Czech University of Life Sciences Prague

Faculty of Environmental Sciences

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

ECAP Vienna Training Visit 2017

Department of Applied Geoinformatics and Spatial Planning
Vítězslav Moudrý (moudry@fzp.czu.cz)

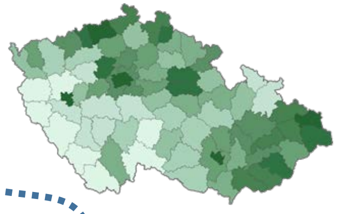
Geographic Data Availability for Environmental Applications

The geographic approach

- **Step 1: Ask**
  - What is the problem you are trying to solve or analyze, and where is it located?
- **Step 2: Acquire**
  - Determine the data needed to complete your analysis and ascertain where that data can be found or generated
- **Step 3: Examine**
  - This includes visual inspection, as well as investigating how the data is organized, how well the data corresponds to other datasets, and the story of where the data came from (its metadata).
- **Step 4: Analyze**
  - Looking at the results can help you decide whether the information is valid or useful
- **Step 5: Act**

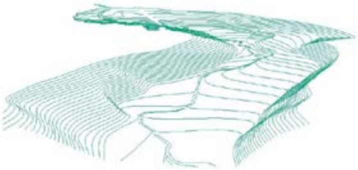
Data Acquisition Methods

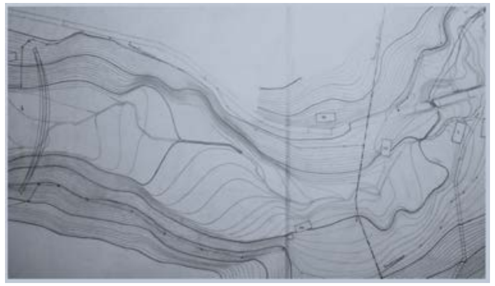
1. Measurements at the locations of known position



2. Field measurements

3. Processing the existing data



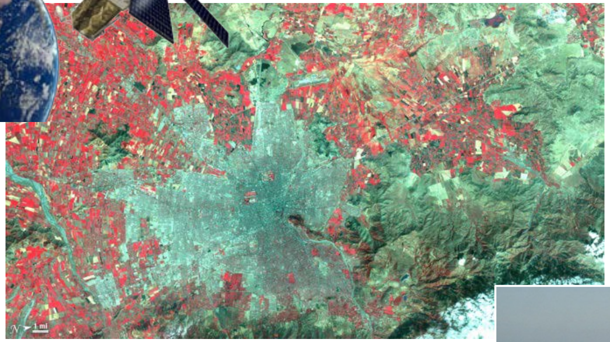


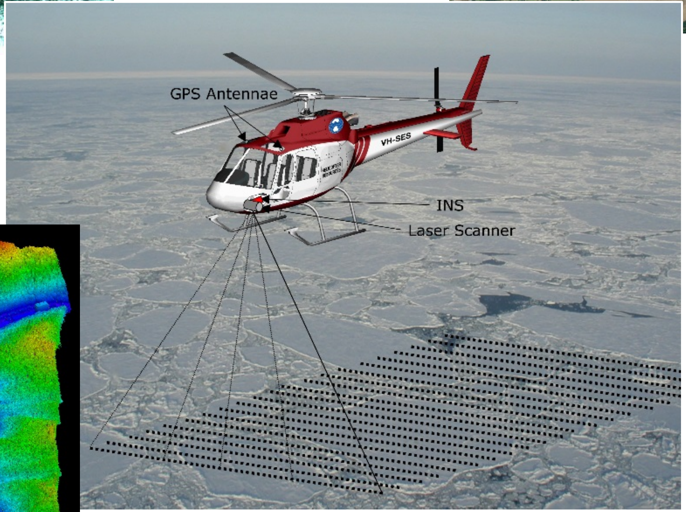
4. Remote sensing

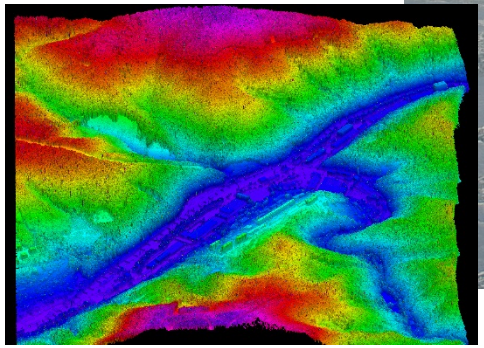
Remote sensing

Aerial photos…

Satellite images…







Laser scanning…

Remote sensing

Principle: Measuring physical, chemical, and biological properties of objects without direct physical contact (usually in a **raster grid**)

Types:

- Passive: Receiving the reflected and emitted radiation

  → Aerial Photography

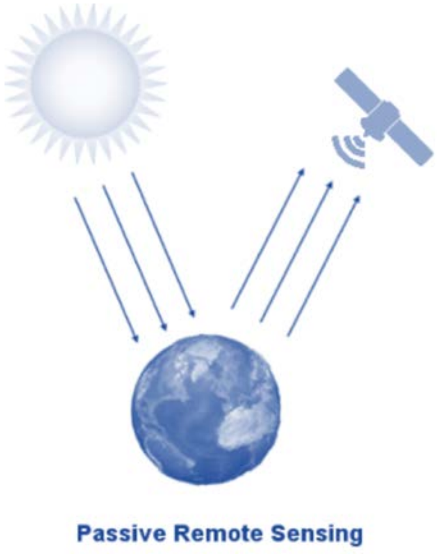
  → Satellite Imagery

- Active: Transmitting electromagnetic signal

  → Radar

  → Laser Scanning

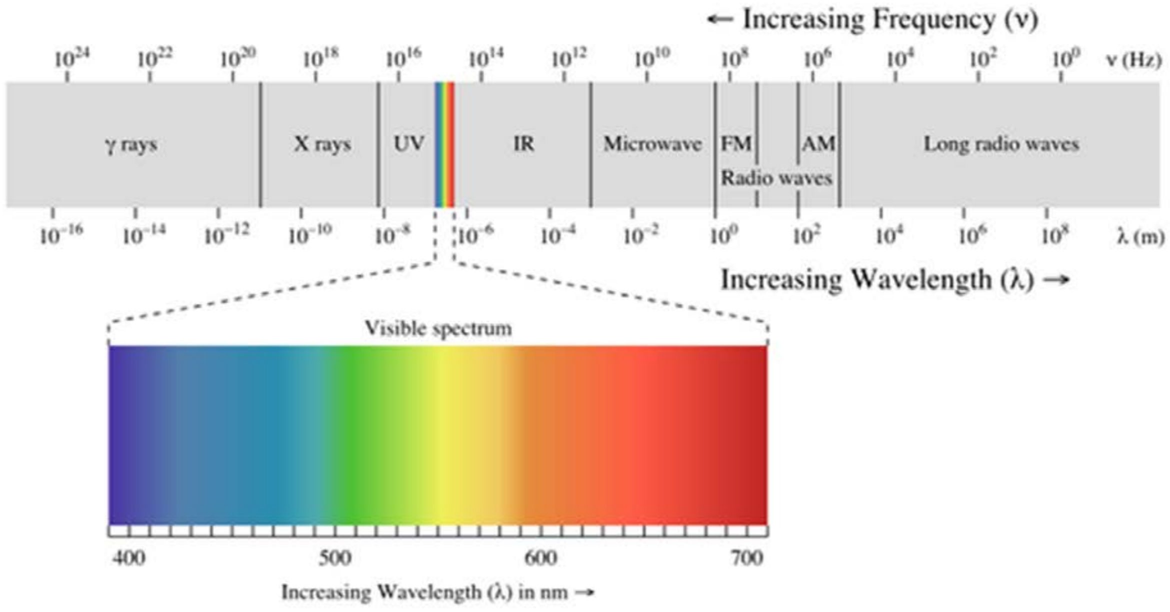
Any restrictions ?



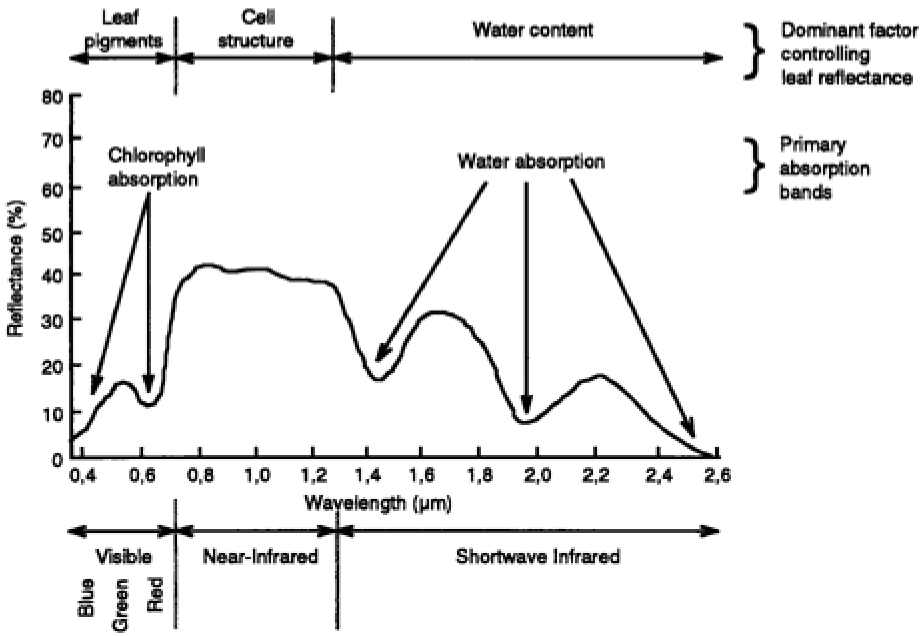
Remote sensing

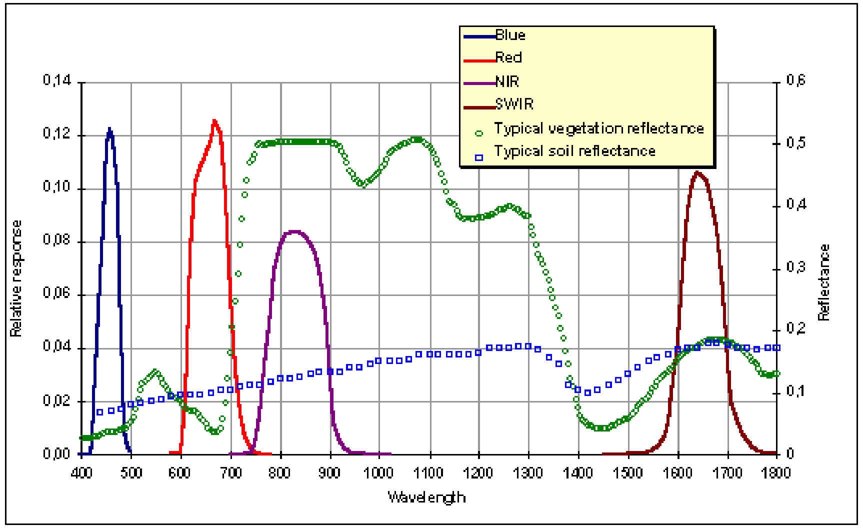
Resolution:

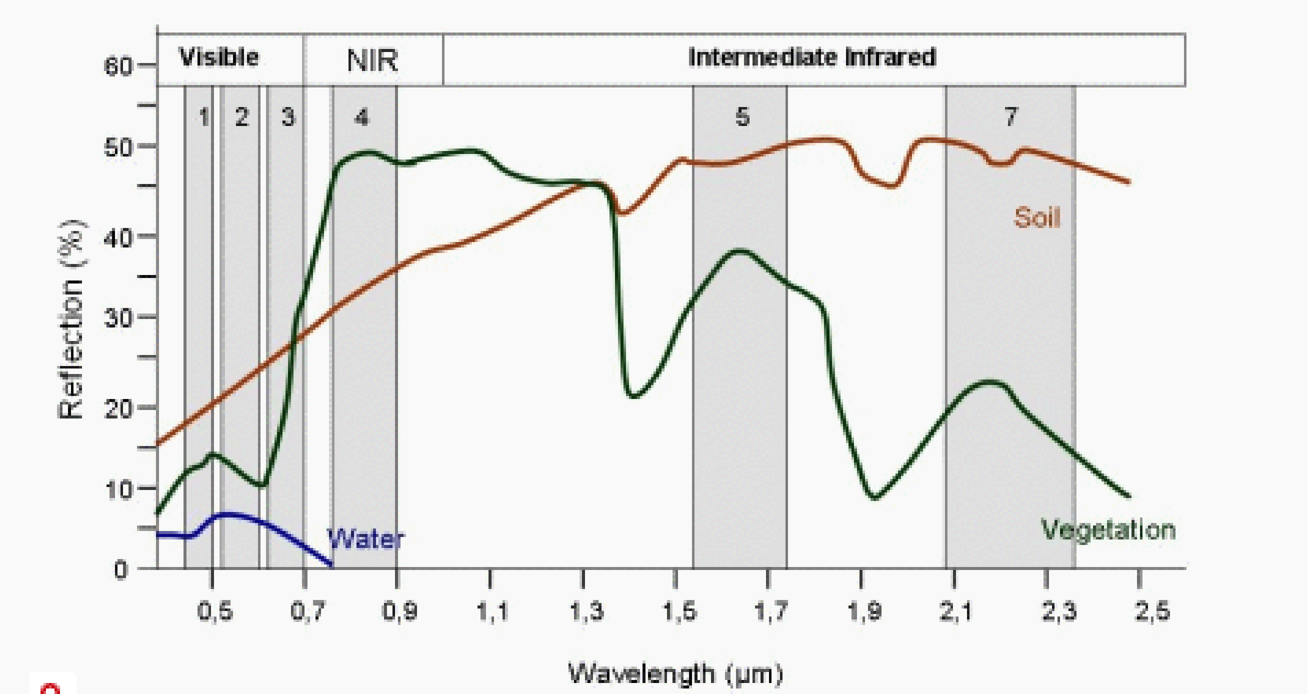
- Spatial
    - Satellite Imagery: 0.5 m – 1 km
    - Aerial Photographs: 1 cm – 5 m
- Spectral (single band, multispectral, hyperspectral)
- Temporal (Earth-orbiting, geostationary satellites)



Spectral signatures (spectral reflectance curves)

