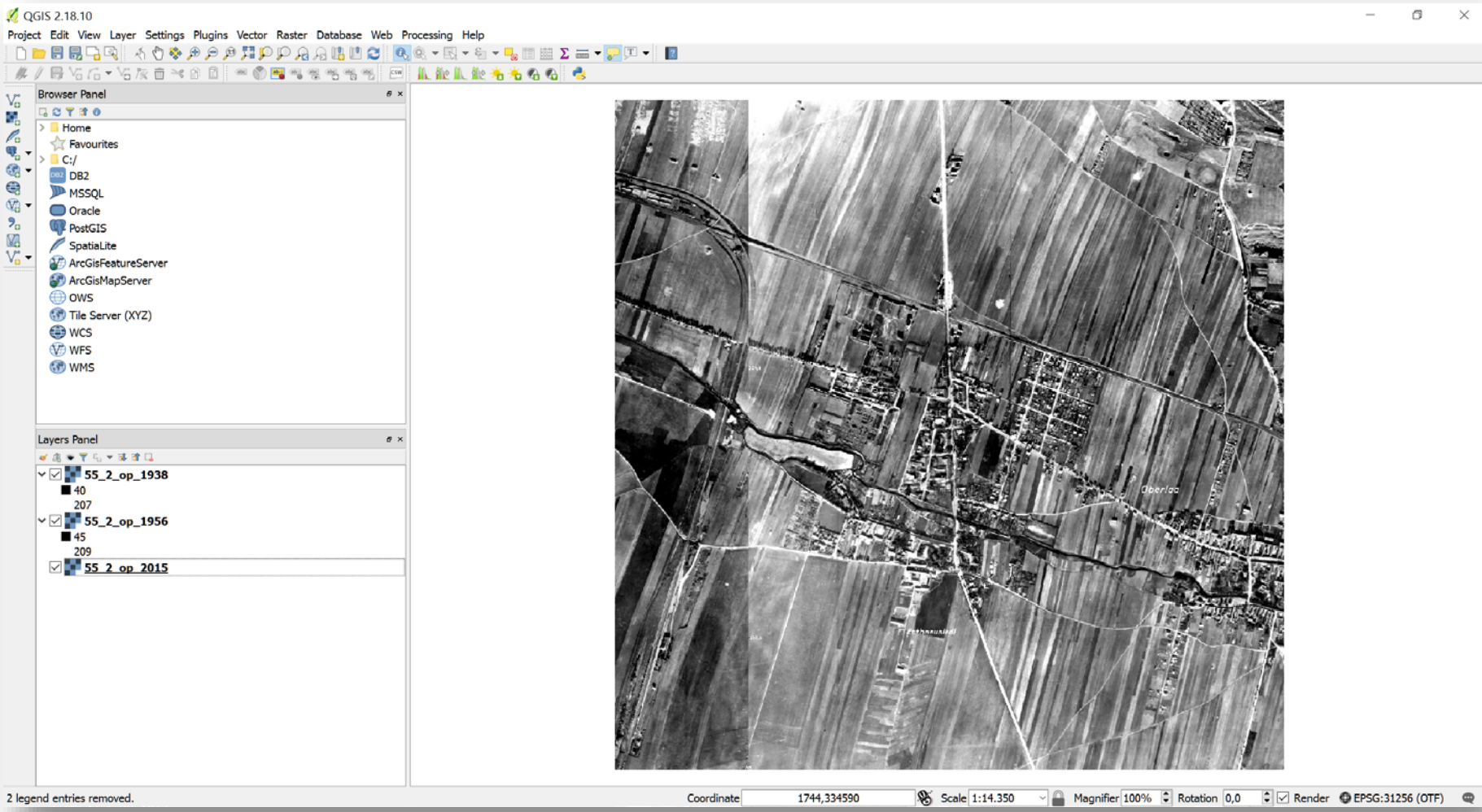


- Orthophotos
  - on demand
  - in Austria: countrywide flights every 3 years
  - oldest (available) data (in Austria) from 1938 → varying



- UAV
  - on demand → very high temporal resolution possible

Remote Sensing
Demo 3: Temporal Resolution

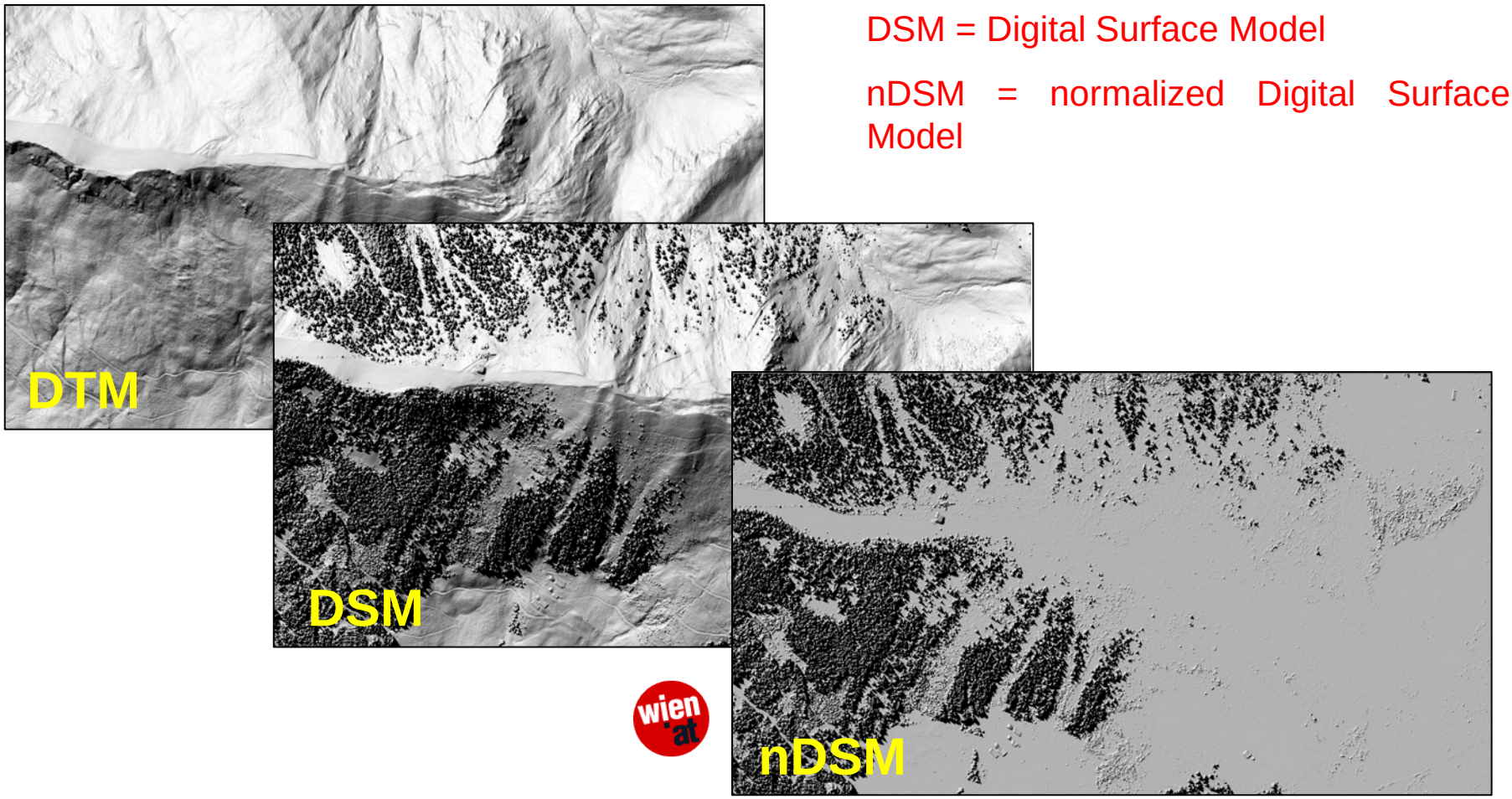


Remote Sensing
Airborne Laserscan Data (ALS)

