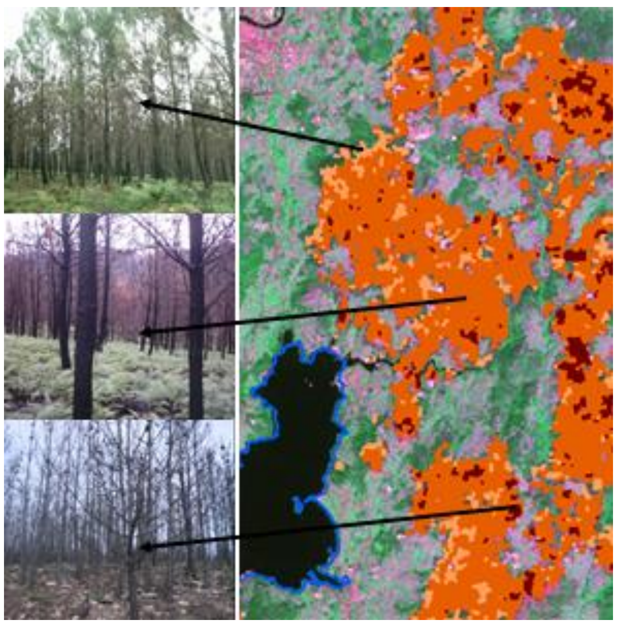
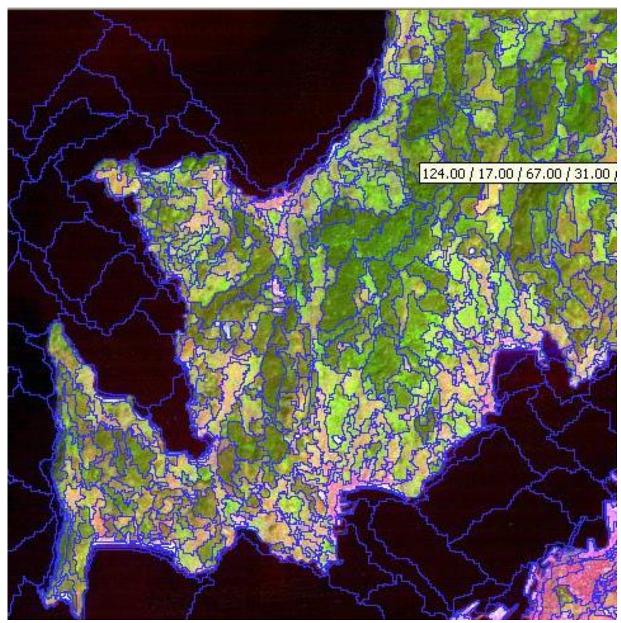
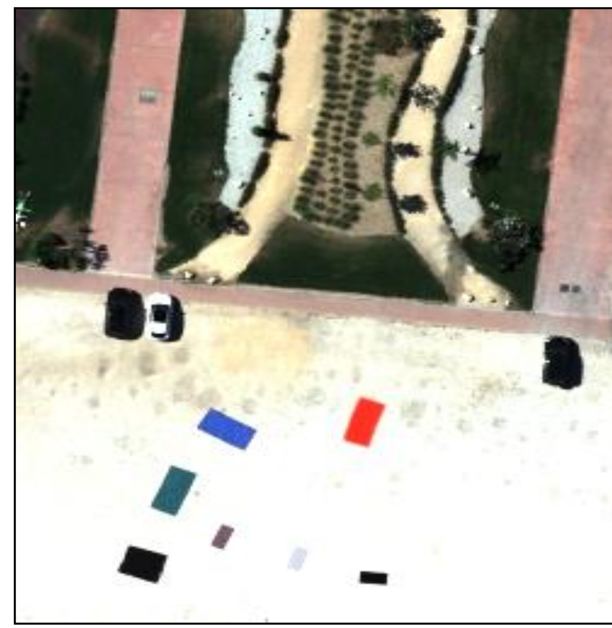
Object Based Image Analysis (OBIA)







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PLANNING

Session 1: Introduction and OBIA applications

Session 2: Study case 1: advanced land cover mapping. Data loading, segmentation, classification, accuracy assessment.

Session 3. Urban areas mapping using orthoimages and LiDAR data.