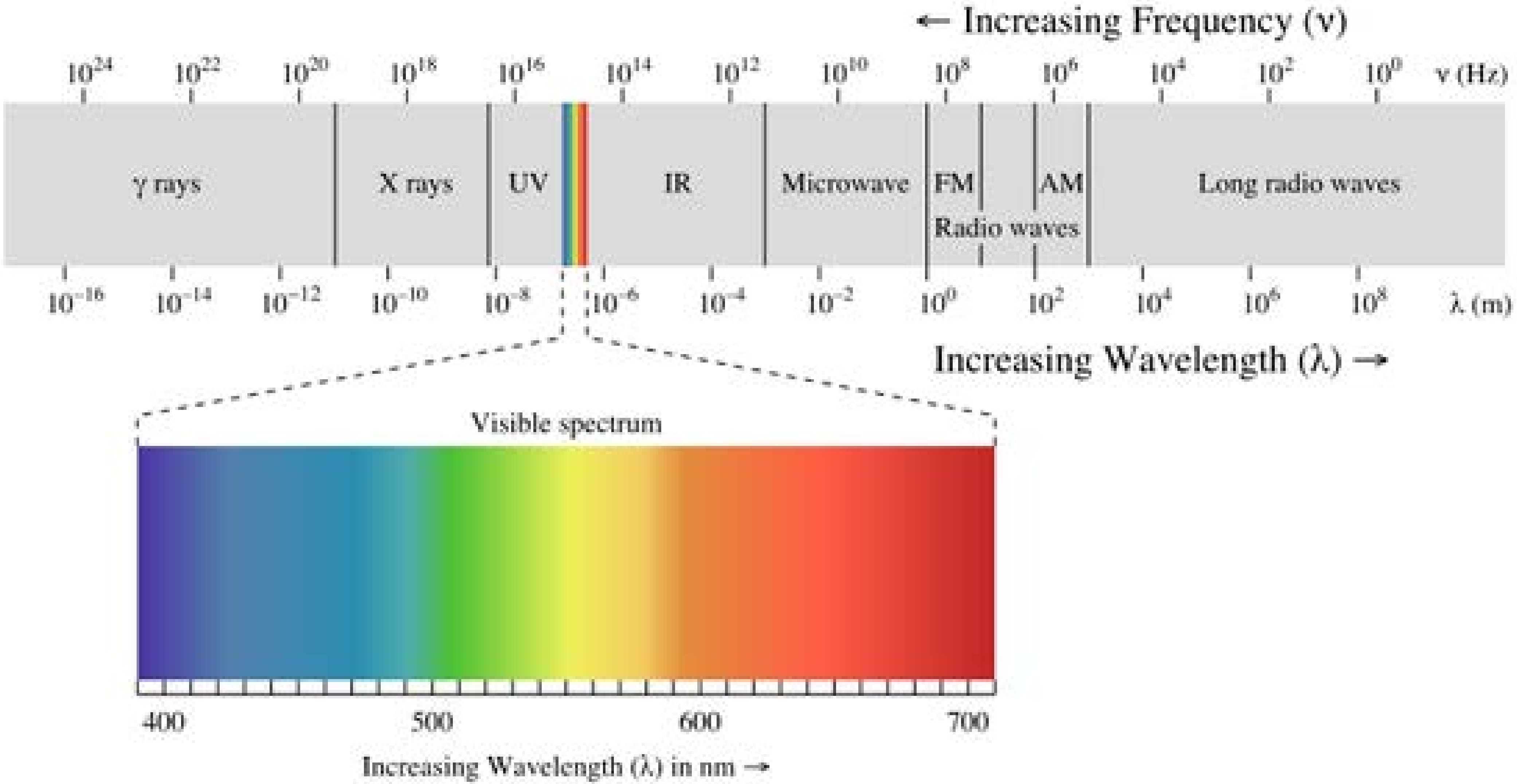




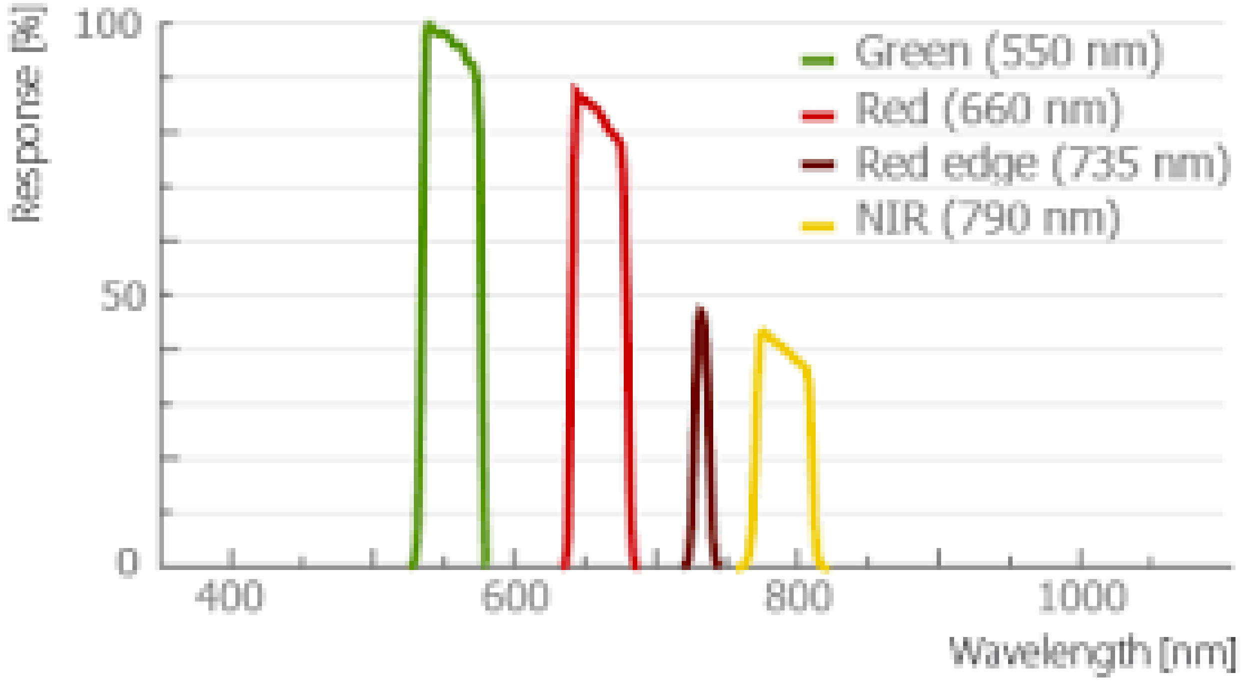


Spectral signatures of soil, vegetation and water, and spectral bands of LANDSAT 7.

http://www.seos-project.eu/modules/agriculture/agriculture-c01-s01.html


← Increasing Frequency (ν)
10^24 10^22 10^20 10^18 10^16 10^14 10^12 10^10 10^8 10^6 10^4 10^2 10^0 ν (Hz)
γ rays
X rays
UV
IR
Microwave
FM
AM
Radio waves
Long radio waves
10^-16 10^-14 10^-12 10^-10 10^-8 10^-6 10^-4 10^-2 10^0 10^2 10^4 10^6 10^8 λ (m)
Increasing Wavelength (λ) →
Visible spectrum
400 500 600 700
Increasing Wavelength (λ) in nm →

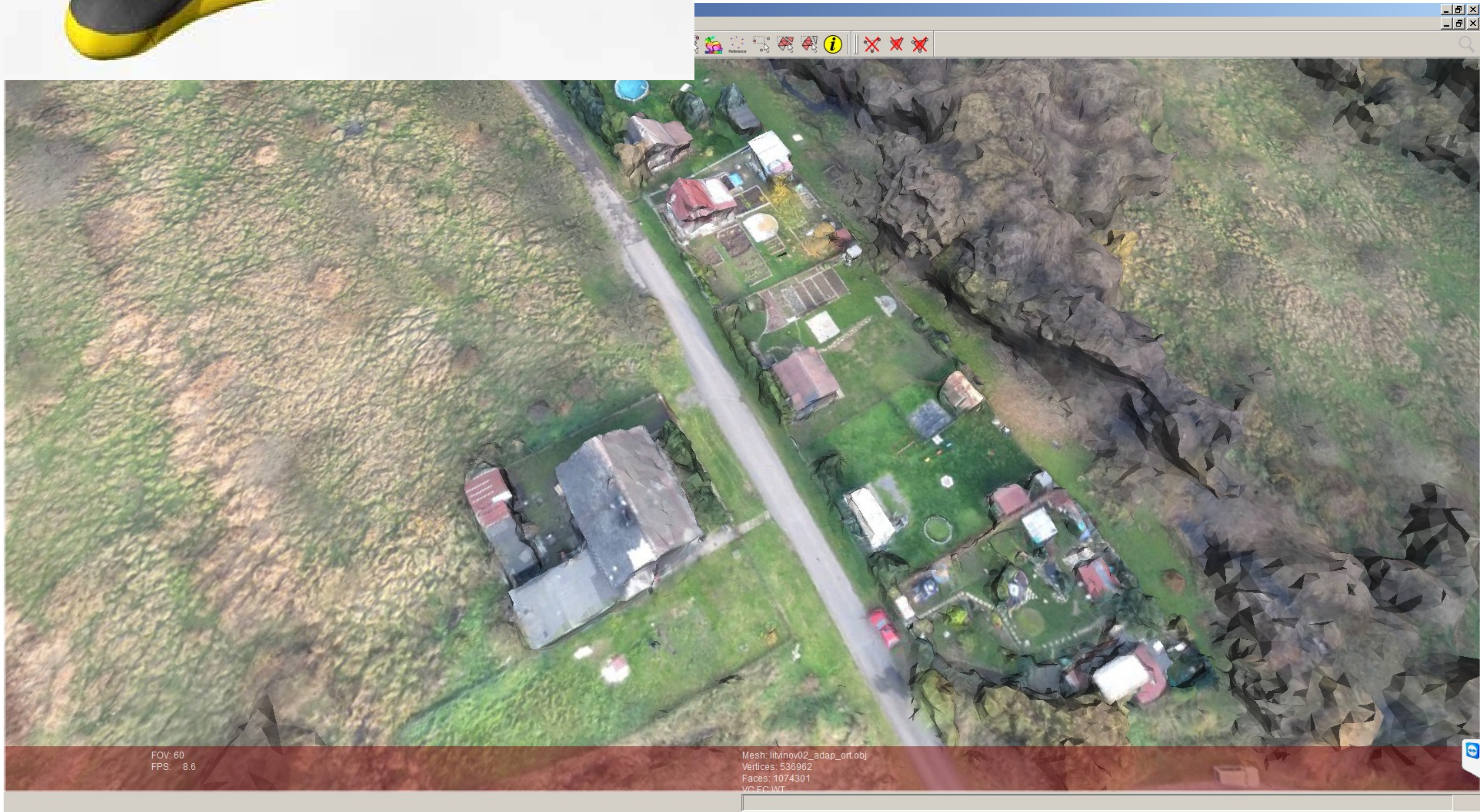

eBee

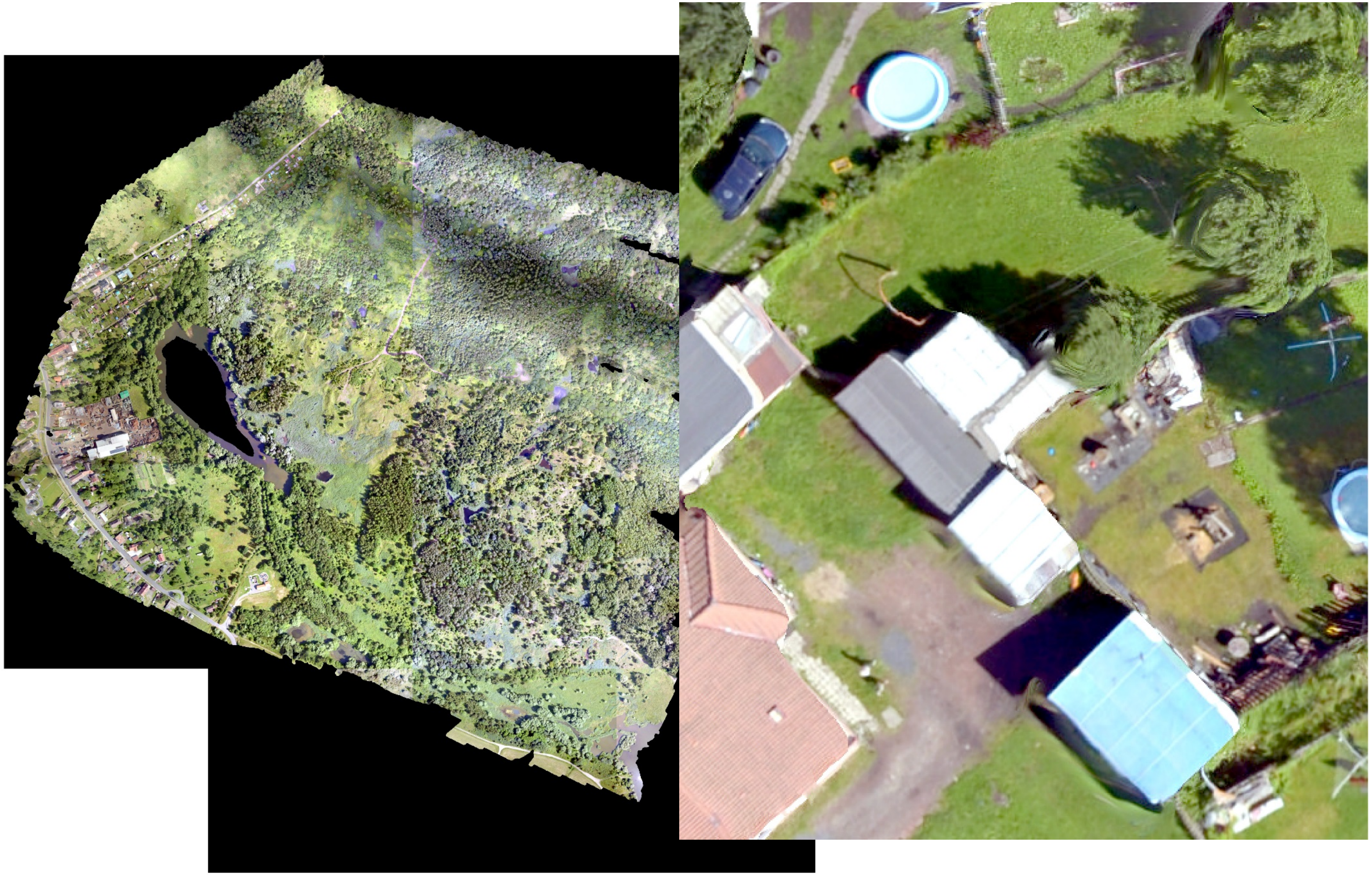

Response [%]
100
50
0
400
600
800
1000
Wavelength [nm]
Green (550 nm)
Red (660 nm)
Red edge (735 nm)
NIR (790 nm)

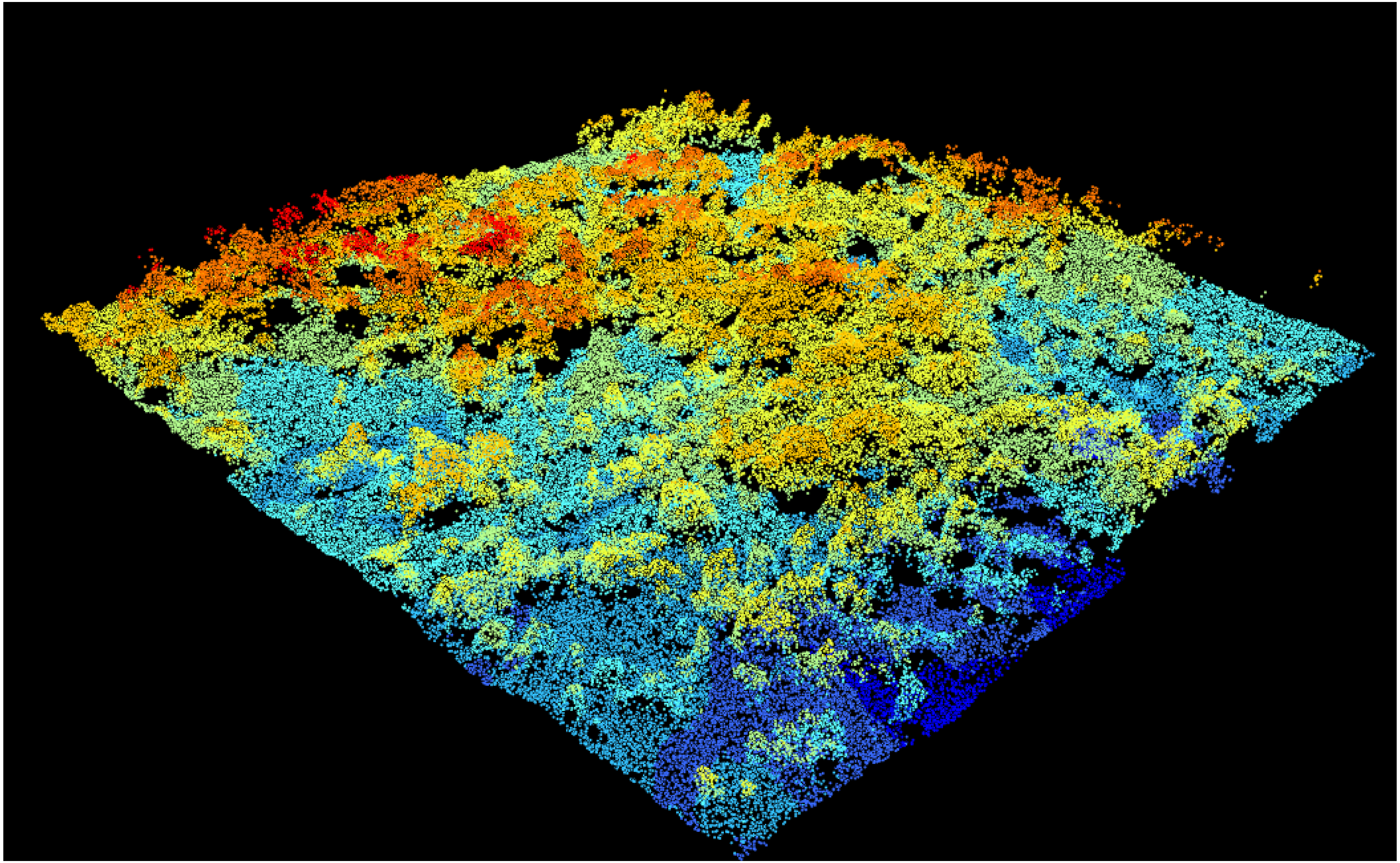
Aerial photographs are very suitable for detailed Surveying and mapping projects.