DTM = Digital Terrain Model

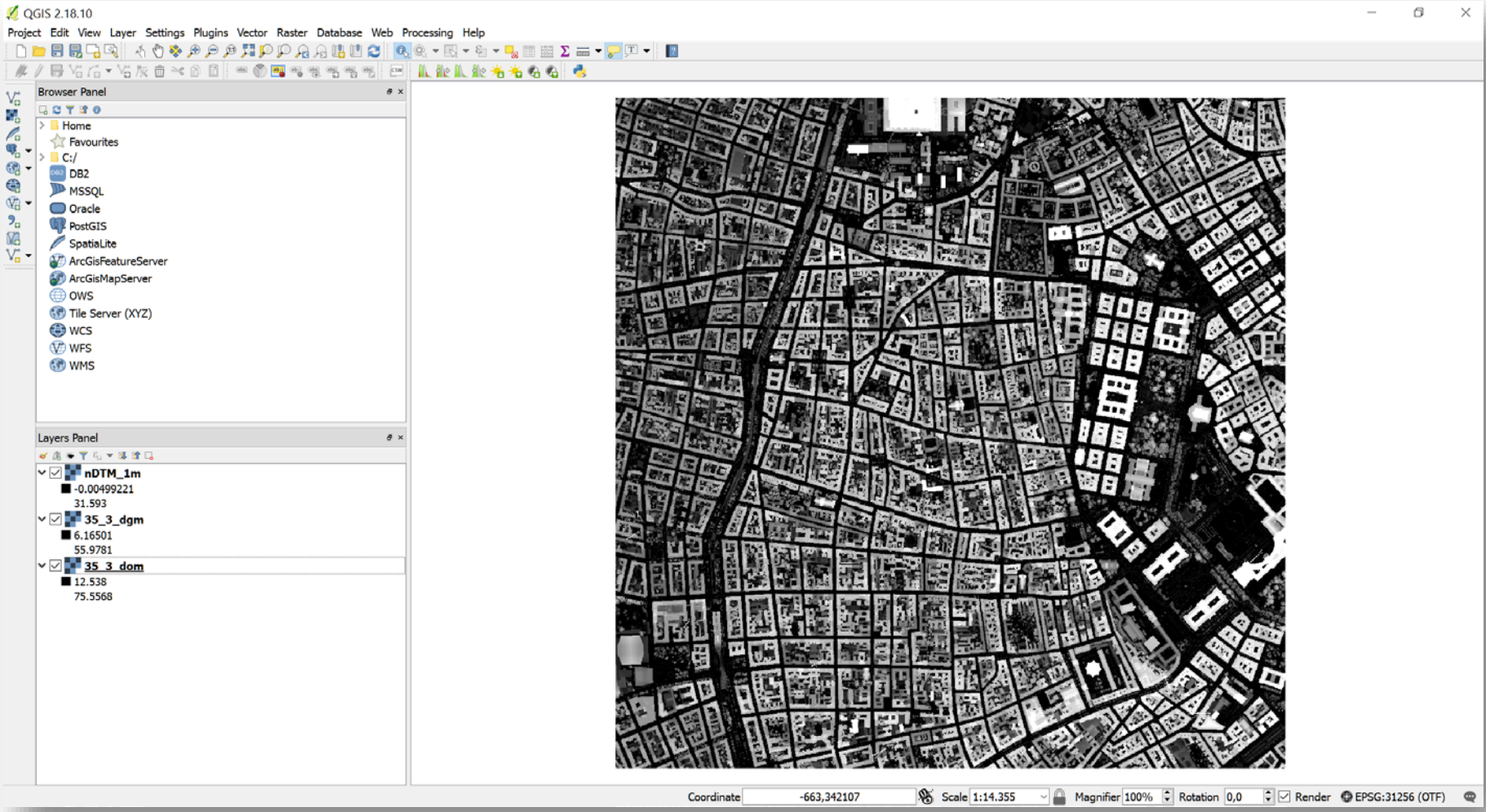
DSM = Digital Surface Model

nDSM = normalized Digital Surface Model



Source: ViennaGIS

Remote Sensing
Demo 4: DSM / DTM / nDSM

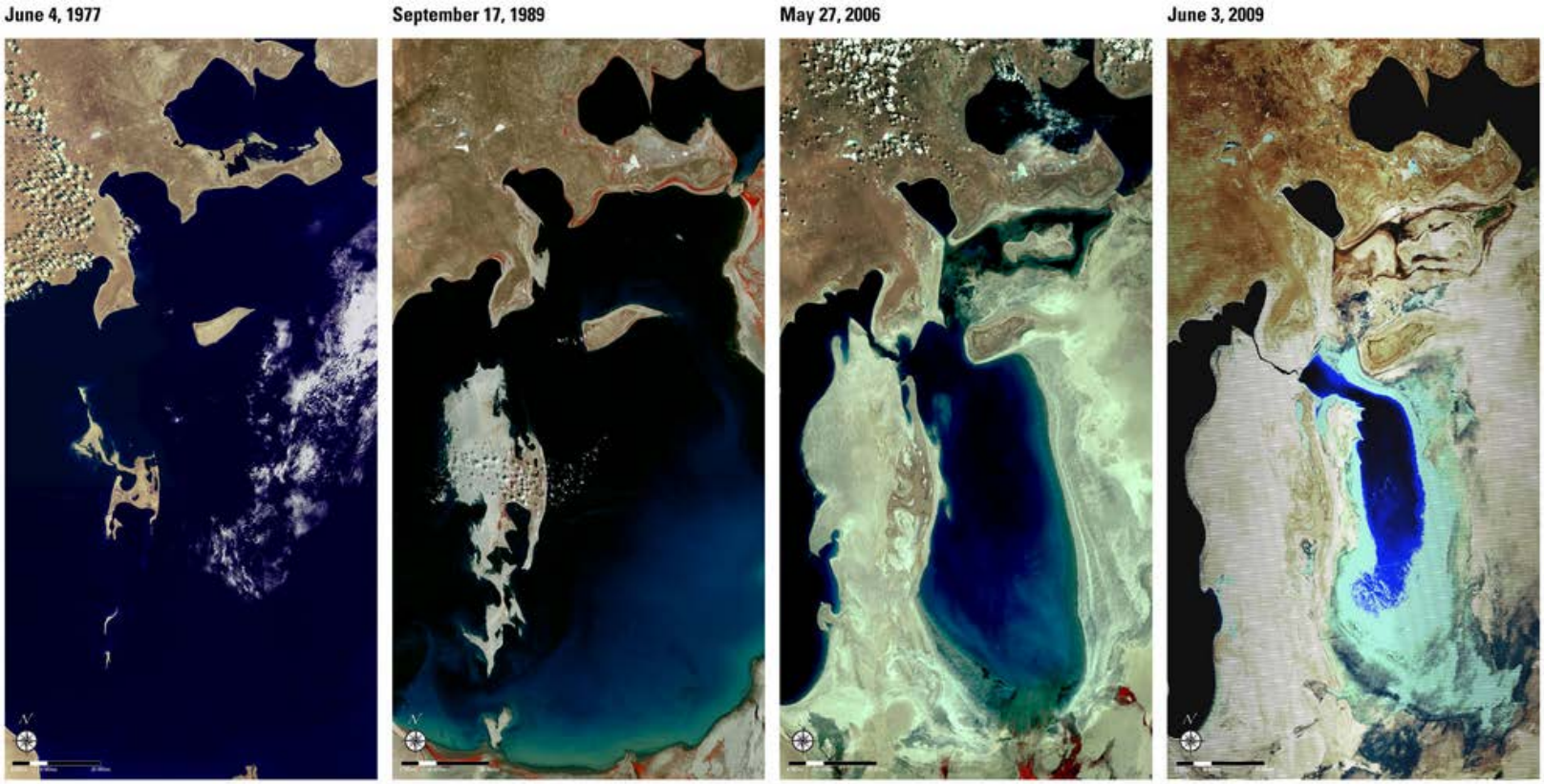


Remote Sensing
Advantages of Geodata from Remote Sensing

- Documentation *(images are persistent documents)*
- Continuous information instead of discrete
- Comparability *(time series)*
- High degree of automatisation when doing analyses
- Retrospective analyses *(historic geodata)*