Guided work: OBIA project

MATERIALS

Available on:

https://ariadna.unileon.es/

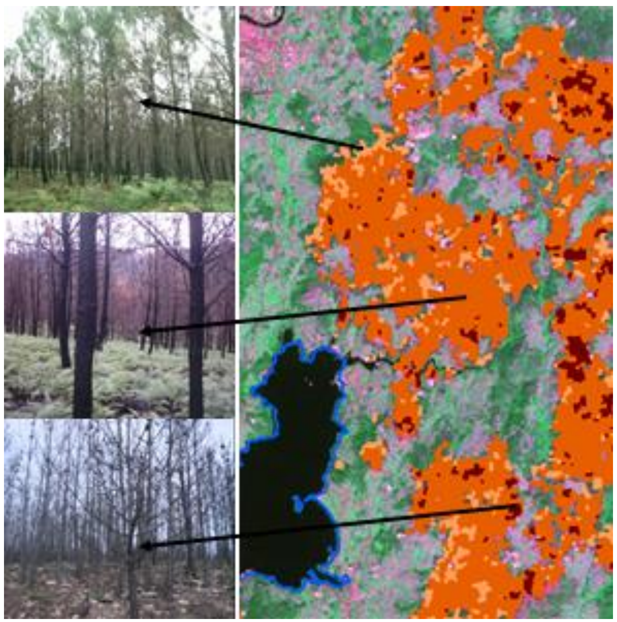
* OTROS

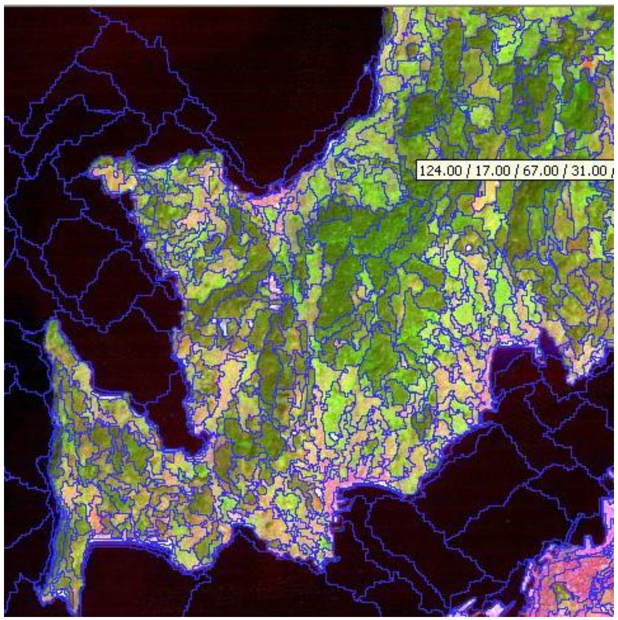
* Geoweb training.

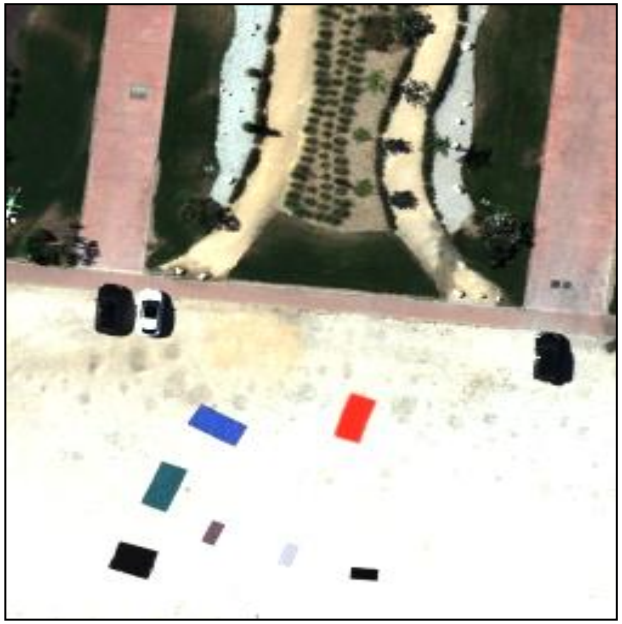
User
Password

Course password: GEOWEB

OBIA: Object Based Image Analysis







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SUMMARY

Fundamentals:

- What is a remote sensing system?
- What do we use those images for?