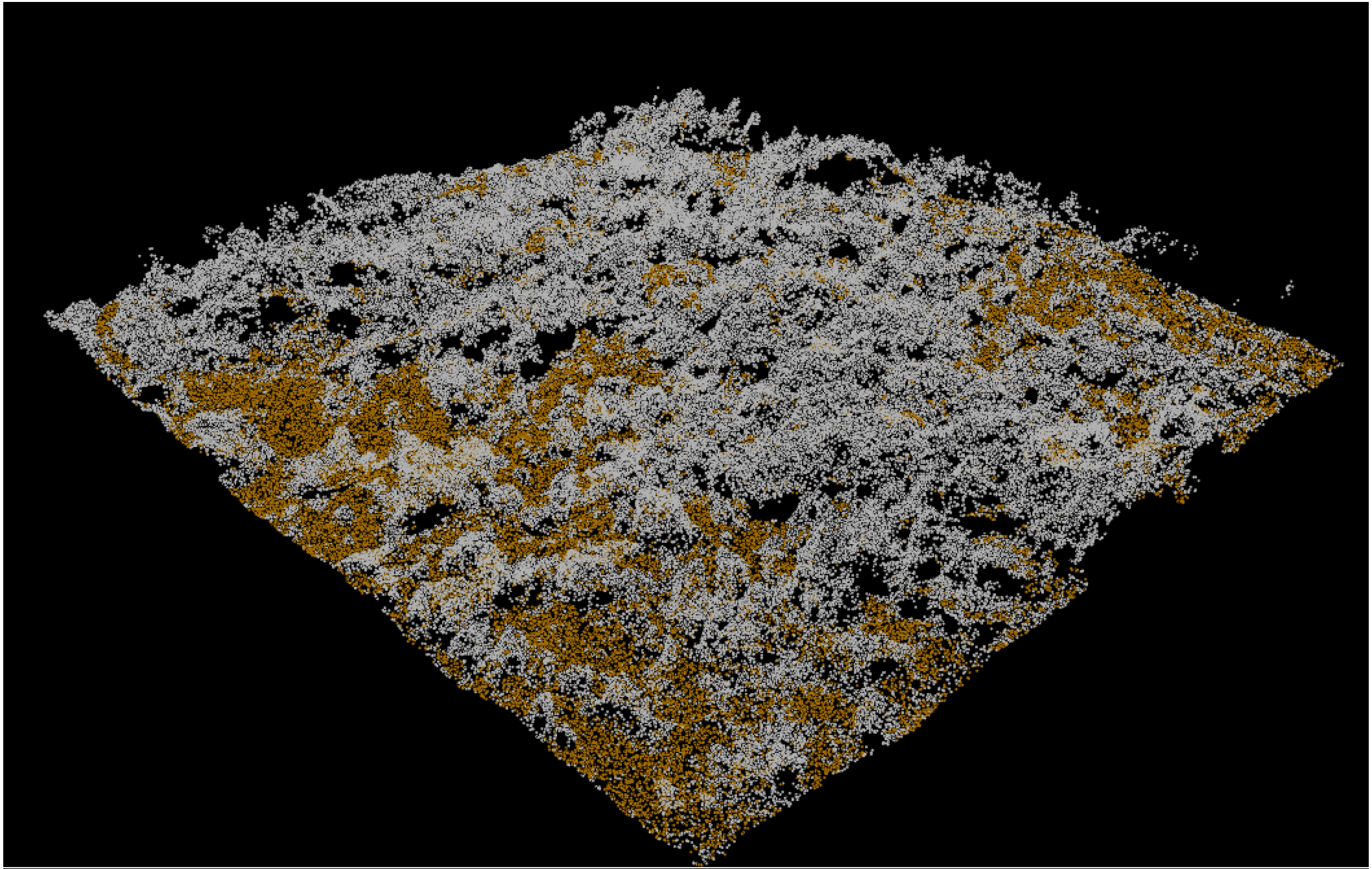
Photogrametry

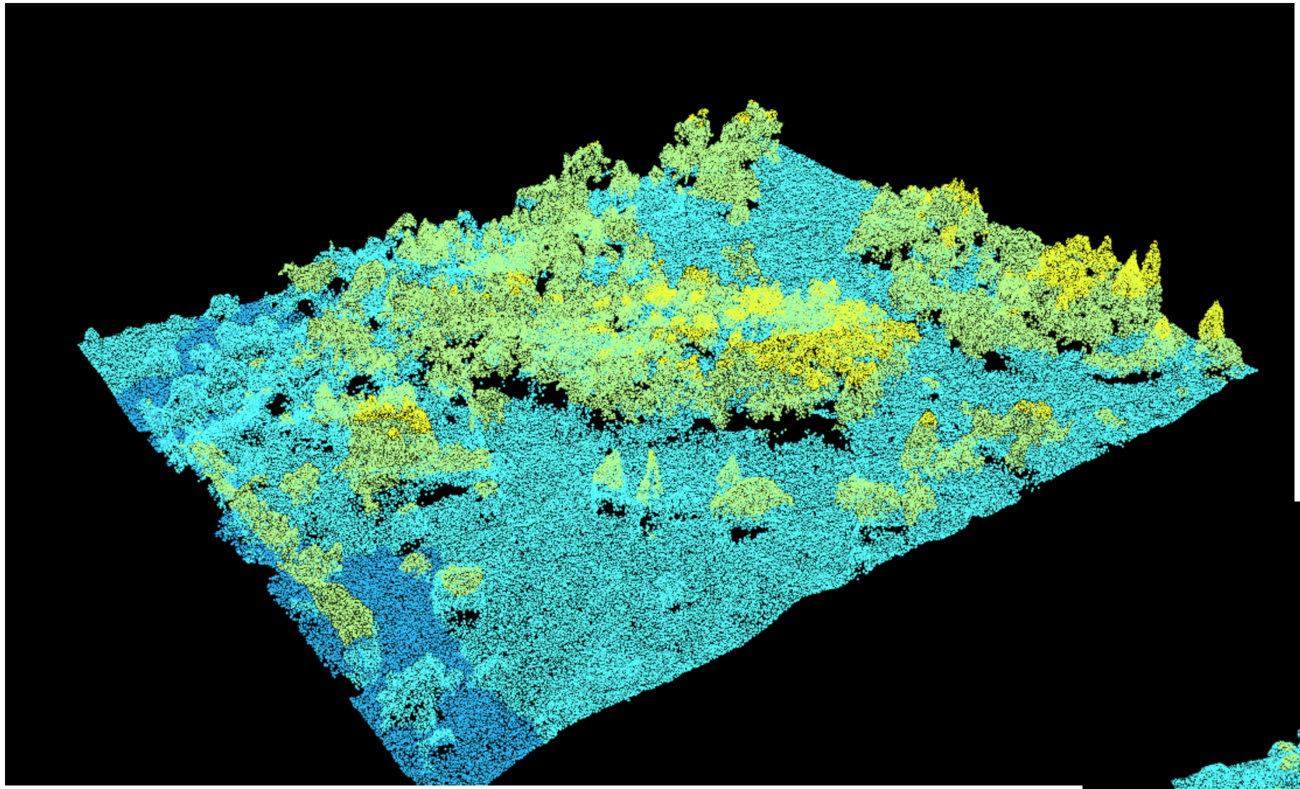
Structure from motion (SfM)

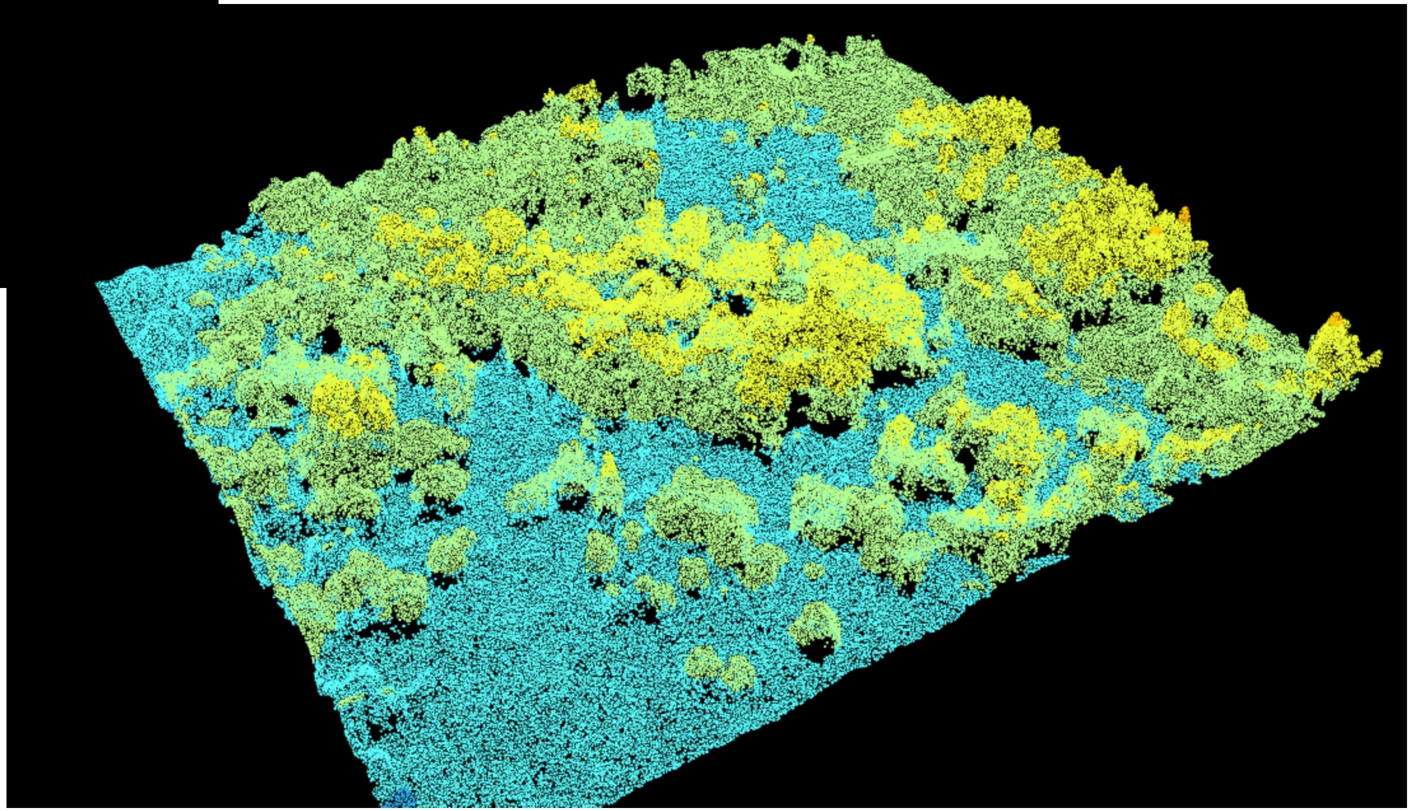












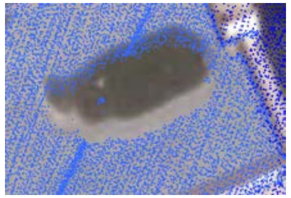
Remote sensing

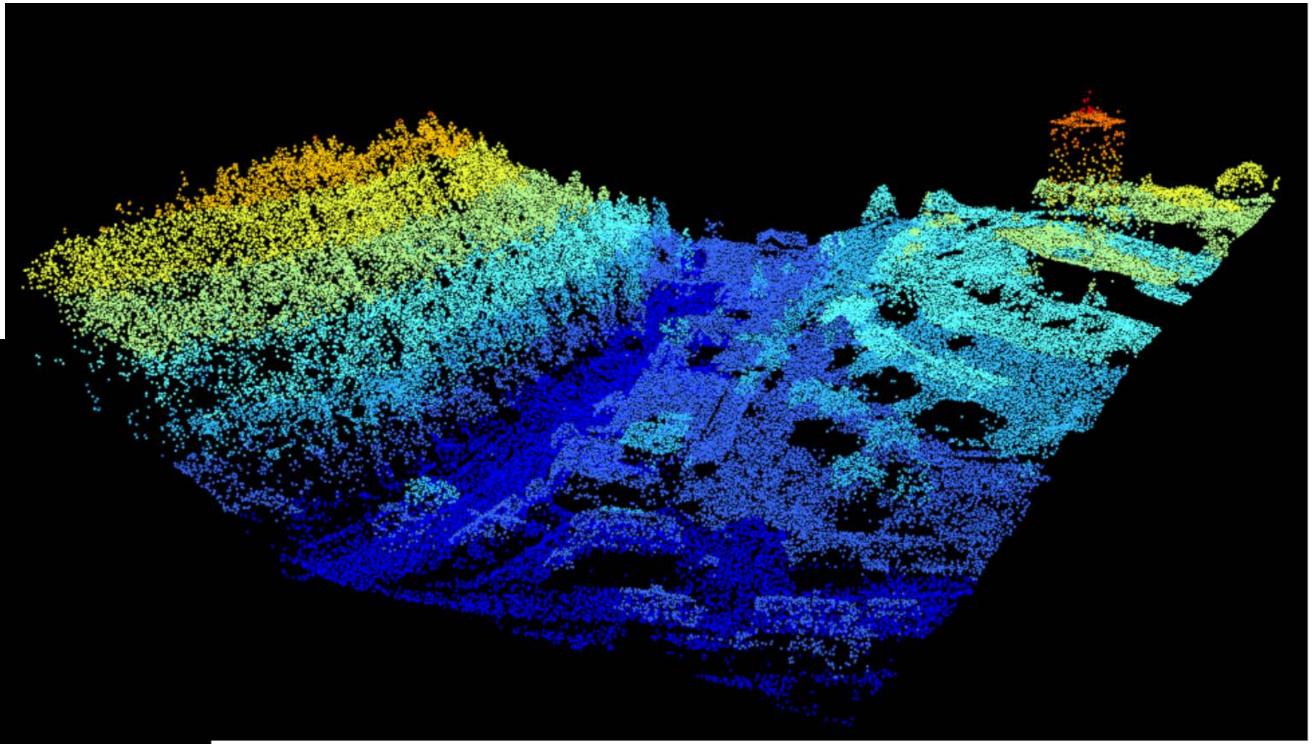
Laser Scanning:

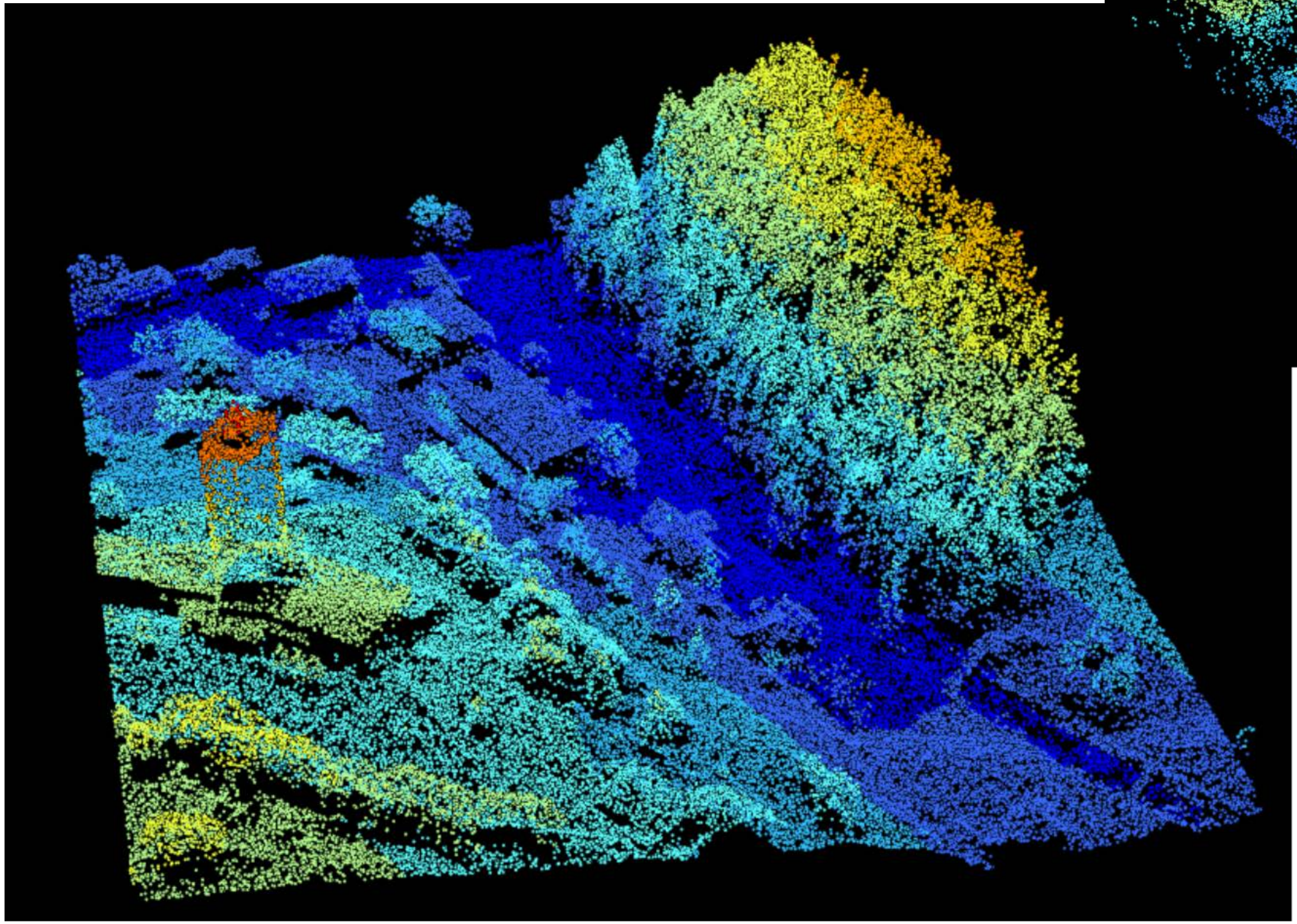
- LiDAR (“Light Detection and Ranging”) technology
- Plane or helicopter with active laser sensor
- Wavelength
  - 1000 – 1600nm (near-infrared for terestrial)
  - 500 – 600nm (blue-green for bathymetry)
- Topographic data of great detail

  → accuracy in cm

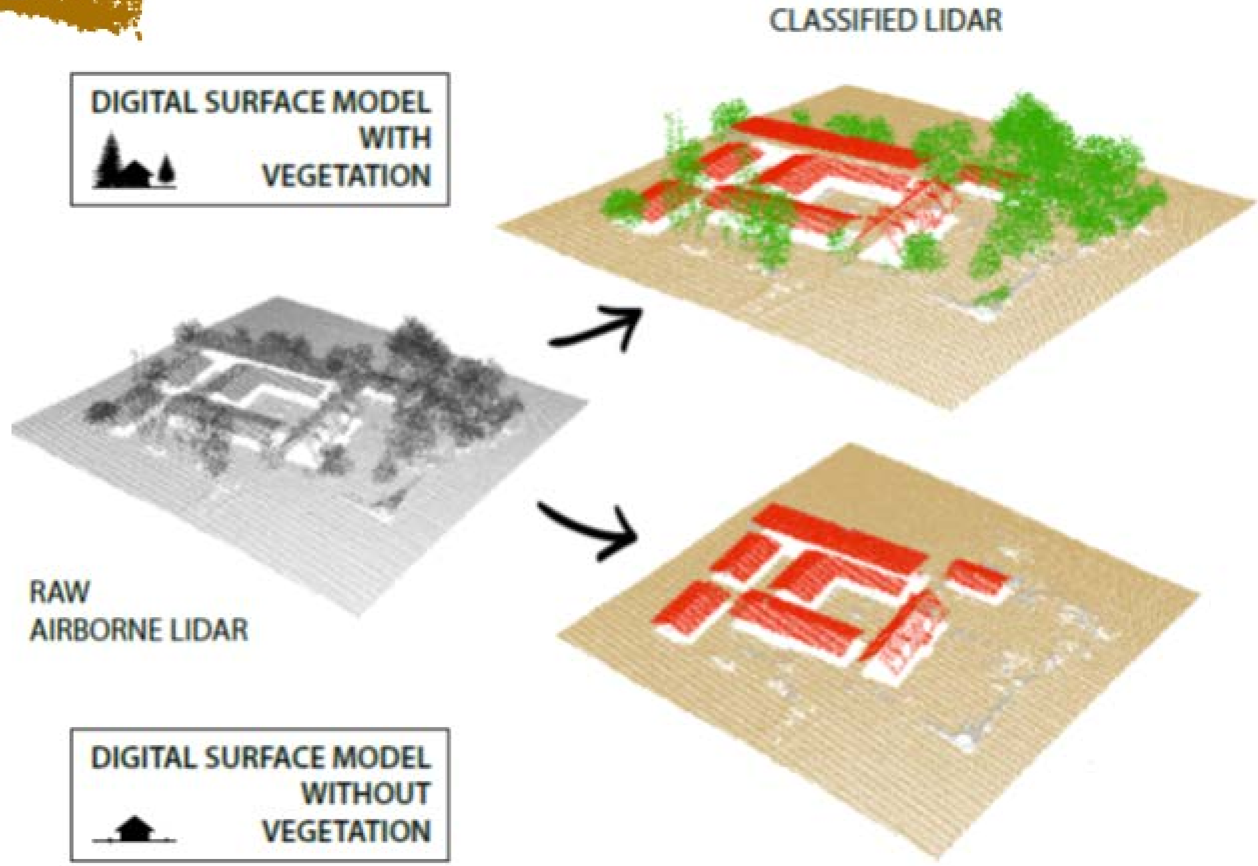
LiDAR







https://mapy.cz/zakladni?x=15.7368333&y=50.6959518&z=18&l=0&m3d=1&base=ophoto


CLASSIFIED LIDAR
DIGITAL SURFACE MODEL WITH VEGETATION
RAW AIRBORNE LIDAR
DIGITAL SURFACE MODEL WITHOUT VEGETATION


FLIR

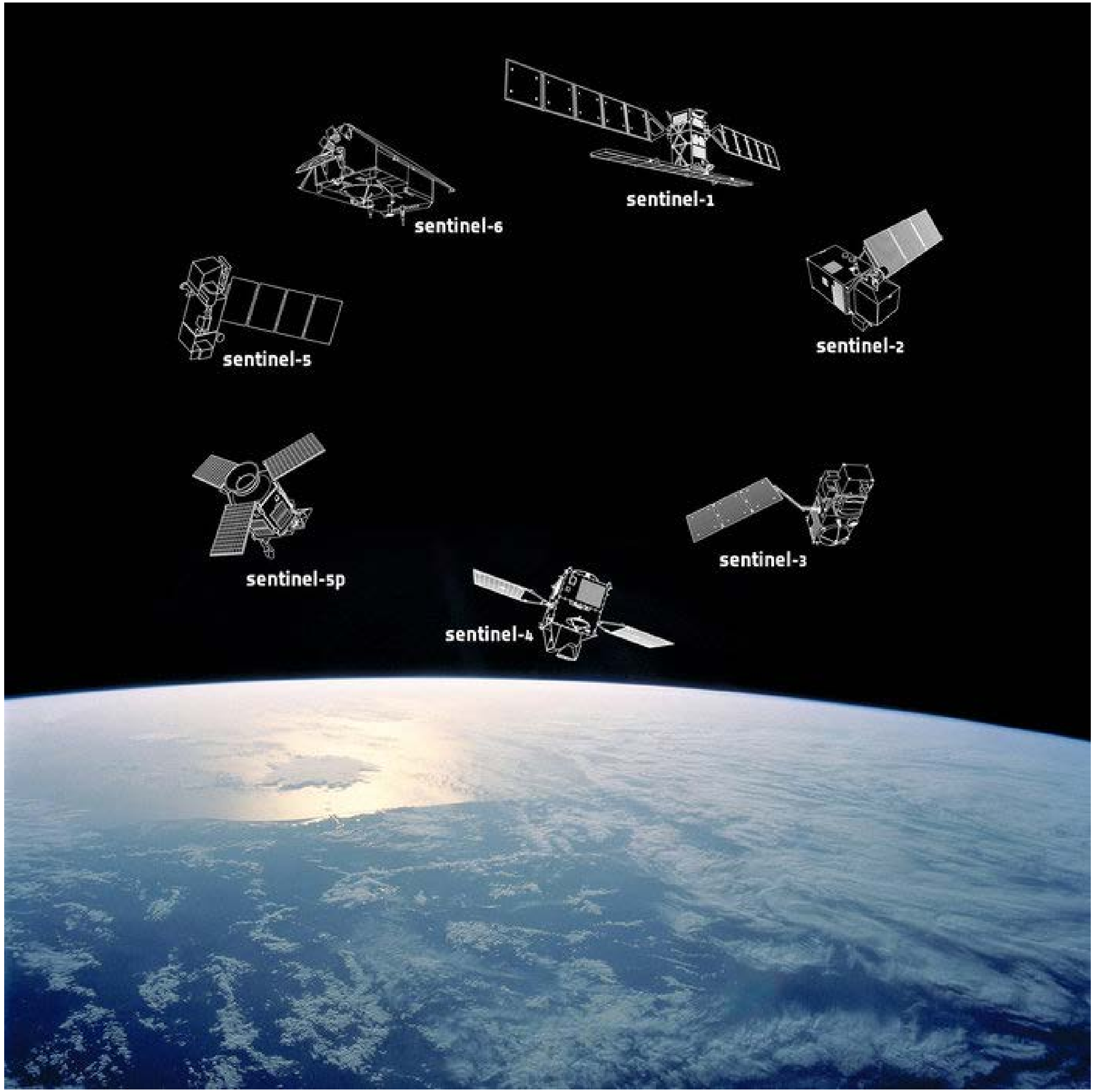
Example of how to combine **GPS**, **LiDAR** and passive **Remote Sensing** technologies to study Earth

- Greg Asner (http://globalecology.stanford.edu/labs/asnerlab/)
- https://www.ted.com/talks/greg_asner_ecology_from_the_air

ESA:
https://earth.esa.int/web/guest/eoli

vs.

SPUTNIK:
https://www.youtube.com/watch?v=RWAz_1Ck01U



http://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Space_Component

- Copernicus http://www.copernicus.eu/

Copernicus, previously known as GMES (Global Monitoring for Environment and Security), is the European Programme for the establishment of a European capacity for Earth Observation.

http://land.copernicus.eu/

Sentinel

http://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Overview3

http://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Overview4

Existing datasets

Land cover/use

DEM

Land cover/use

Land cover (LC) is defined as the biophysical material over the surface of the Earth including, among others, grass, shrubs, forests, croplands, barren, waterbodies and man-made structures

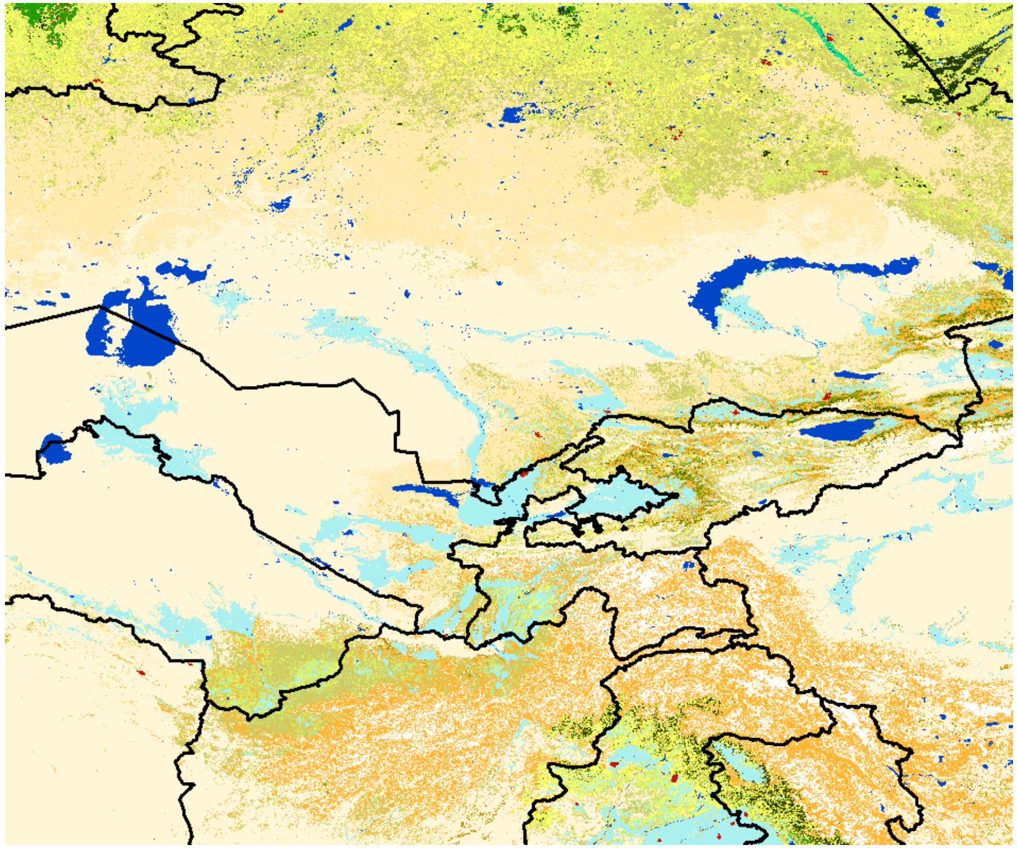
Land cover change (LCC) is the conversion from one LC category to another

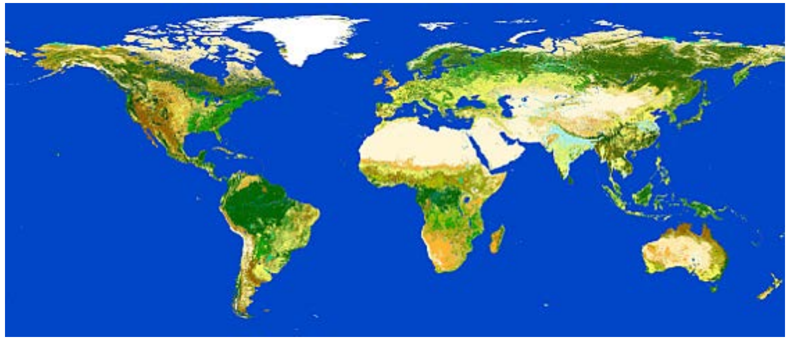
LCC causes significant environmental changes at the local, regional, and global scales. For example, forest transition to agricultural land or urban expansion into croplands affects the biodiversity, soil quality, climate, and human health.