Remote Sensing
Change Detection: Landsat Time Series

Lake Aral: Time Series



Source: NASA

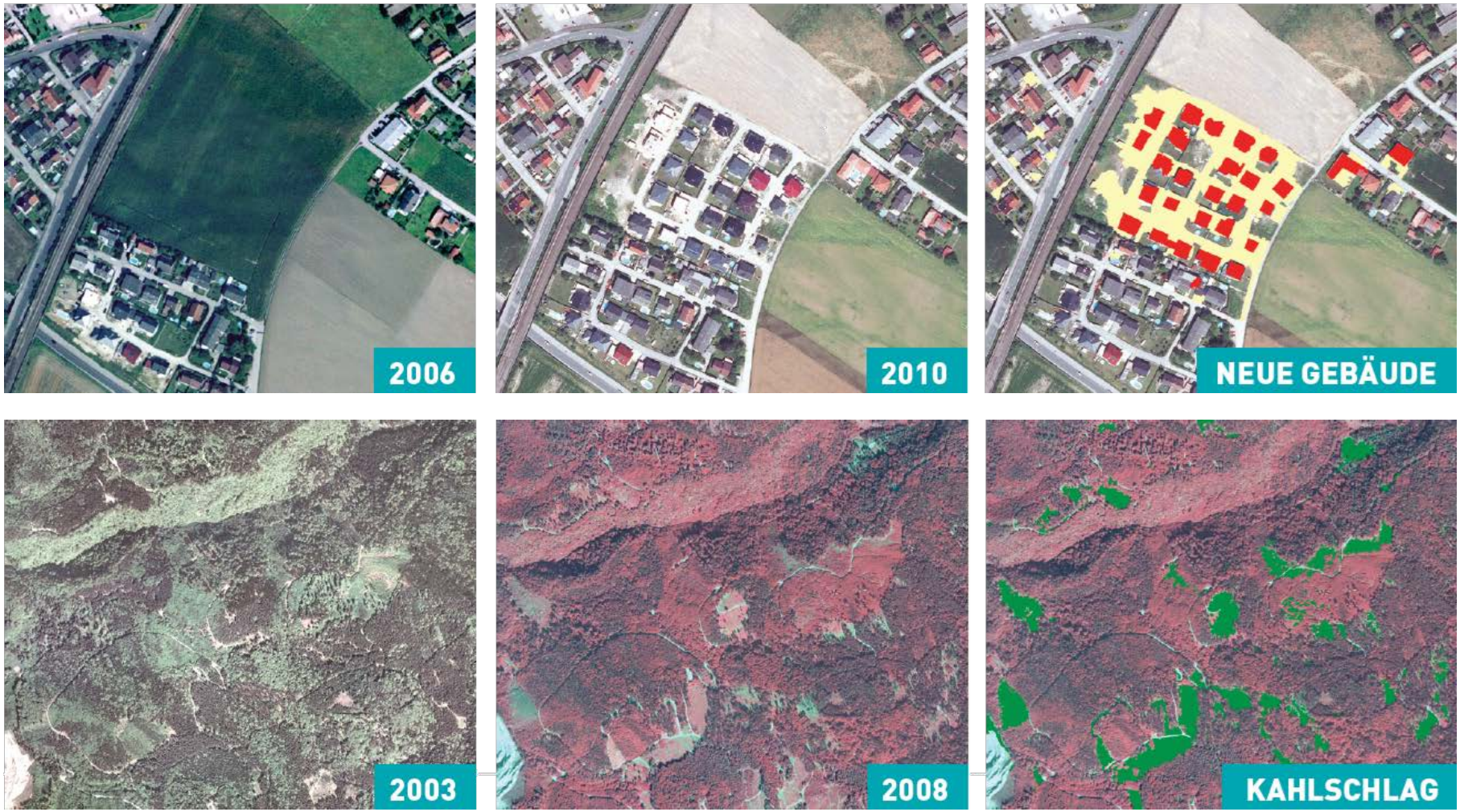
Remote Sensing
Change Detection: Landsat Time Series

August 13, 2015

http://scienceblogs.de/astrodicticum-simplex/wp-content/blogs.dir/28/files/2012/09/i-8d5fce9e46cce47a9d26e001ac412c54-aralsea_tmo_2000238-thumb-500x500-32160.jpg

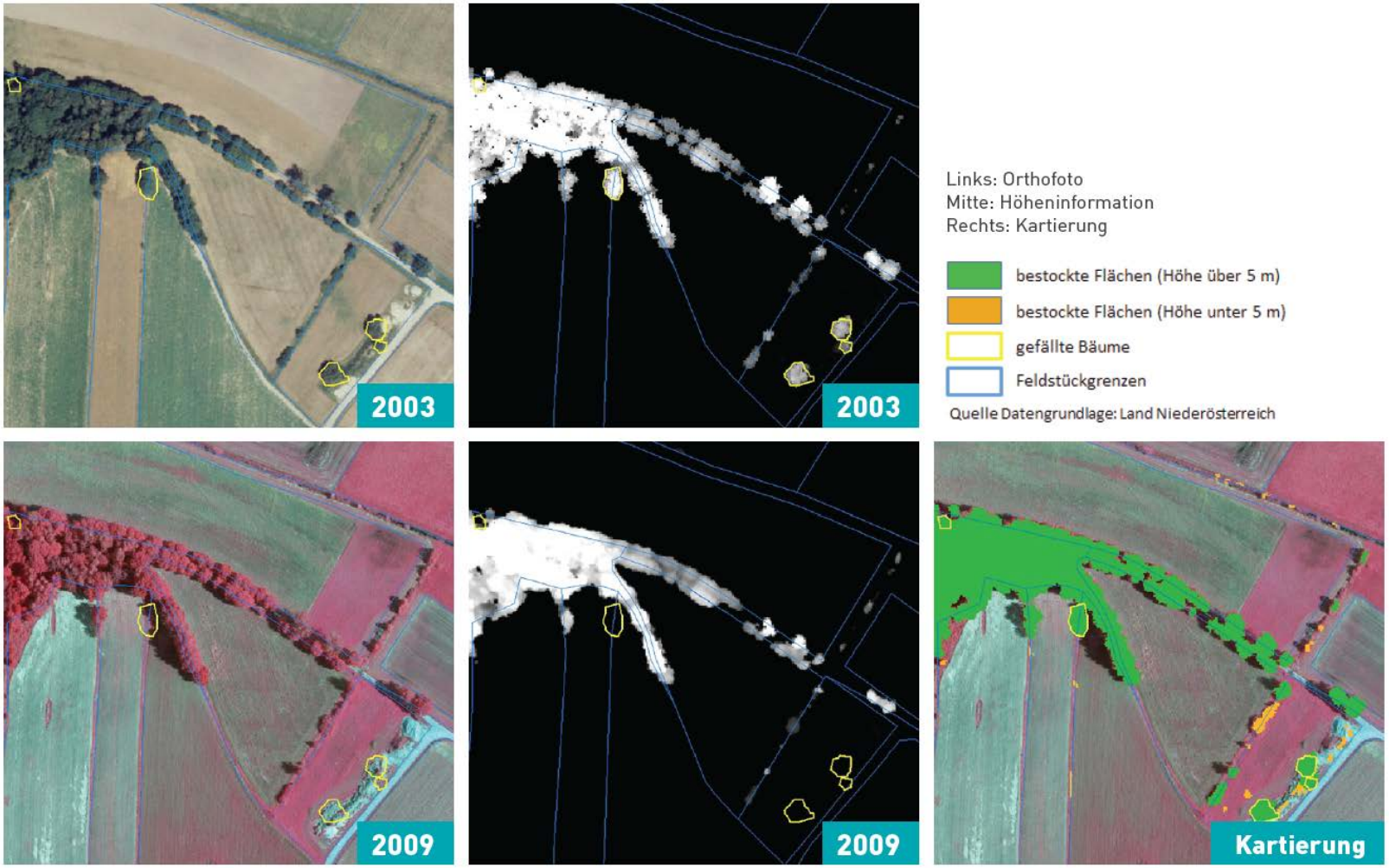
http://earthobservatory.nasa.gov/Features/WorldOfChange/aral_sea.php