Information extraction:

- How do we process imagery?

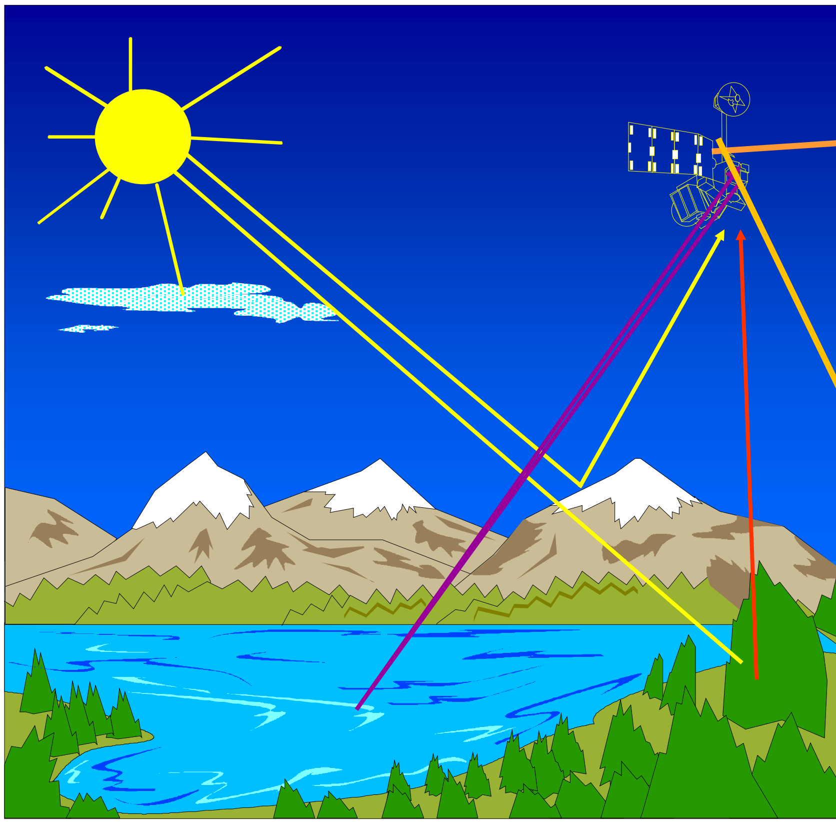
Applications:

- OBIA projects: 2004 – 2016

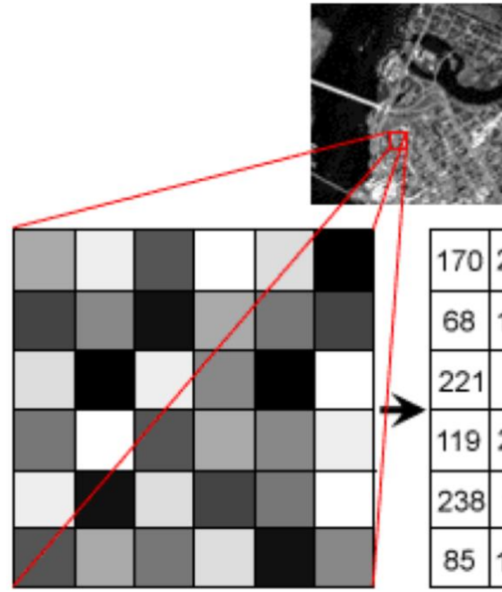
What is a remote sensing system?