Land cover/use

GlobCover

- http://due.esrin.esa.int/page_globcover.php





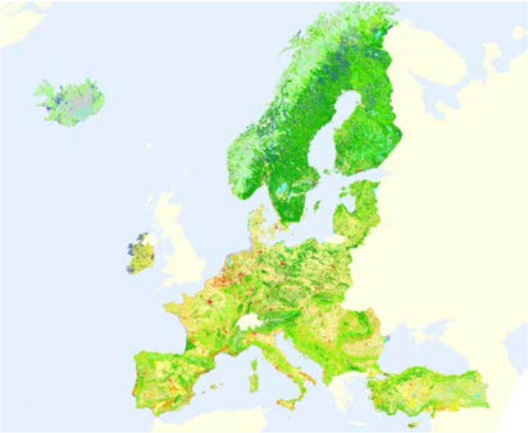
The aim of the project was to develop a service capable of delivering global composites and land cover maps using as input observations from the **300m MERIS sensor** on board the ENVISAT satellite mission. ESA makes available the land cover maps, which cover **2 periods**: December 2004 - June 2006 and January - December 2009.

The GlobCover 2009 dataset classifies land cover into **22 classes.**

Land cover/use

CORINE Land Cover

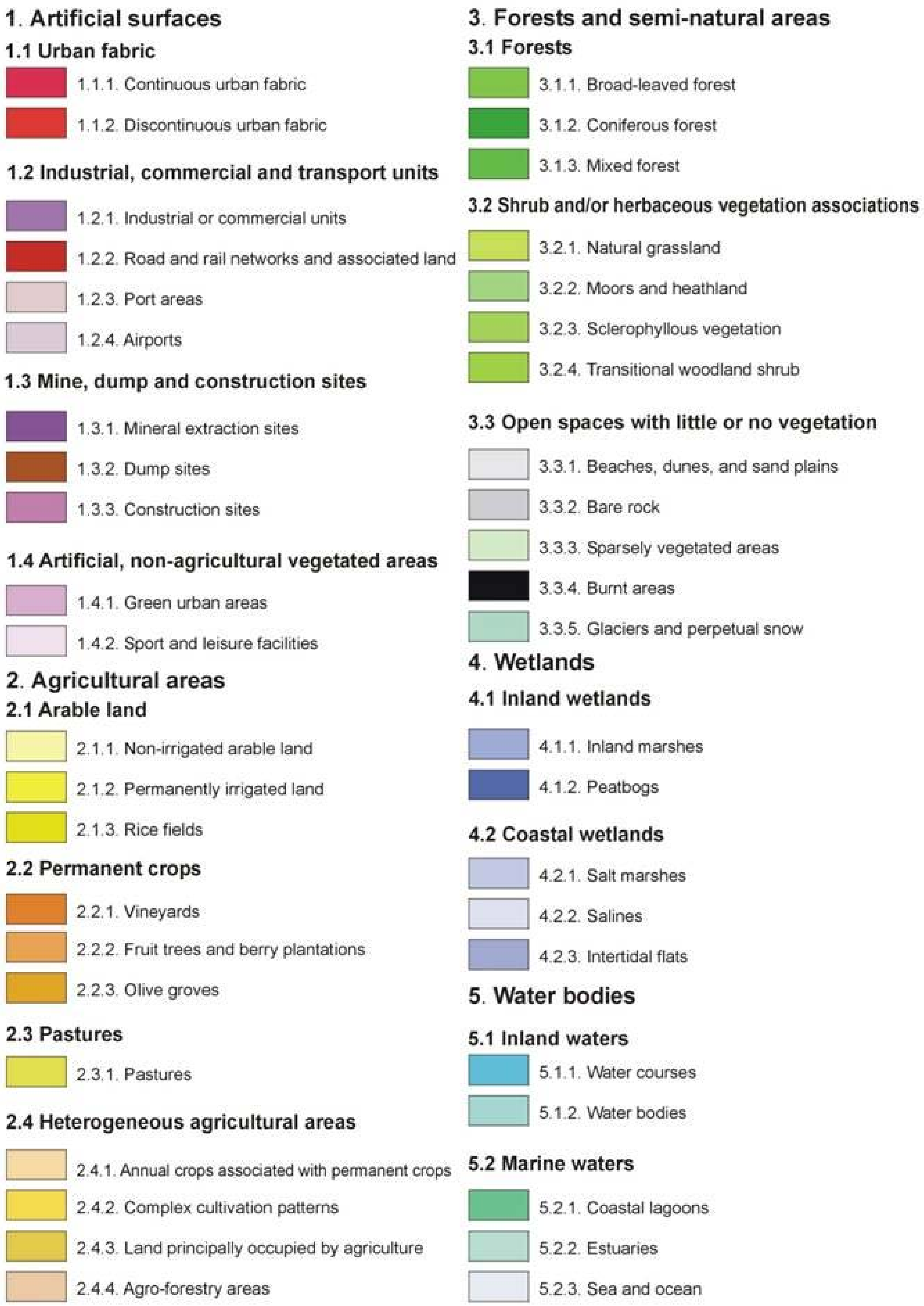
- http://land.copernicus.eu/pan-european/corine-land-cover
- https://europelandcover.ourecosystem.com/interface/#layers

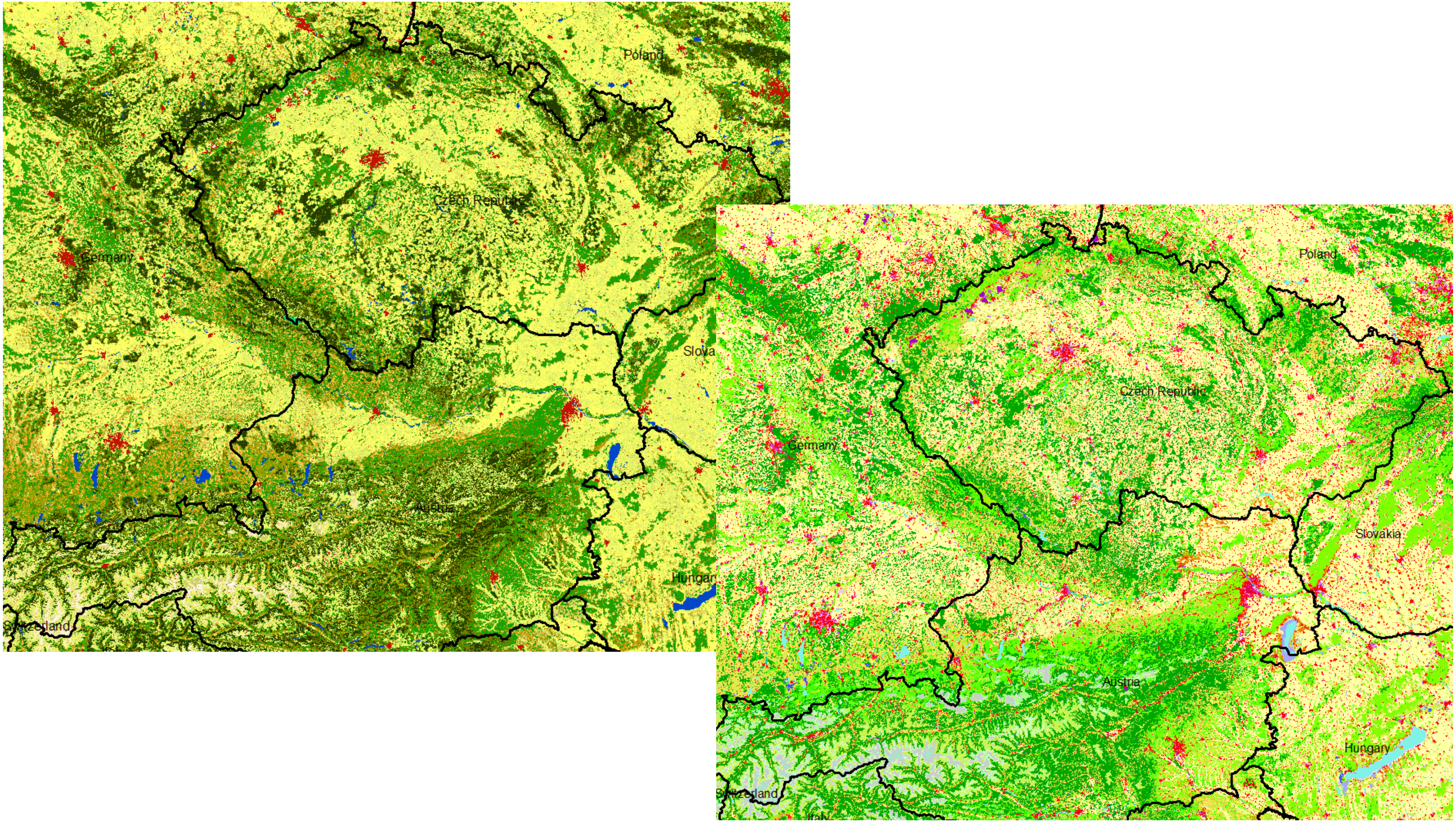


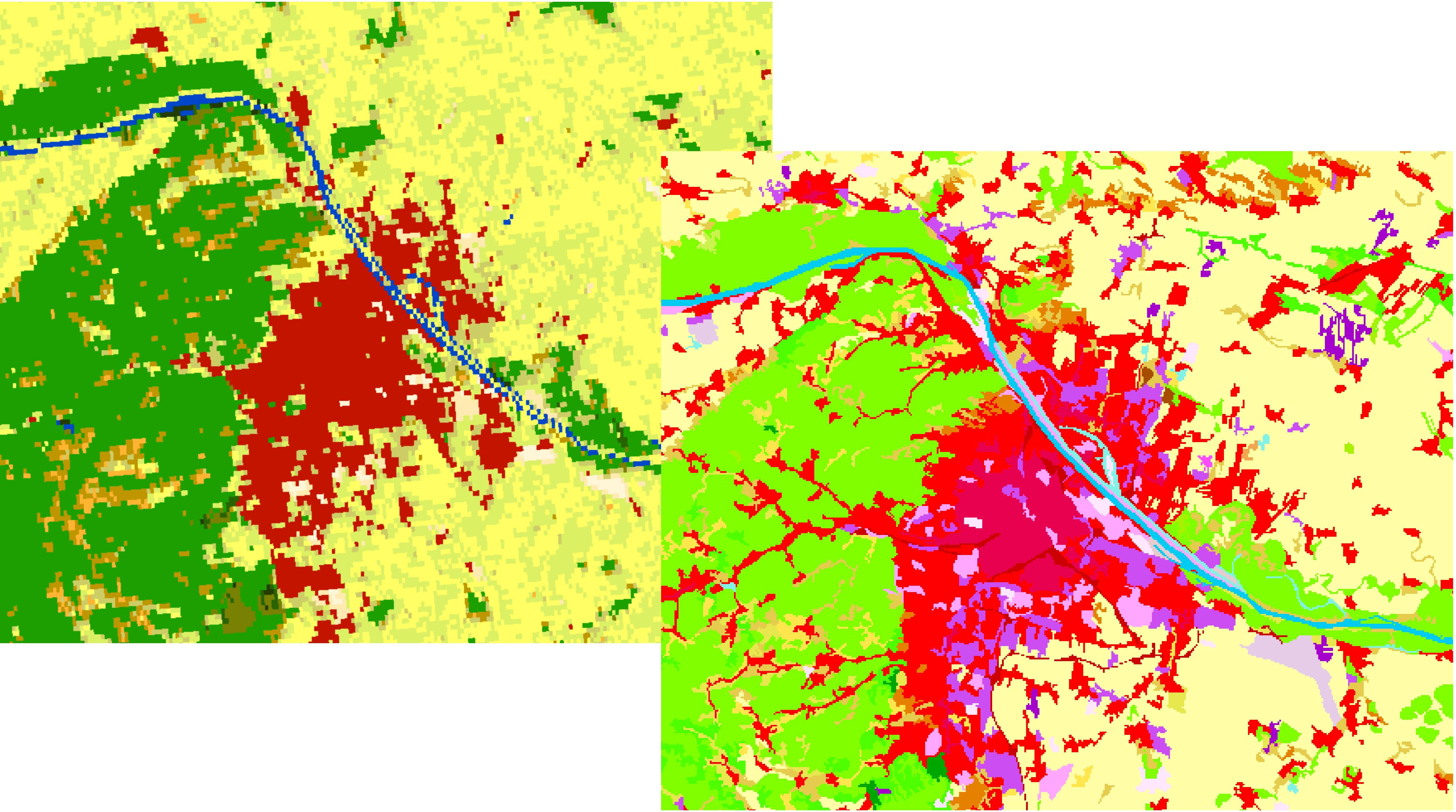
The CORINE Land Cover (CLC) was initiated in 1985 (reference year **1990**). Updates have been produced in **2000, 2006, and 2012**. It consists of an inventory of land cover in **44 classes**. CLC uses a Minimum Mapping Unit (MMU) of 25 hectares (ha) for areal phenomena and a minimum width of 100 m for linear phenomena. The time series are complemented by change layers, which highlight changes in land cover with an MMU of 5 ha.

CLC is produced by the majority of countries by visual interpretation of high resolution satellite imagery. In a few countries semi-automatic solutions are applied, using national in-situ data, satellite image processing, GIS integration and generalisation.

Classification systems come in two basic formats, ***hierarchical*** and *non-hierarchical*. Most systems are hierarchically structured because such a classification offers more consistency owing to its ability to accommodate different levels of information, starting with structured broad-level classes, which allow further systematic subdivision into more detailed sub-classes. At each level the defined classes are mutually exclusive.