Remote Sensing
Change Detection: Urban & Forest



Source: LISA Project

Remote Sensing
Combination of Images & Height information



Source: LISA Project

Remote Sensing
Band combinations

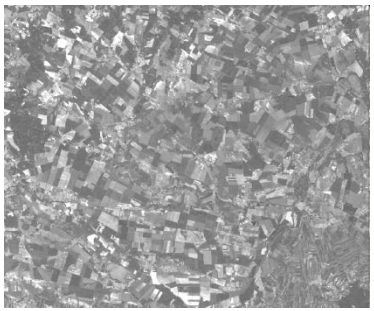
TM True color (4,3,2)

TM Color IR (5,4,3)

TM False Natural color (6,5,4)

Source: http://earthexplorer.usgs.gov/

Remote Sensing
Band Combinations of Landsat 8



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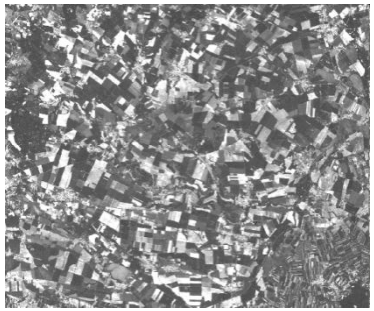

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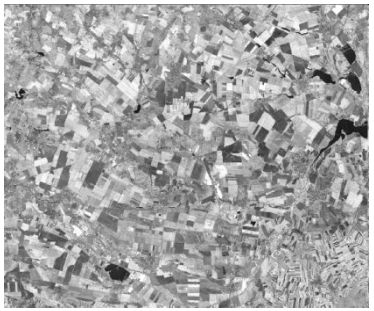

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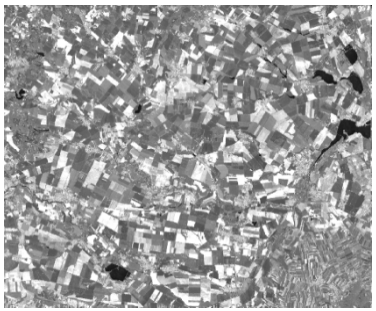

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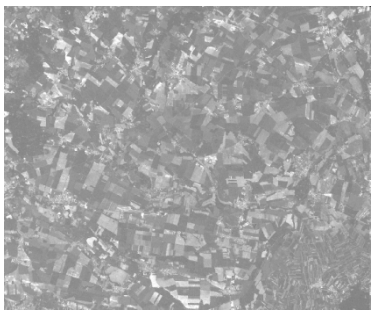

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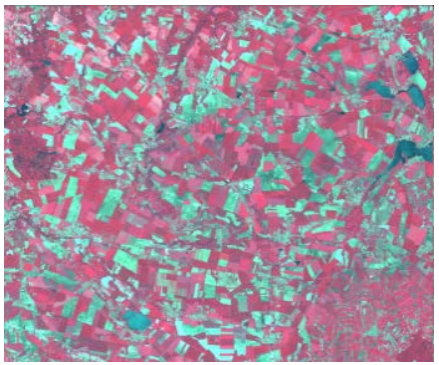
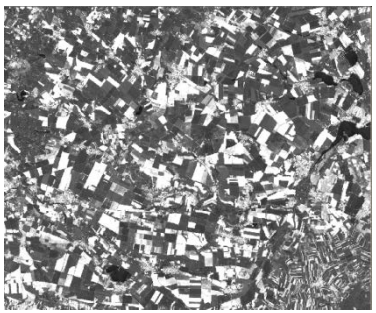
B5, B4, B3 (G-R-NIR)





L5188034_03420030625_B70.TIF

Land Cover Mapping

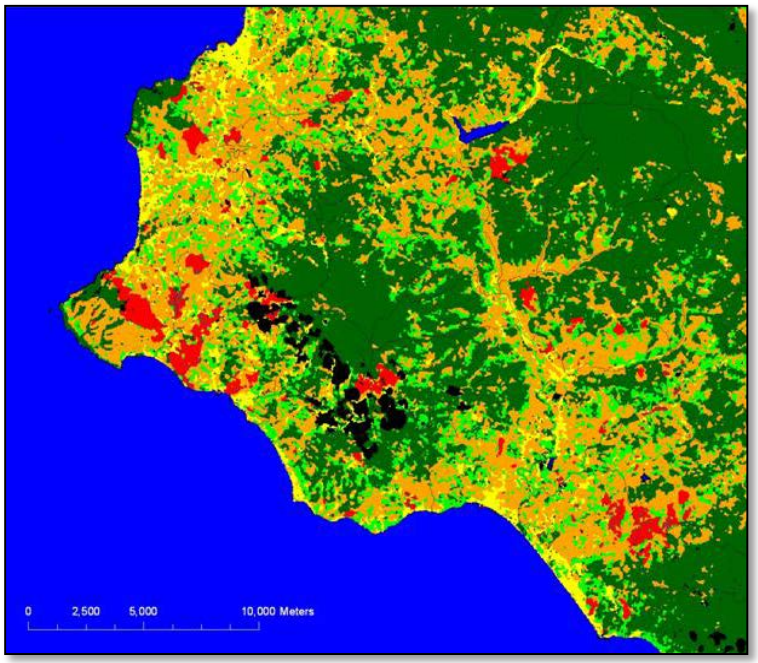
Example of a simplified land cover map (Lans, Tirol, Austria)

Source: LISA Project

Land Cover Mapping
Classification

Classification is the process of assigning pixels to categories (organize data into categories) based on their numerical properties (DN/pixel value, radiance, reflectance, etc…).

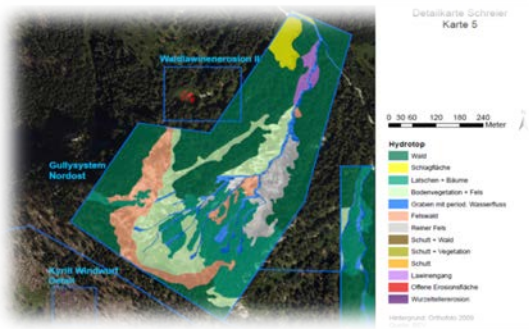
Raster data → Thematic map



Land Cover Mapping
Assessment methods

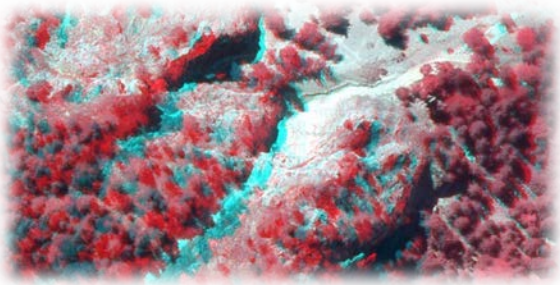
Visual interpretation and manual segmentation

(Orthophoto → two-dimensional)



Stereoscopic assessment

(Photogrammetry → three-dimensional)