REMOTE SENSING SYSTEMS

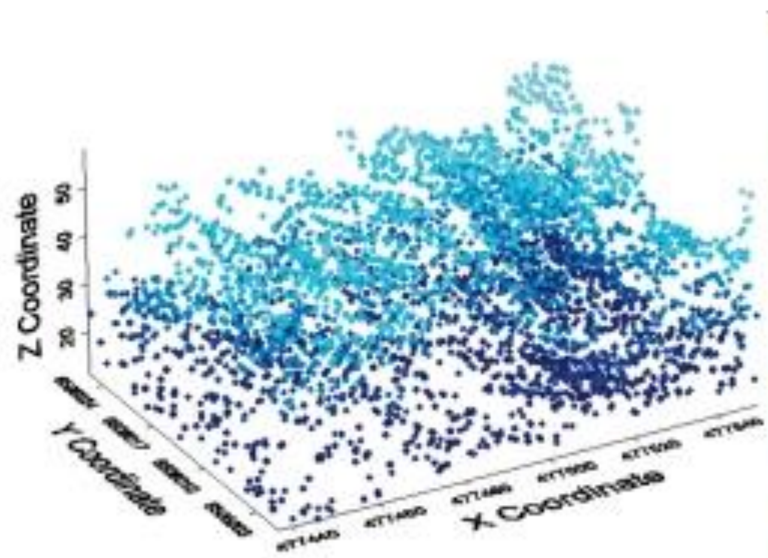
Satellite, airplane, drone



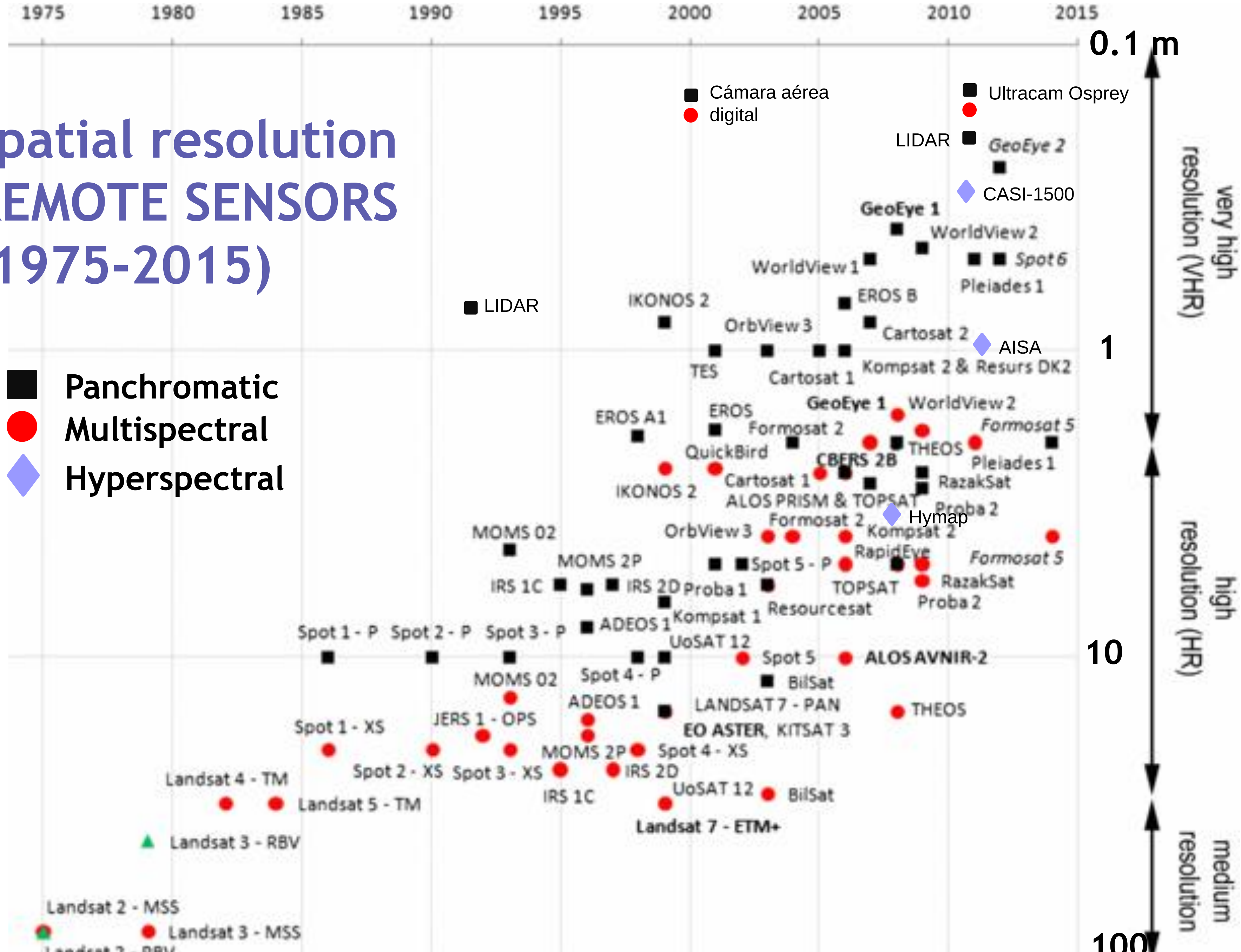
(Chuvieco, 2002)