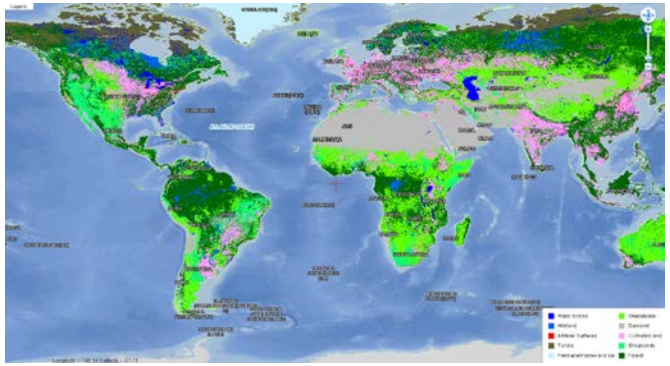

Poland
Czech Republic
Germany
Austria
Poland
Czech Republic
Germany
Slovakia
Austria
Hungary

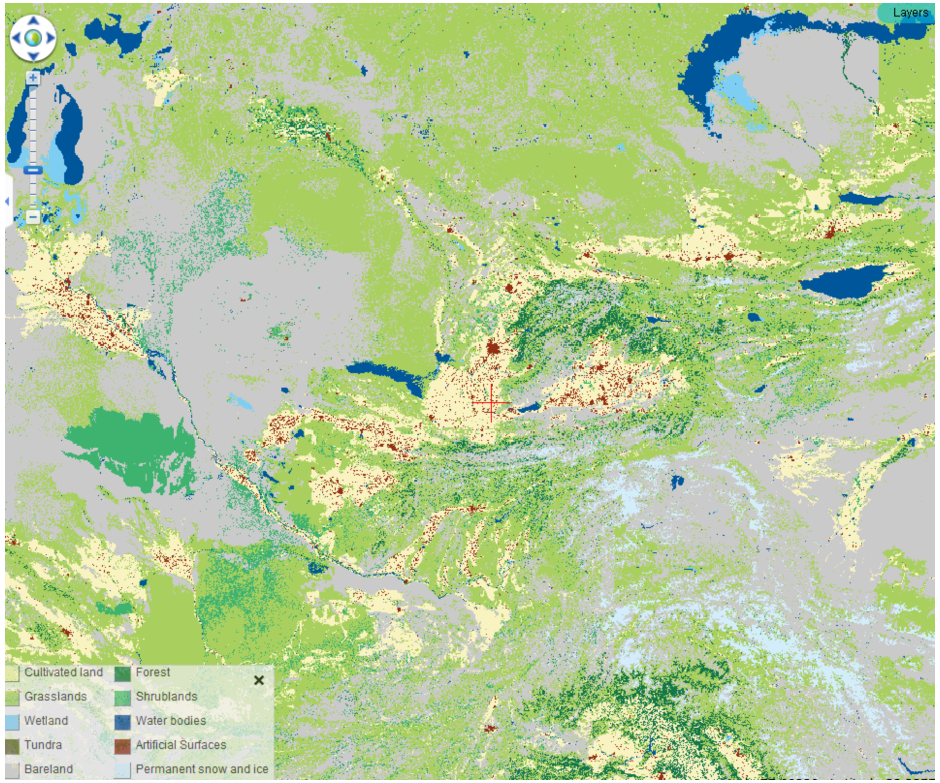


Land cover/use

GlobeLand30

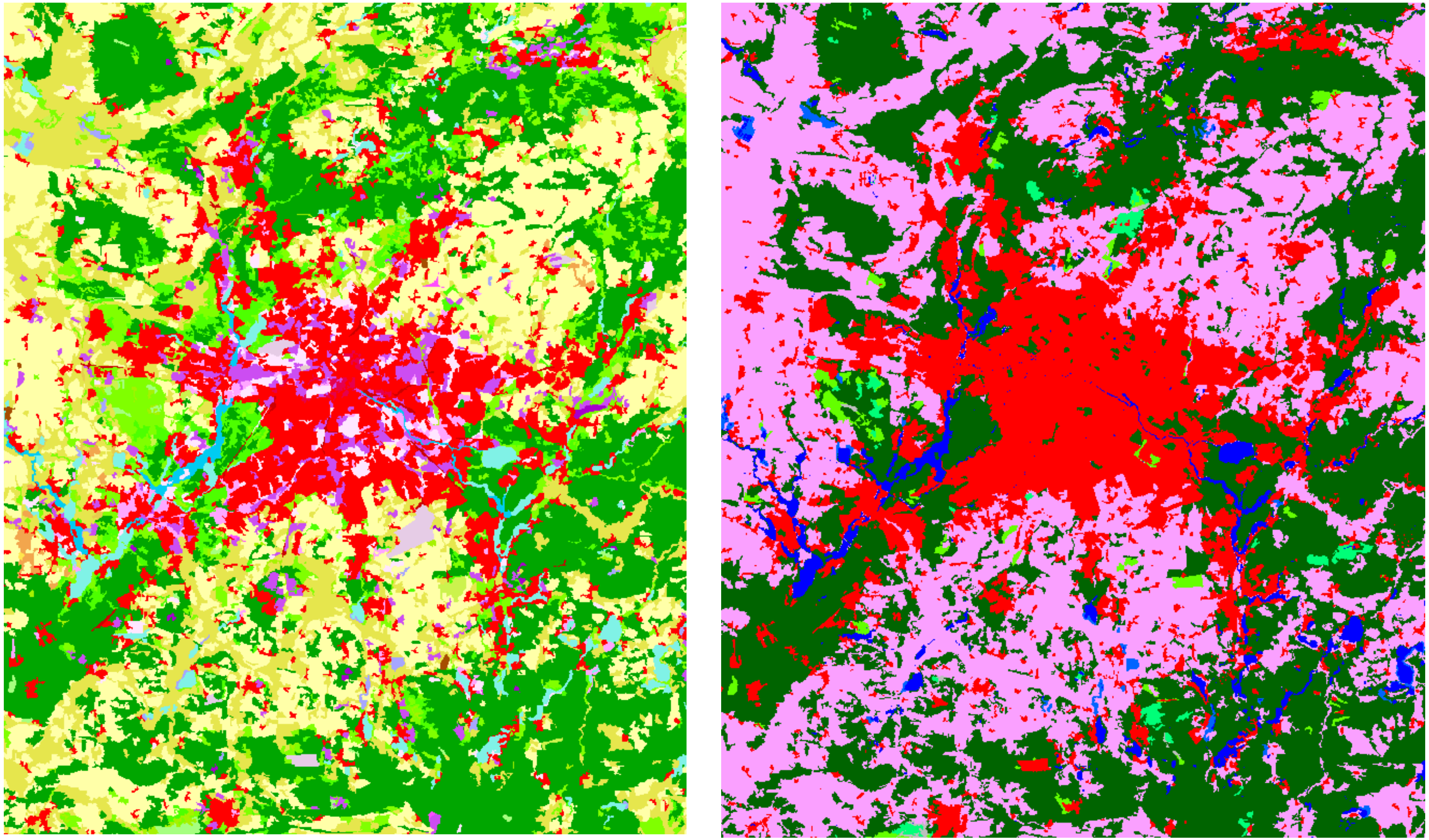
- http://glc30.tianditu.com/
- http://www.globallandcover.com/User/Login.aspx

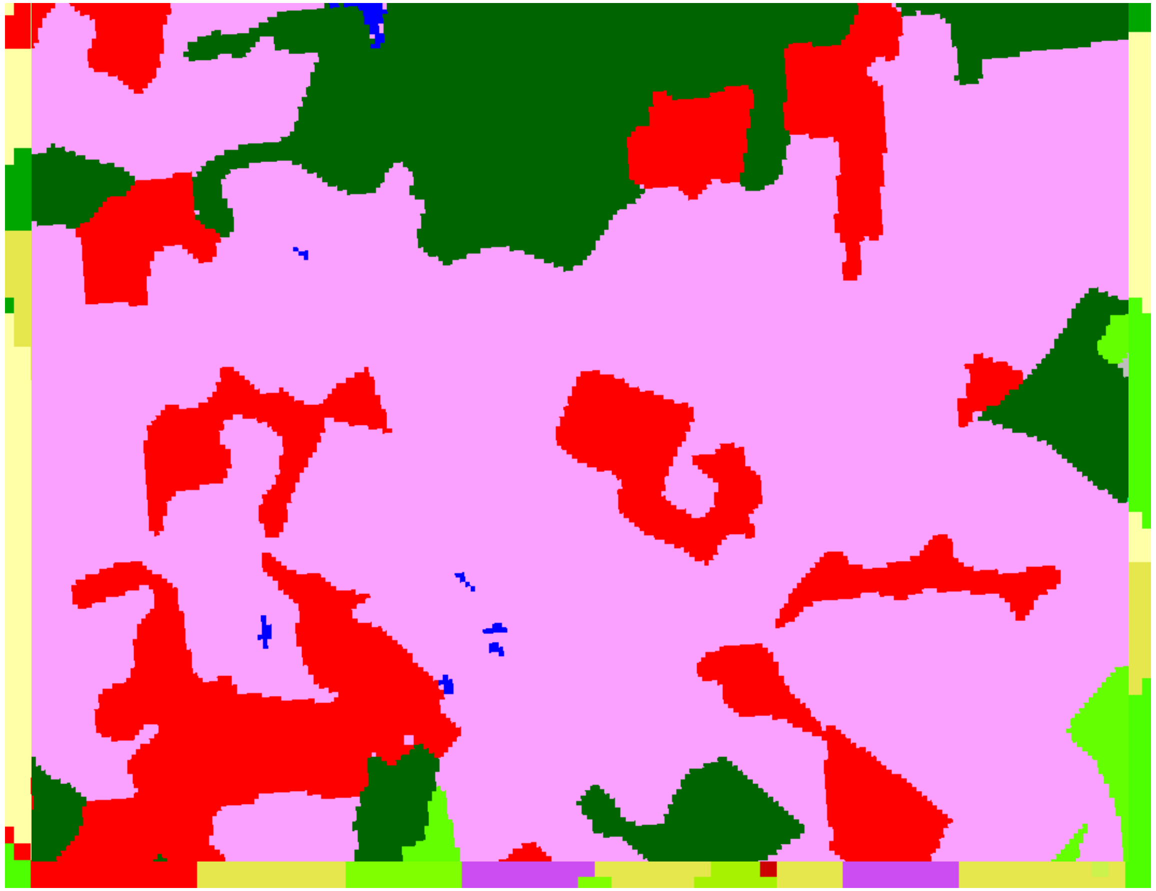




The first **30 m** resolution global land cover data set with **10 classes** and for the **year 2000 and 2010**. Over 10,000 Landsat-like satellite images are required to cover the entire Earth at 30 m resolution.

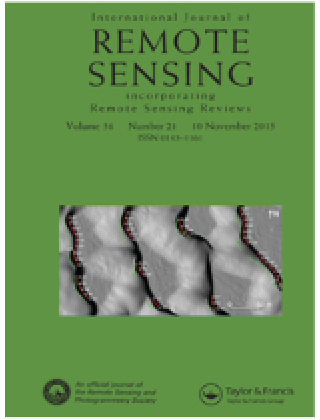
Data citation: CHEN Jun et al. (2015) Global land cover mapping at 30 m resolution: A POK-based operational approach. ISPRS Journal of Photogrammetry and Remote Sensing Volume 103, May 2015, Pages 7–27.





The mixed pixel problem: The low accuracy of land use/cover is due to mixed pixel problem, which result from the fact that the scale of observation (i.e. pixel resolution) fails to correspond to the spatial characteristics of the target.

Remote sensing need in situ data



Taylor & Francis
Taylor & Francis Group

International Journal of Remote Sensing

ISSN: 0143-1161 (Print) 1366-5901 (Online) Journal homepage: http://www.tandfonline.com/loi/tres20

An overview of 21 global and 43 regional land-cover mapping products

George Grekousis, Giorgos Mountrakis & Marinos Kavouras

To cite this article: George Grekousis, Giorgos Mountrakis & Marinos Kavouras (2015) An overview of 21 global and 43 regional land-cover mapping products, International Journal of Remote Sensing, 36:21, 5309-5335, DOI: 10.1080/01431161.2015.1093195

To link to this article: http://dx.doi.org/10.1080/01431161.2015.1093195

Current global land cover data:
http://worldgrids.org/doku.php/wiki:land_cover_and_land_use

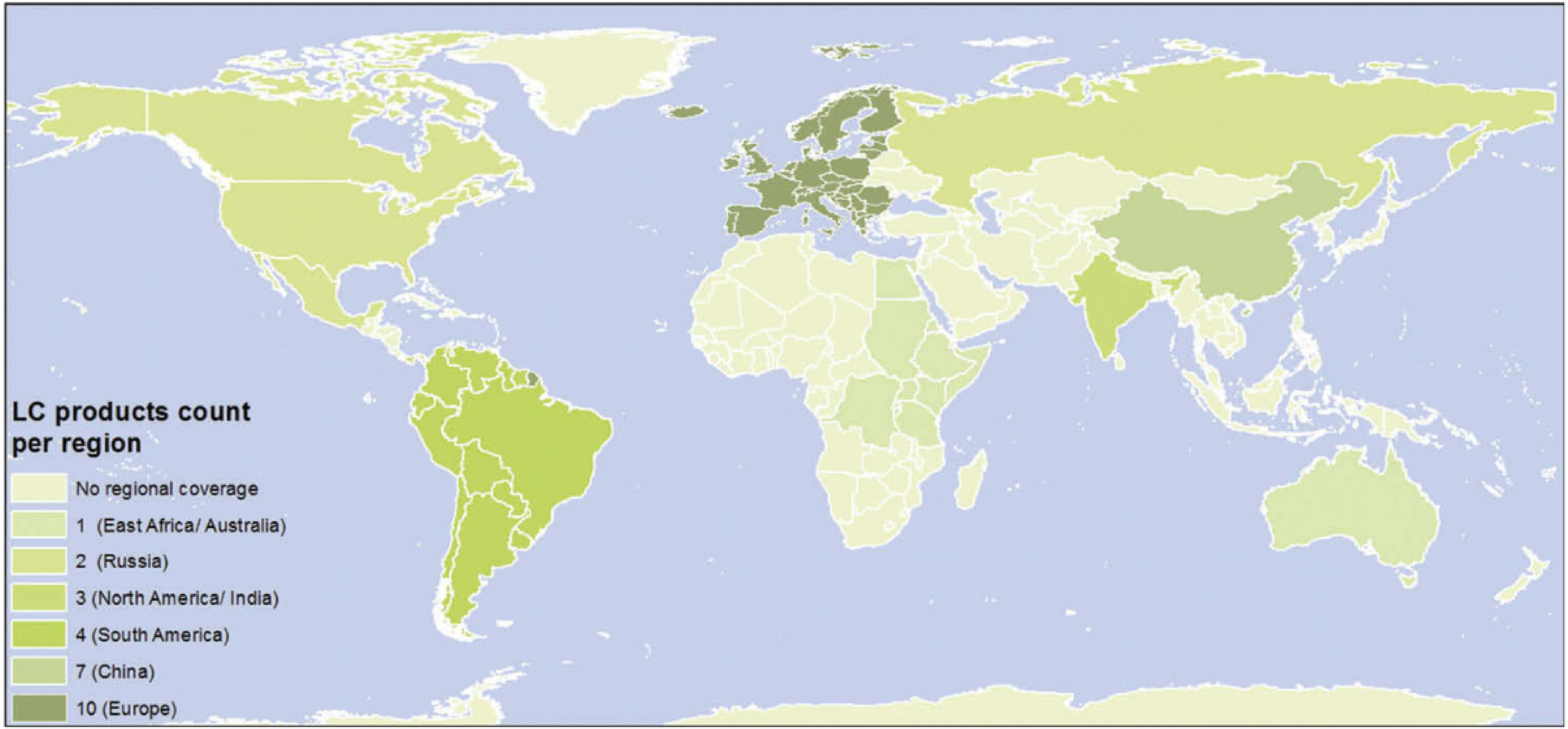


Figure 2. Regional LC products count by location. Names of LC products per region along with the reference year in parenthesis are also included. Europe, China, and the USA offer a plethora of LC products for multiple reference years especially during the decade 2000–2010. Asia and Africa do not have a complete regional product solely developed for these regions. East Africa is only covered from Africover and Asia is covered sparsely by national efforts.

- Understanding and monitoring LC distribution and dynamics are important factors in environmental studies. Updated LC information is essential for governments, non-governmental organizations, and other stakeholders assisting in the development and implementation of environmental policies for a sustainable future.