Automatic methods

- objectbased classification
- pixelbased classification

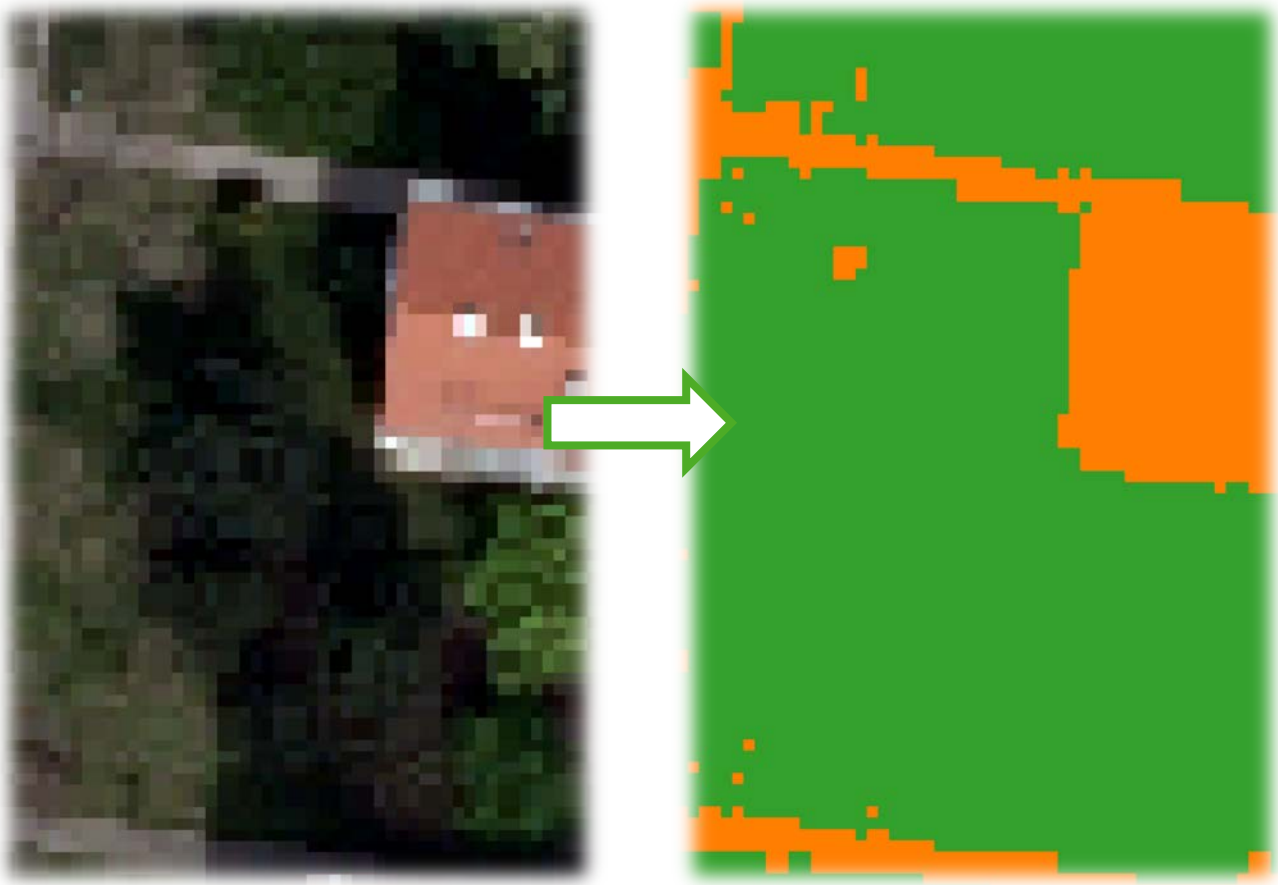
Pixelbased

Objectbased

Source: BEV

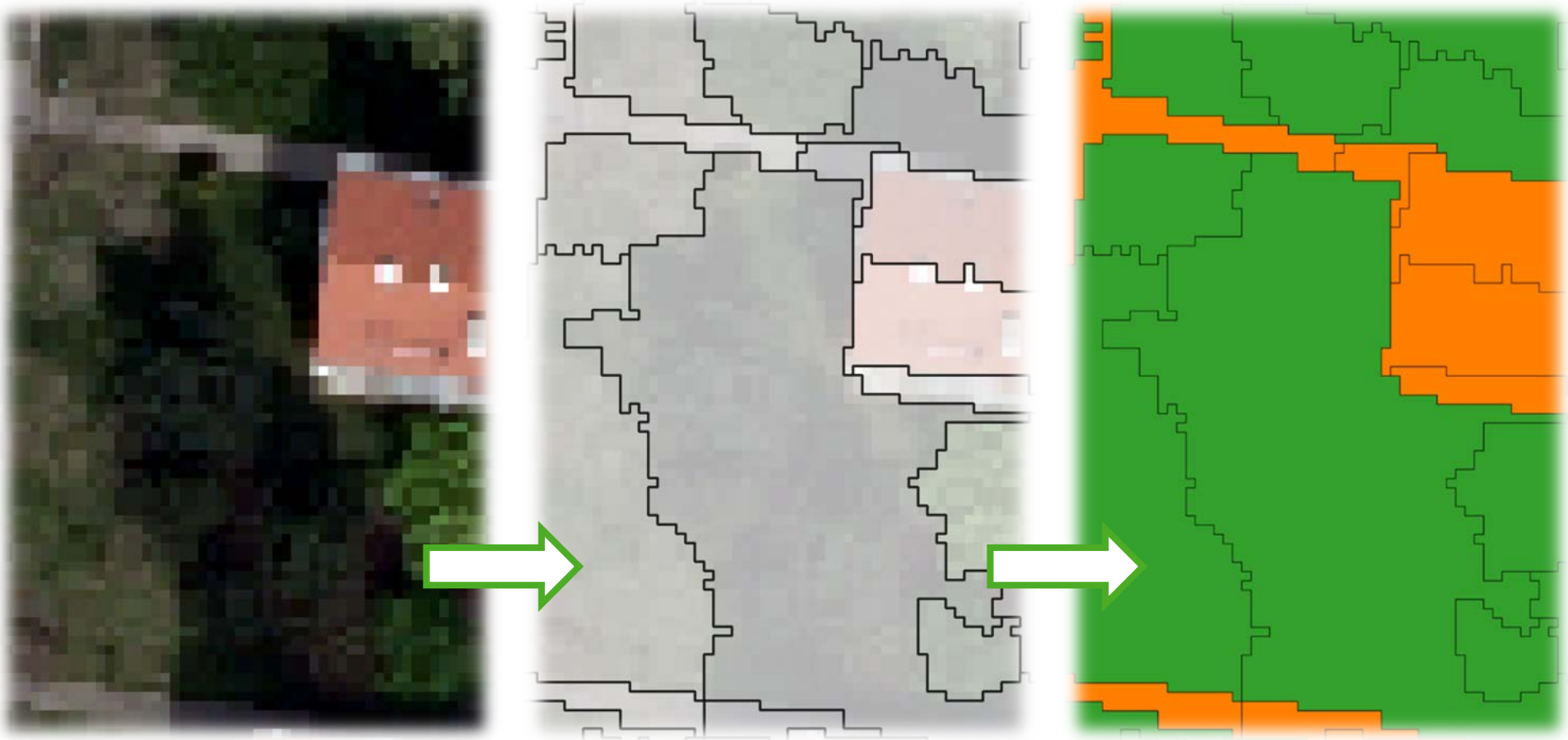
Land Cover Mapping
Automatic Classification Methods 1

- Pixel-based Approach (each pixel of the image is classified)



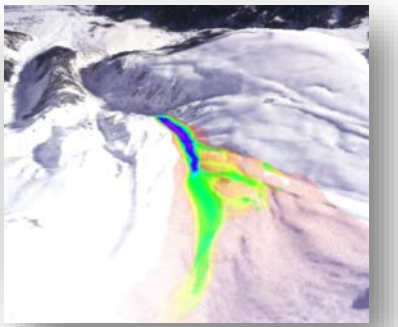
Land Cover Mapping
Automatic Classification Methods 2

- Object-based Approach (segmentation & classification of segments)