170	238	85	255	221	0
68	136	17	170	119	68
221	0	238	136	0	255
119	255	85	170	136	238
238	17	221	68	119	255
85	170	119	221	17	136

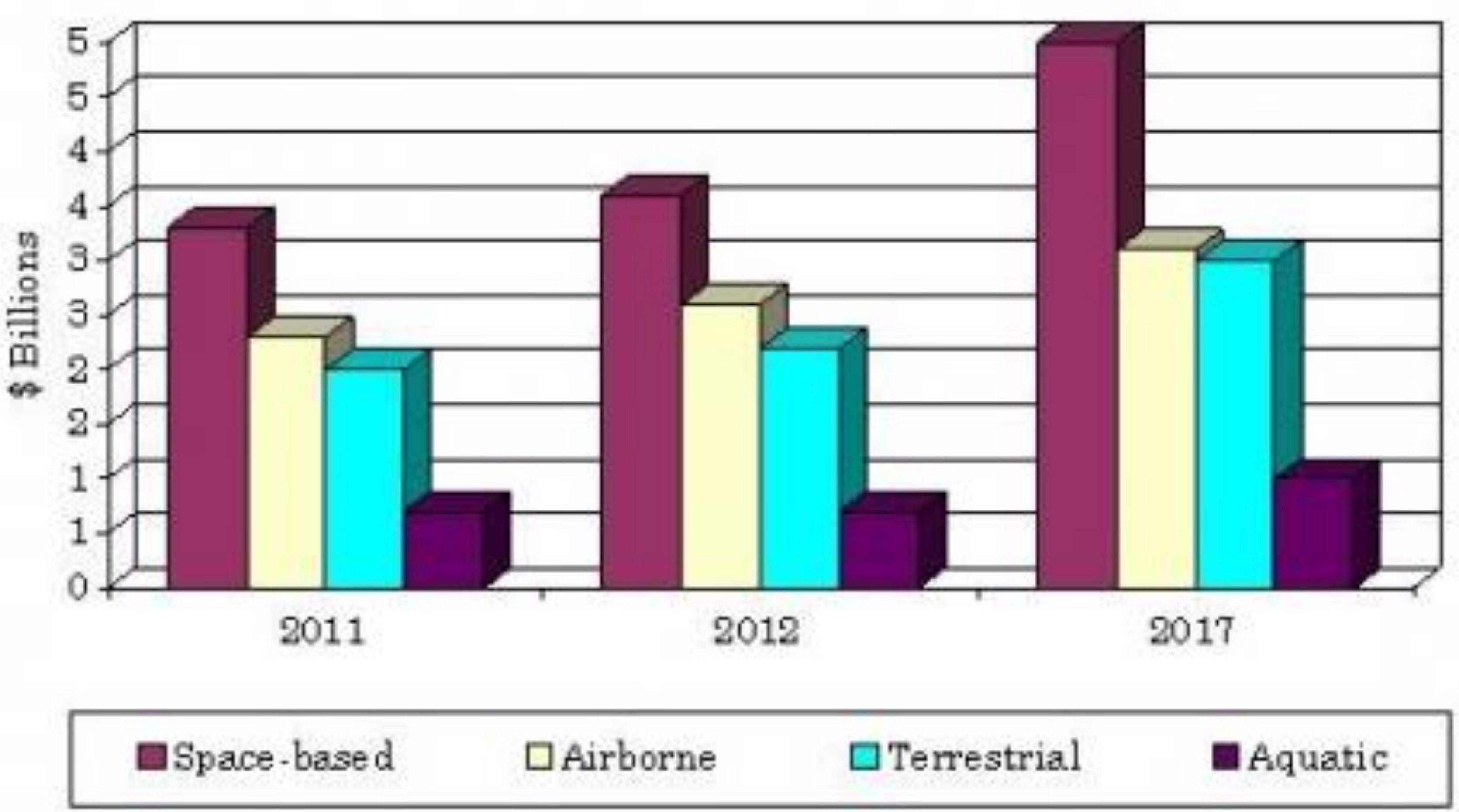


Spatial resolution REMOTE SENSORS (1975-2015)