- For this reason, it is essential that LC products are as accurate and reliable as possible so that the outcomes are reliable and consistent. In reality though, because of the wide differences in the methodological approaches for each product (e.g. classification schemes, classification techniques, time of data acquisition, spatial resolution), there is often poor agreement among different data sets when applied at the regional or global level

Taylor & Francis
Taylor & Francis Group

International Journal of Digital Earth

ISSN: 1753-8947 (Print) 1753-8955 (Online) Journal homepage: http://www.tandfonline.com/loi/tjde20

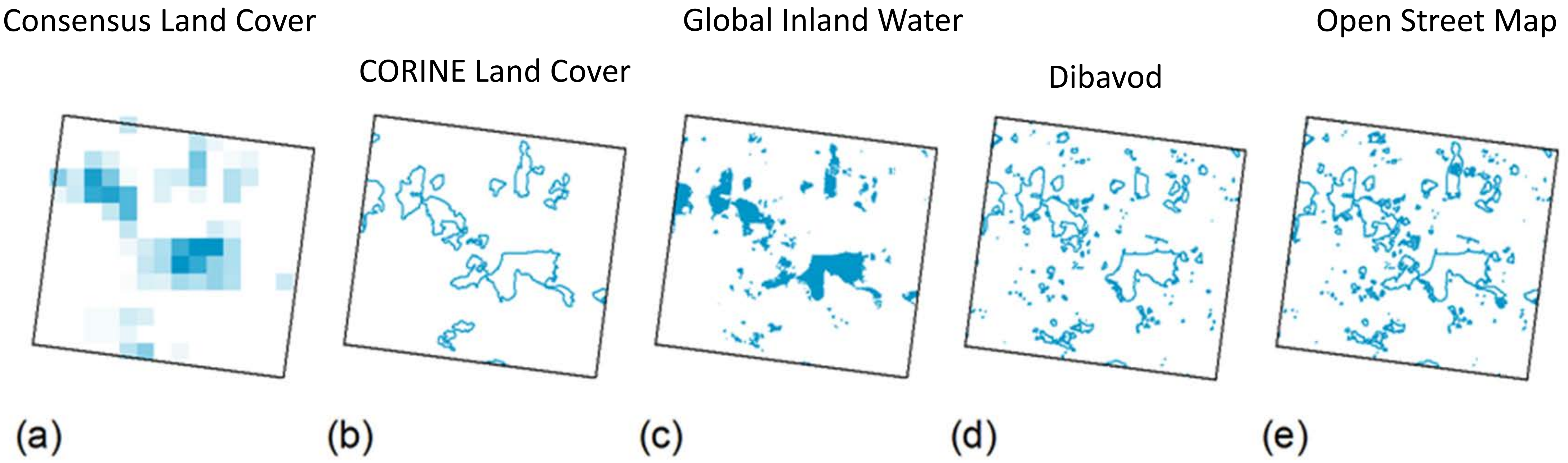
A global, high-resolution (30-m) inland water body dataset for 2000: first results of a topographic–spectral classification algorithm

Min Feng, Joseph O. Sexton, Saurabh Channan & John R. Townshend

To cite this article: Min Feng, Joseph O. Sexton, Saurabh Channan & John R. Townshend (2016) A global, high-resolution (30-m) inland water body dataset for 2000: first results of a topographic–spectral classification algorithm, International Journal of Digital Earth, 9:2, 113-133, DOI: 10.1080/17538947.2015.1026420

Link to data: http://glcf.umd.edu/data/watercover/

Single thematic products dedicated to only one LC class (Often forest or water)



Available Data - Water

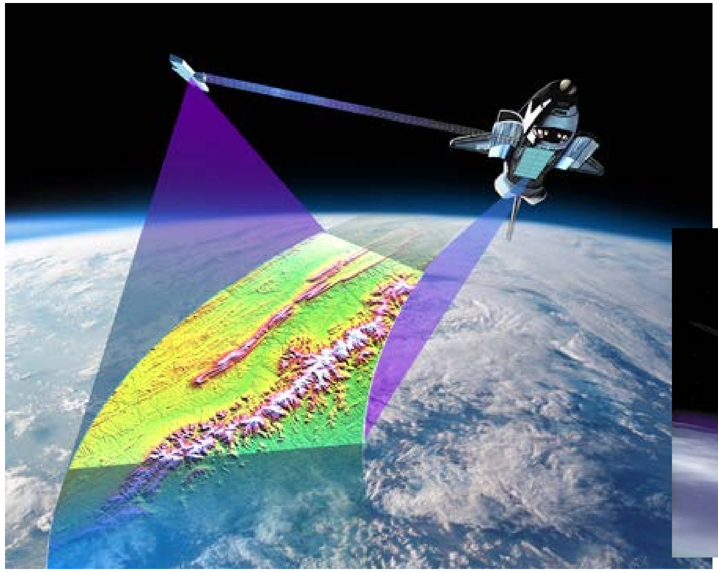
- https://global-surface-water.appspot.com/download
- http://www.nature.com/nature/journal/v540/n7633/full/nature20584.html

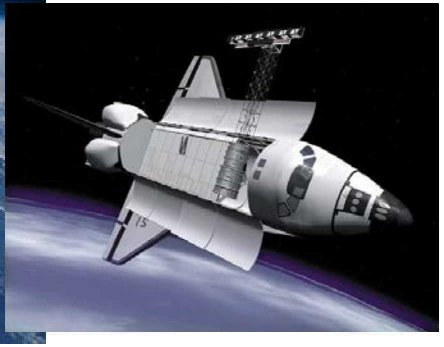
- Different download mechanisms (web, WMS,…)

DEM

SRTM (Shuttle Radar Topography Mission**)**

- https://earthexplorer.usgs.gov/
- https://lta.cr.usgs.gov/SRTM1Arc

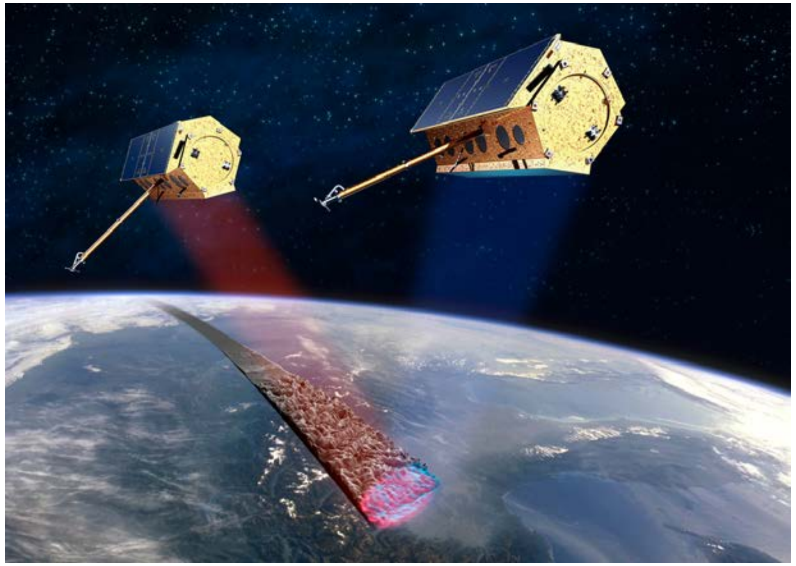




The Shuttle Radar Topography Mission (SRTM) is an international research effort that obtained digital elevation models on a **near-global scale** from 56° S to 60° N. SRTM consisted of a specially modified radar system that flew on board the Space shuttle Endeavour during the **11-day mission in February 2000**. To acquire topographic data, the SRTM payload was outfitted with two radar antennas.

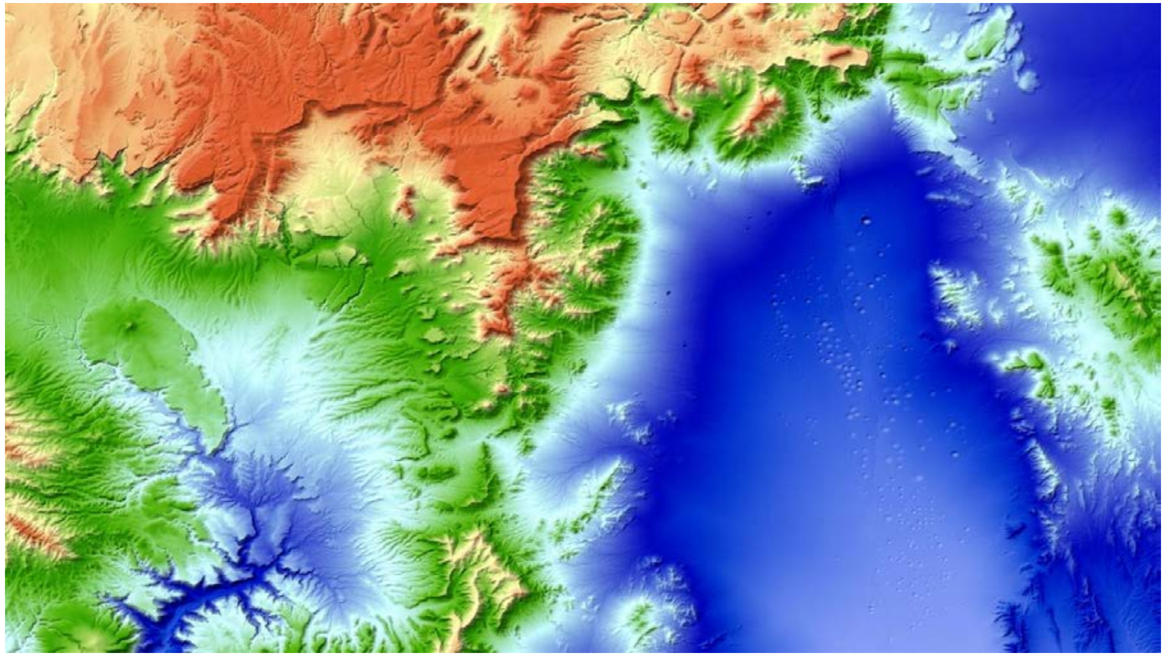
1-arc second global digital elevation model (30 meters) is available

DEM

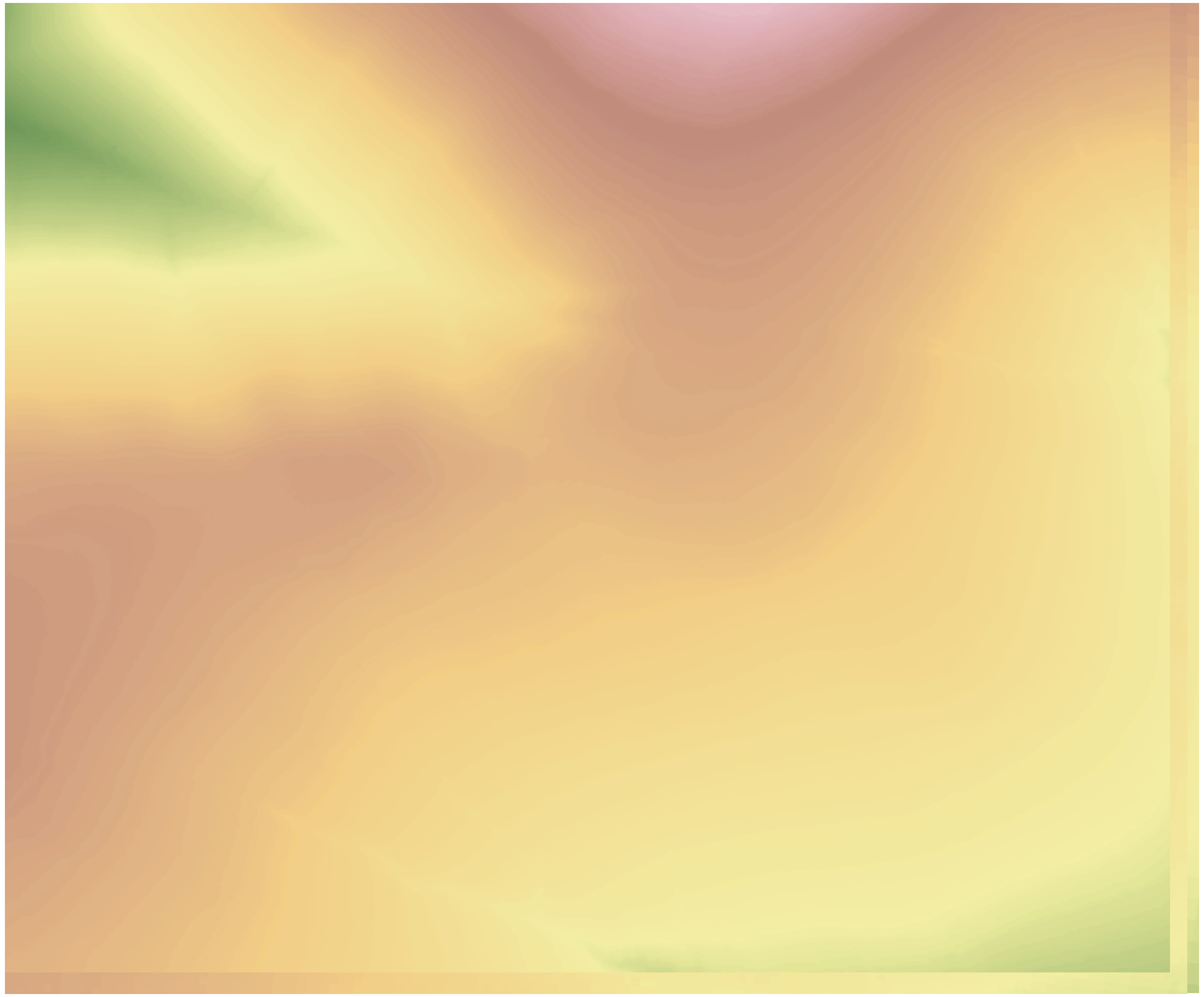


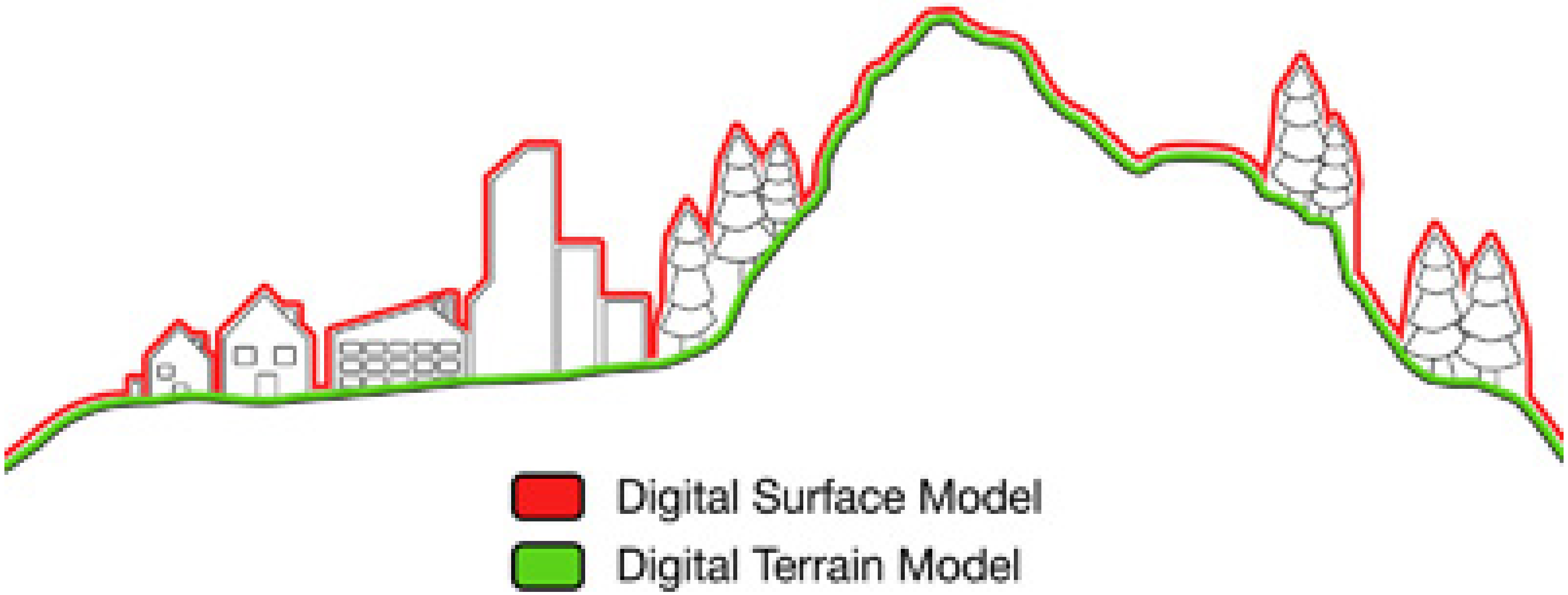
TanDEM-X

- https://tandemx-science.dlr.de/
- http://www.dlr.de/rd/en/desktopdefault.aspx/tabid-2440/3586_read-16692/



The approximately 150 million square kilometres of land surface were scanned from space. The use of radar technology based on two satellites orbiting in close formation is still unique and was key to the high-precision remapping of Earth.
It is a Public Private Partnership project operated in conjunction with Airbus Defence and Space. DLR is responsible for providing TanDEM-X data to the scientific community, mission planning and implementation, radar operation and calibration, control of the two satellites, and generation of the digital elevation model.
Access to the TanDEM-X Digital Elevation Model (DEM) is restricted – DLR supplies the data free of charge to scientific projects.