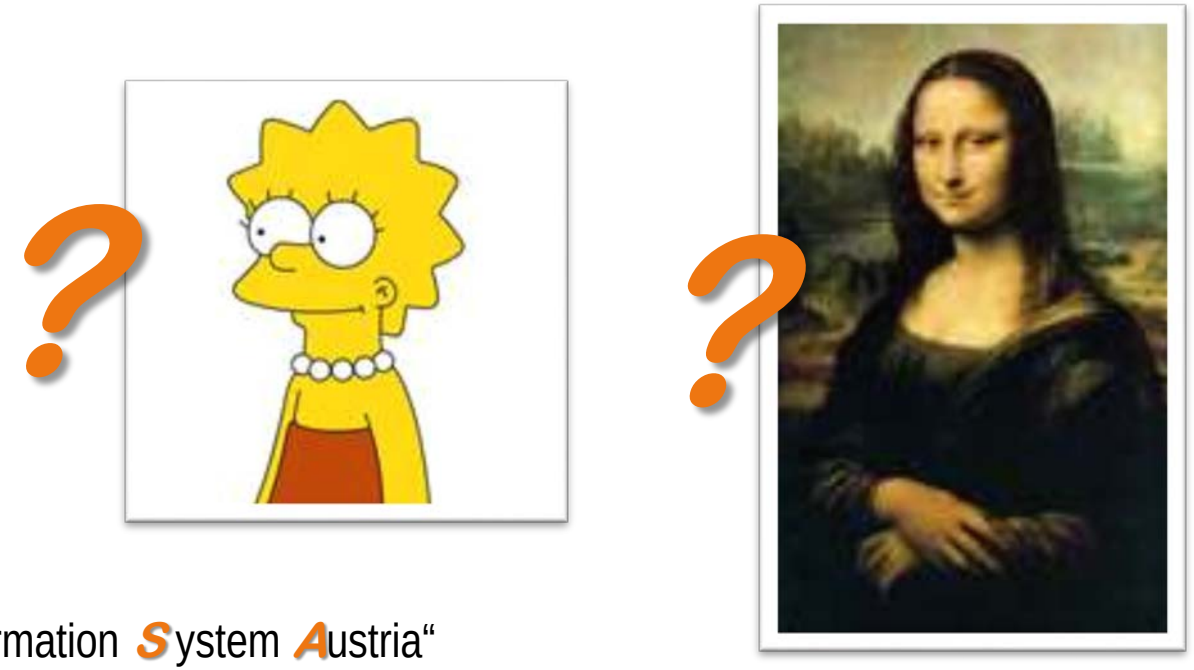
Land Cover Information System Austria
Introduction

- Need of standardized land information- und monitoring systems for
  - Planning processes
  - Controlling & Monitoring
  - Modelling & Simulations



- In Austria are land cover and land use data available, but ...
  - Limited countrywide comparability
  - Standards (thematic, technical & geometric) are missing
  - Lack of information for specific applications
  - Time Series not available
  - ...

LISA



- „**L**and **i**nformation **S**ystem **A**ustria“
- financed by Austrian Ministry (BMVIT / FFG in Research Programme ASAP VI (GMES/Copernicus)
- Coordinator: GeoVille Information Systems

LISA
Objectives of Project

- Development of a harmonized country-wide land cover and
  land use data model
- Application of proper RS & GIS methods to access land cover and land use information by merging countrywide available geodata sets
- Checking the technical and economic feasibility for a periodic and country-wide land cover & land use monitoring system

Land cover is the observed (bio)physical cover on the earth's surface.

Examples: forest, grass, desert, water,...

Land use is how people utilize the land (including the socio-economic activities):

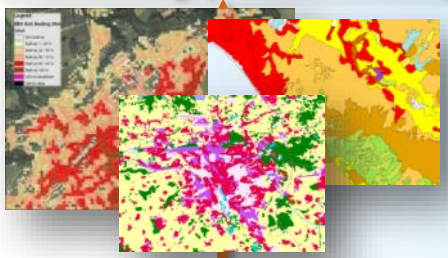
Examples: urban and agricultural land…

LISA
Framework

Demands of Users

- Land Monitoring
- Specific Applications
- Reporting Commitment

European Land Monitoring (GMES LMCS)



LiSA

Monitoring-System & Data Model

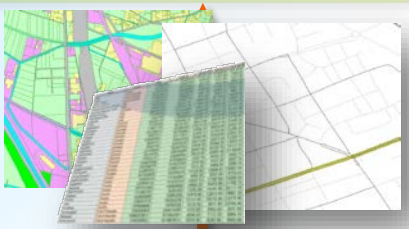
Harmonisation

Interoperability

Comparability

Up-/downscaling

Regional & National Data Bases



INSPIRE Metadata & Spatial Data-Infrastructures

Internat. References

GMES-DSL, SIOSE, DeCOVER,…

LISA
Project Partner

•USER COMMUNITY

•Federal Environment Agency European

• Land-, forst- und wasserwirtschaftliches Rechenzentrum GmbH

•Regional governments of all the Austrian provinces (9)

•Topic Centre for Land Use & Spatial Information (ETC-LUSI)

STAB

AIT
Austrian Institute of Technology

TU Vienna
Institute of Photogram. and Remote Sensing

BOKU
Institute of Surveying, Remote Sensing and Land Information

PRODUCERS

Data Acquisition

GeoVille Information Systems GmbH

Joanneum Research

Data Model

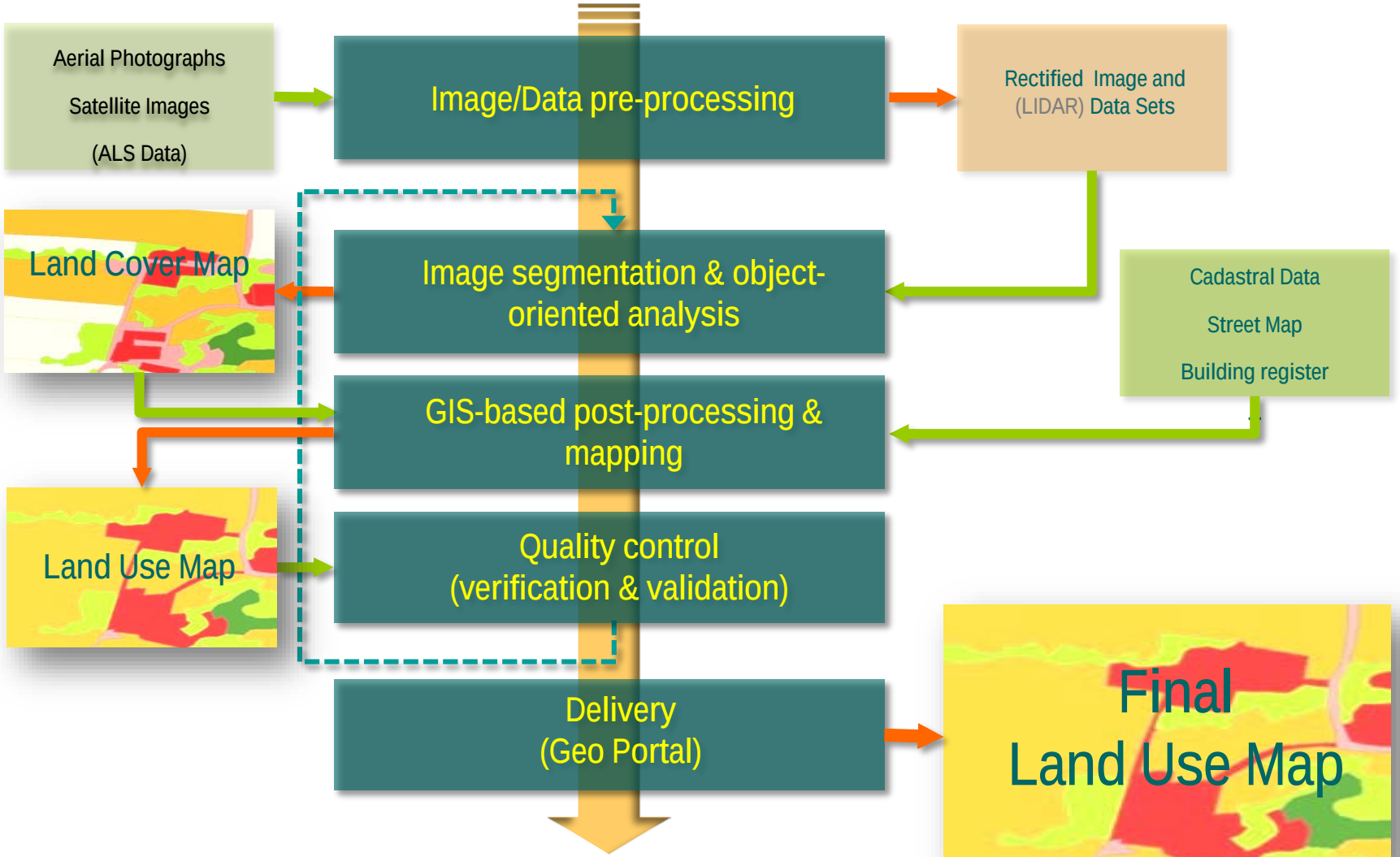
University of Applied Sciences Wiener Neustadt

IFP - Institute of Photogrammetry and Remote Sensing, TU Graz

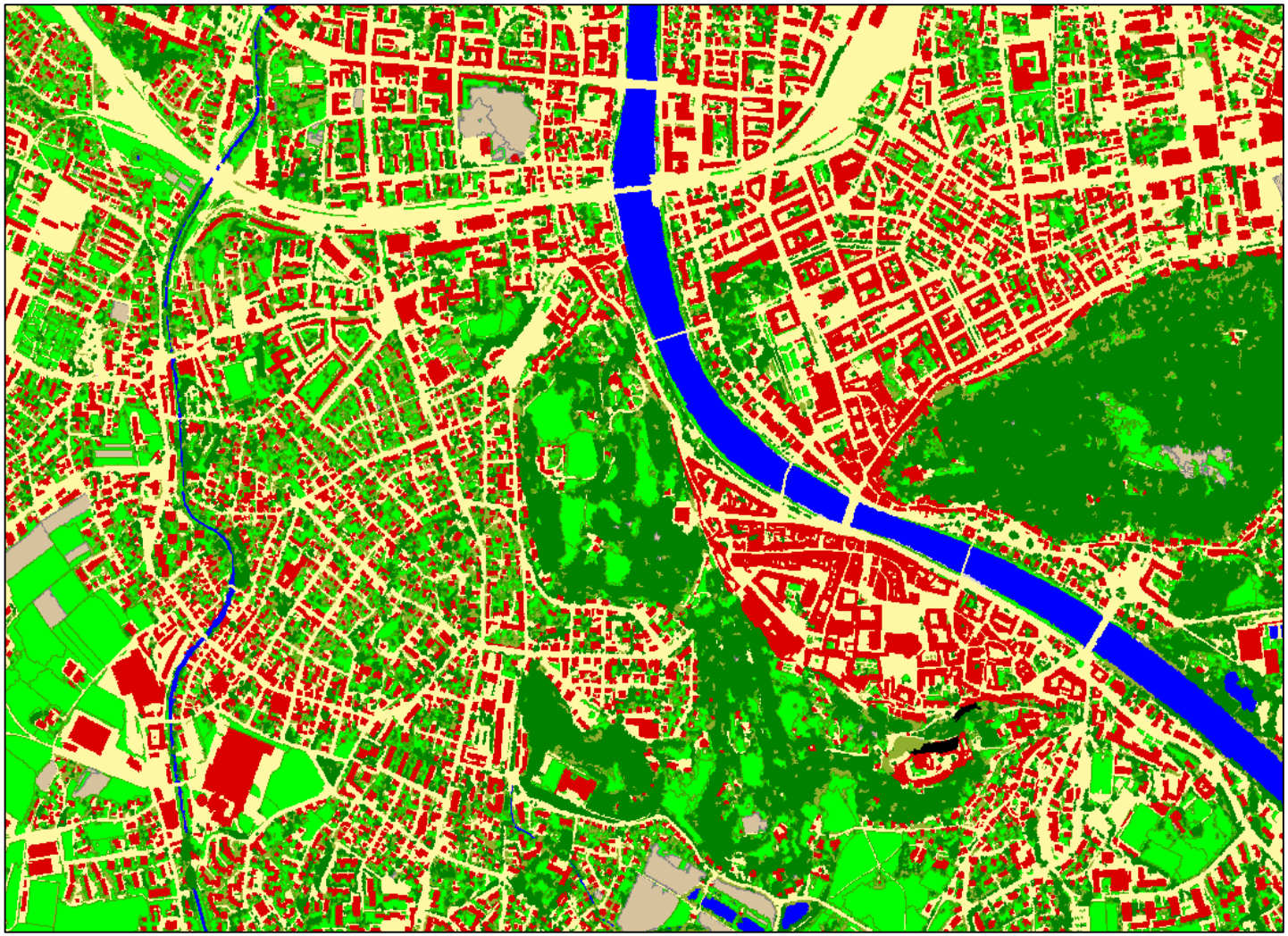
Geo-Portal

EOX GmbH

LISA
Concept

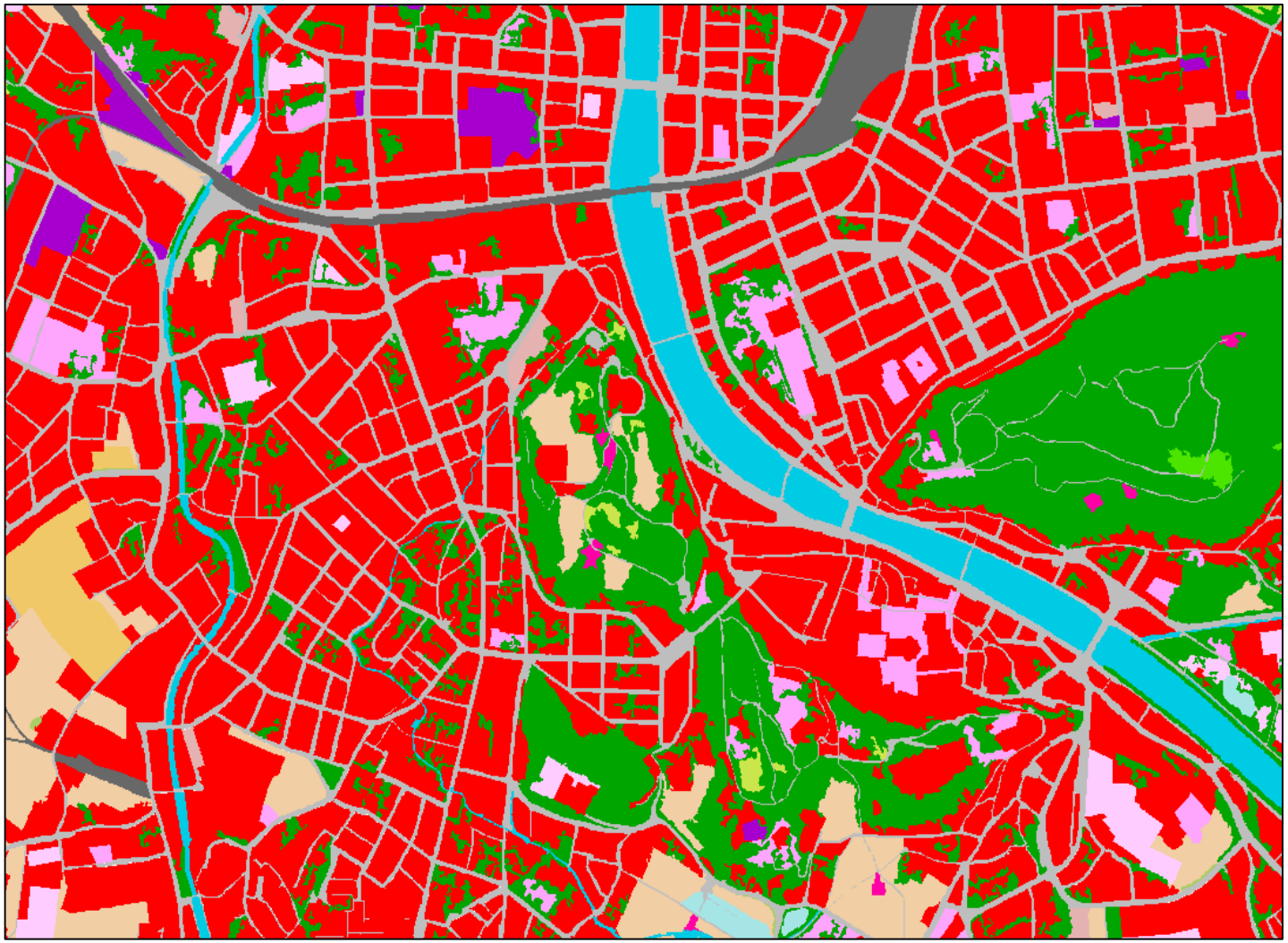


Land Cover Mapping
Results



http://www.landinformationsystem.at/

Results – Land Use

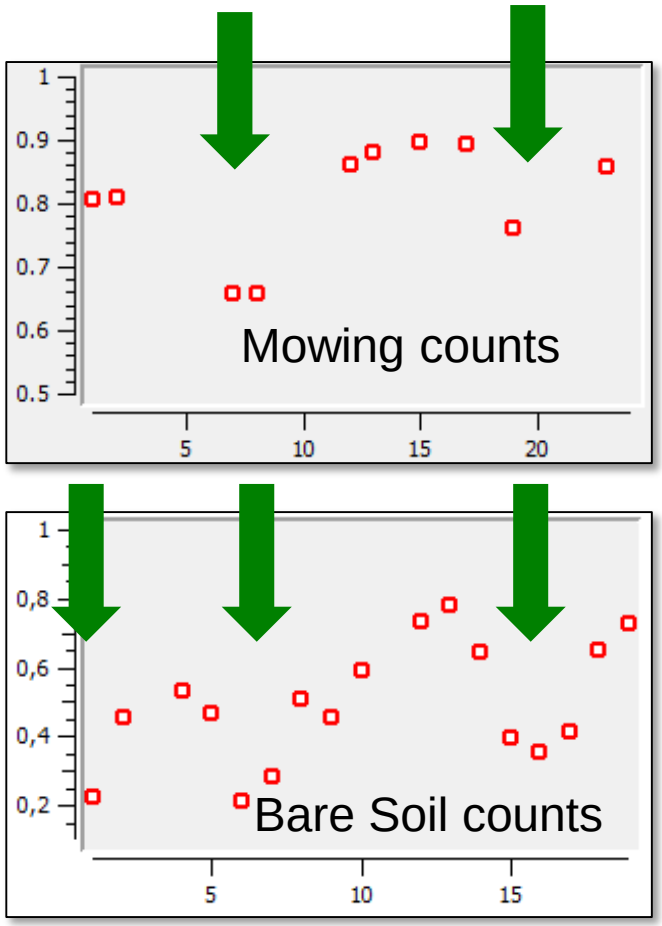


http://www.landinformationsystem.at/

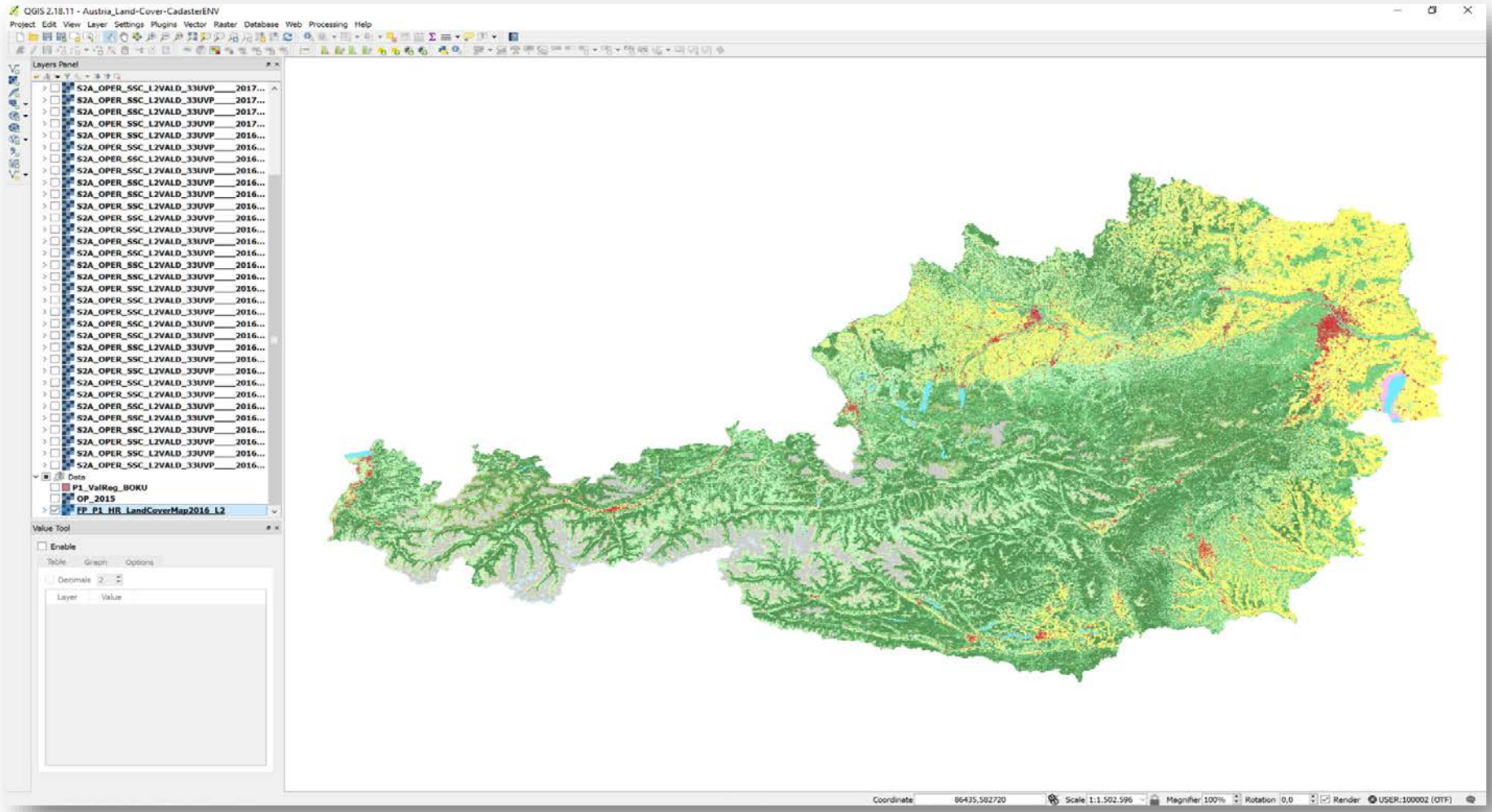
LISA / Cadaster ENV

What data sets are used for gaining LC information?

- Spectral information (different spectral bands) from one acquisition;
- Time series (multi-temporal approach);
- Texture and other spatial information;
- Additional information (height / nDSM, slope, soil type, climatology, existing land cover maps, etc.).



Remote Sensing
Demo 5: Land Cover Classification Austria (countrywide)



Reinfried MANSBERGER

University of Natural Resources and Life Sciences (BOKU Vienna)
Department for Landscape, Spatial and Infrastructure Sciences
Institute of Surveying, Remote Sensing and Land Information

A-1190 Vienna, Peter Jordan-Straße 82,
Tel.: +43 1 47654-85715
E-mail: mansberger@boku.ac.at