Radar vs. Lidar

DTM – Terrain attributes

Primary Attributes

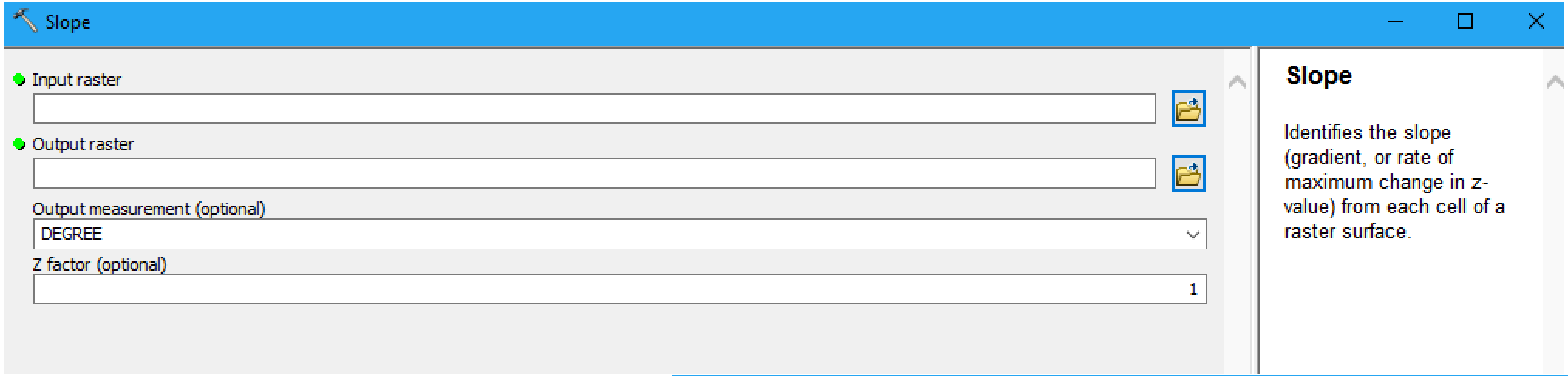
- Slope
- Aspect
- Plan and Profile Curvature
- Hillshade
- Flow direction

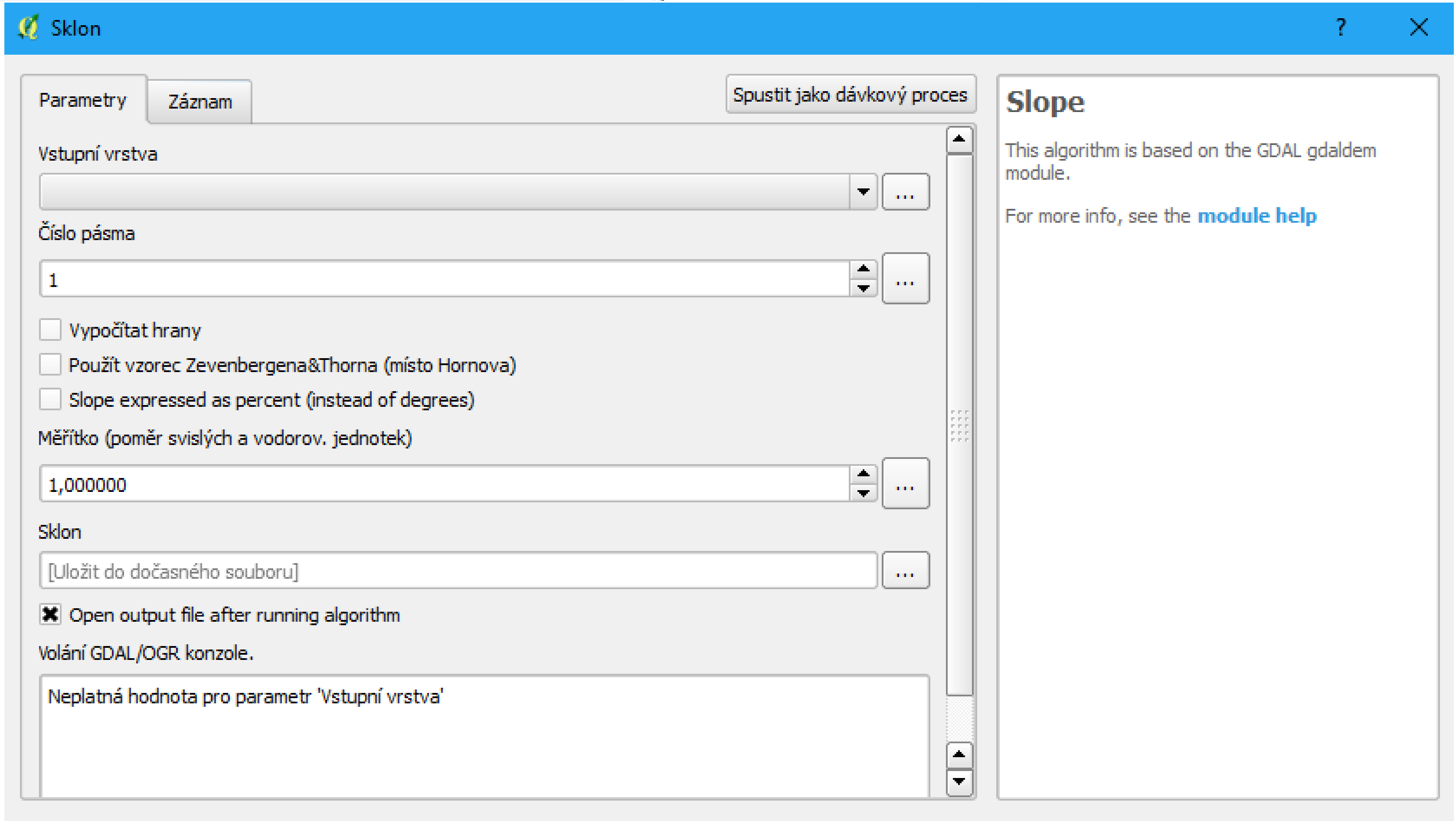
Secondary Attributes

- Flow accumulation

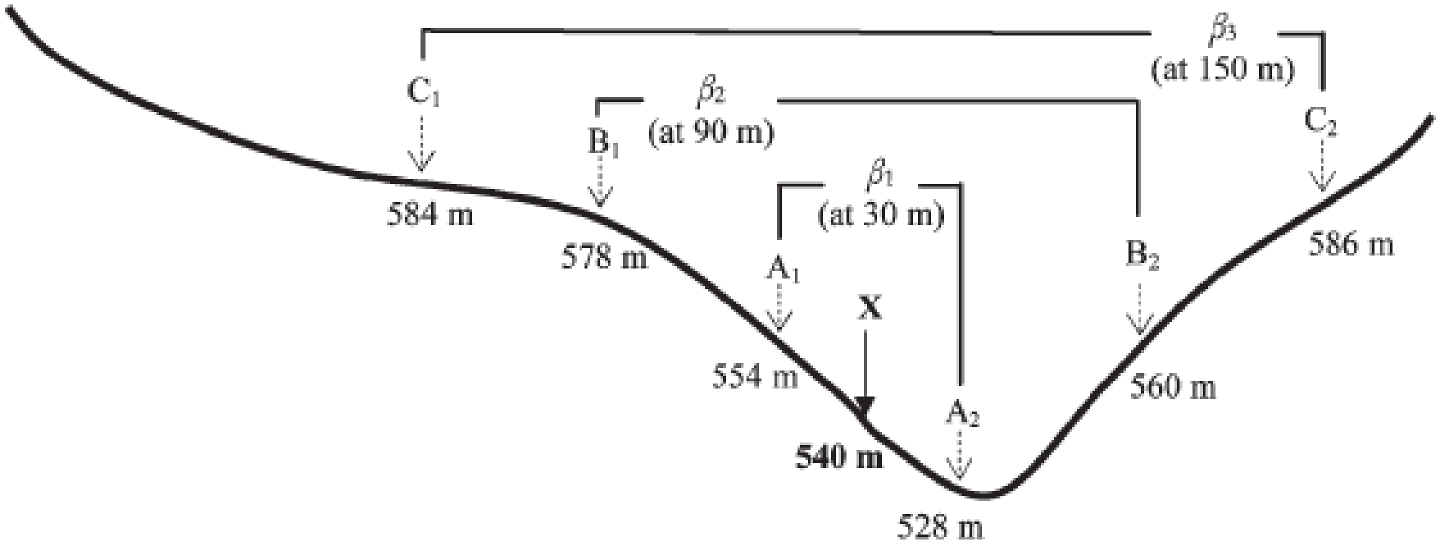
http://desktop.arcgis.com/en/arcmap/10.3/tools/spatial-analyst-toolbox/how-slope-works.htm

Slope ArcGIS vs QGIS



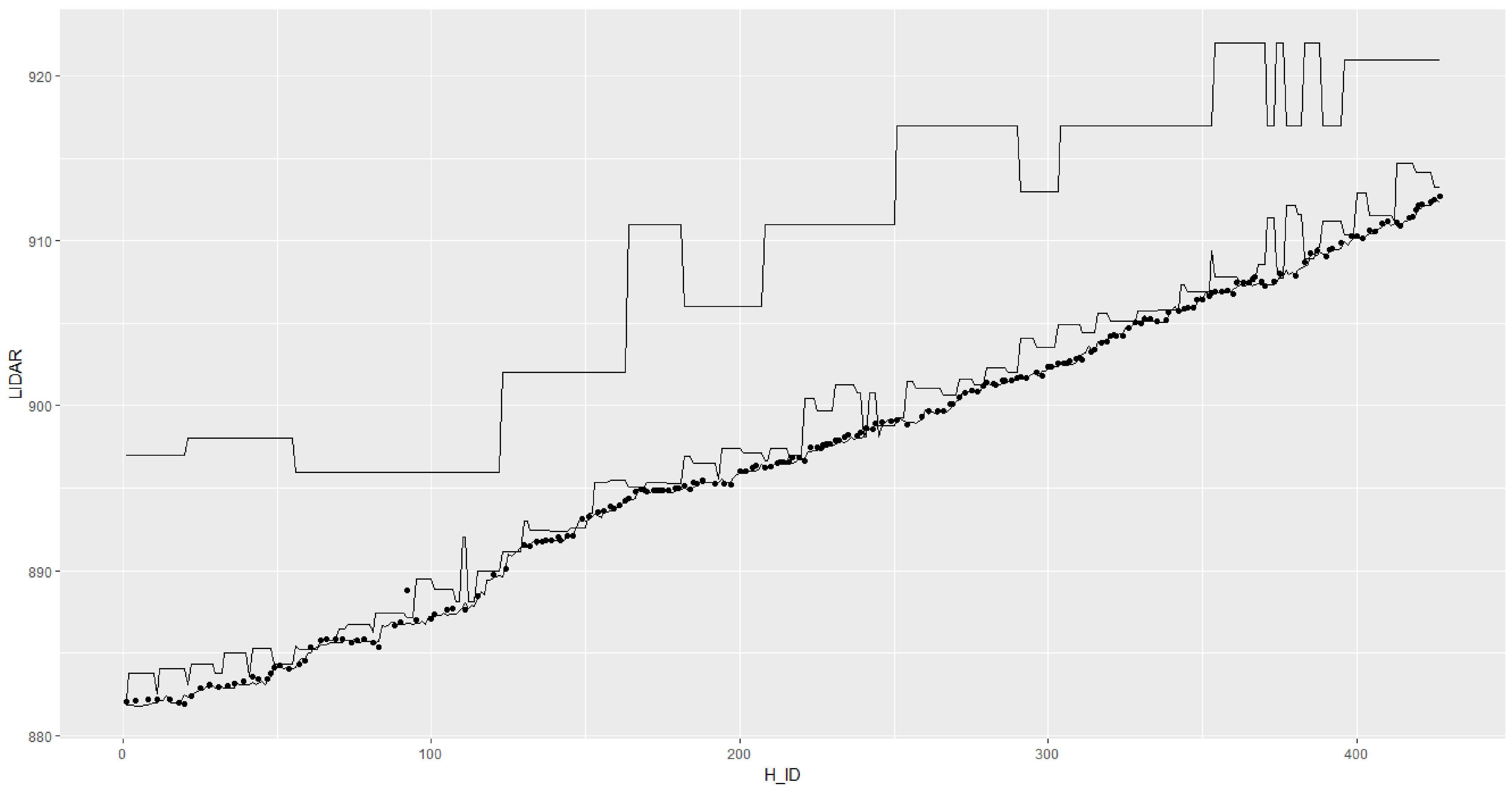


DTM – Terrain attributes (scale effects)



β_1 = (554 m – 528 m) × 100% / 30 m = 87%, β_1 is the slope gradient for X at 30-m spatial resolution, pointing from A_1 to A_2
β_2 = (578 m – 560 m) × 100% / 90 m = 20%, β_2 is the slope gradient for X at 90-m spatial resolution, pointing from B_1 to B_2
β_3 = (586 m – 584 m) × 100% / 150 m = 1%, β_3 is the slope gradient for X at 150-m spatial resolution, pointing from C_2 to C_1

Y. Deng , J. P. Wilson & B. O. Bauer (2007) DEM resolution dependencies of terrain attributes across a landscape, International Journal of Geographical Information Science, 21:2, 187-213, DOI: 10.1080/13658810600894364



LIDAR
H_ID
880
890
900
910
920
0
100
200
300
400

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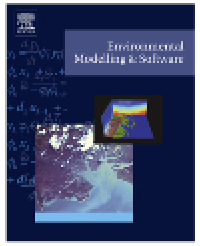

Towards a framework for terrain attribute selection in environmental studies

Vincent Lecours [a, *], Rodolphe Devillers [a], Alvin E. Simms [a], Vanessa L. Lucieer [b], Craig J. Brown [a, c]

[a] Department of Geography, Memorial University of Newfoundland, 232 Elizabeth Avenue, St. John's, Newfoundland and Labrador, A1B 3X9, Canada
[b] Institute for Marine and Antarctic Studies, University of Tasmania, 20 Castray Esplanade, Battery Point, Tasmania, 7004, Australia
[c] Applied Ocean Technology Research Department, Nova Scotia Community College, 80 Mawiomi Place, Dartmouth, Nova Scotia, B2Y 0A5, Canada

A B S T R A C T

Terrain attributes (*e.g.* slope, rugosity) derived from digital terrain models are commonly used in environmental studies. The increasing availability of GIS tools that generate those attributes can lead users to select a sub-optimal combination of terrain attributes for their applications. Our objectives were to identify sets of terrain attributes that best capture terrain properties and to assess how they vary with surface complexity. 230 tools from 11 software packages were used to derive terrain attributes from nine surfaces of different topographic complexity levels. Covariation and independence of terrain attributes were explored using three multivariate statistical methods. Distinct groups of correlated terrain attributes were identified, and their importance in describing a surface varied with surface complexity. Terrain attributes were highly covarying and sometimes ambiguously defined within software documentation. We found that a combination of six to seven particular terrain attributes always captures more than 70% of the topographic structure of surfaces.

Czech University of Life Sciences Prague
Faculty of Environmental Sciences

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Thank you for attention!

Department of Applied Geoinformatics and Spatial Planning
Vítězslav Moudrý (moudry@fzp.czu.cz)