Modified from http://ej.iop.org/images/1742-2140/9/4/S40/Full/jge422698f3_online.jpg

VALUE OF REMOTE SENSING PRODUCTS (2011-2017)



http://www.bccresearch.com/report/remote-sensing-technologies-markets-ias022c.html

Multisensor approach

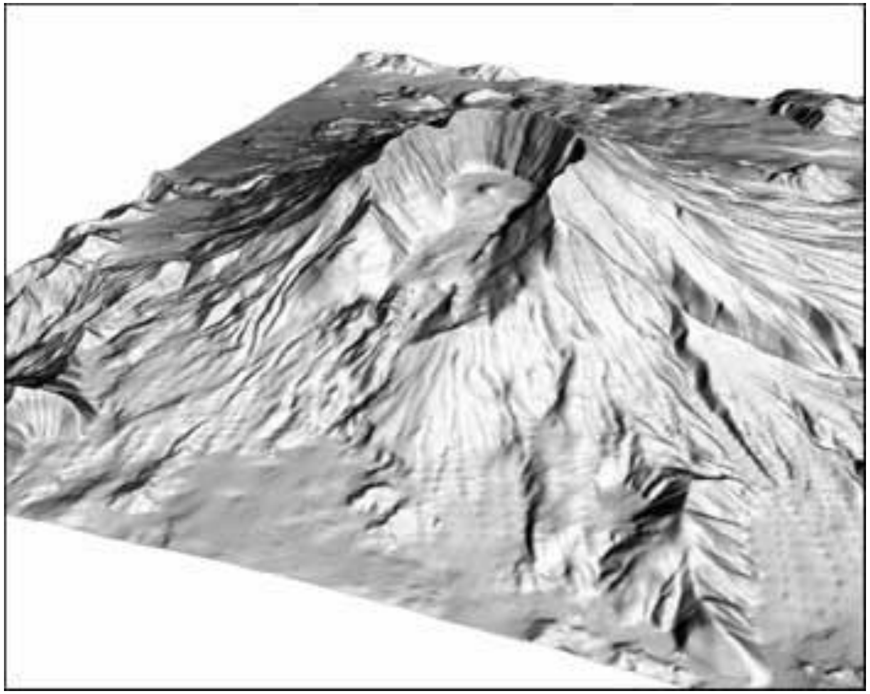
Sensors with different resolutions
LIDAR + aerial camera
LIDAR + aerial camera+ hyperspectral sensor

Landsat/Spot + LIDAR
...

How do we process those data?

What do we use those images for?

DEM

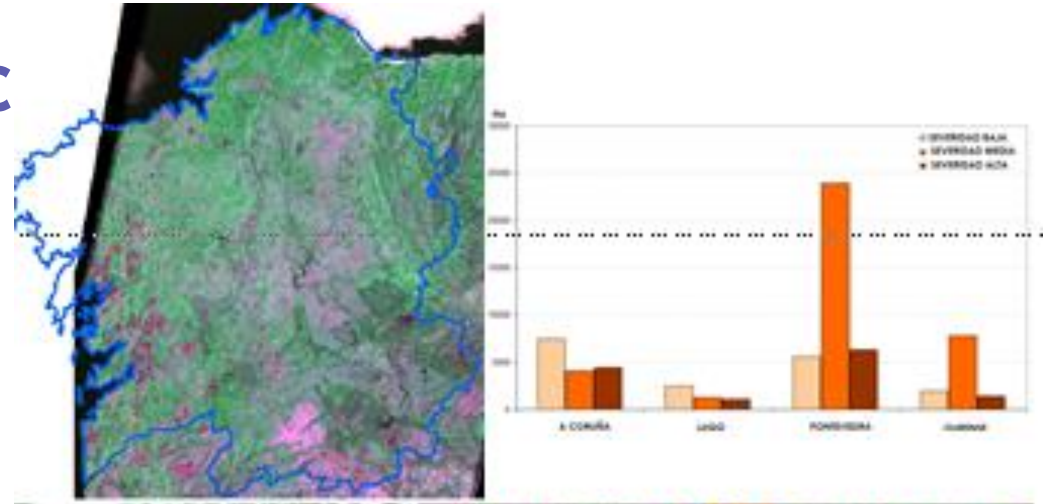


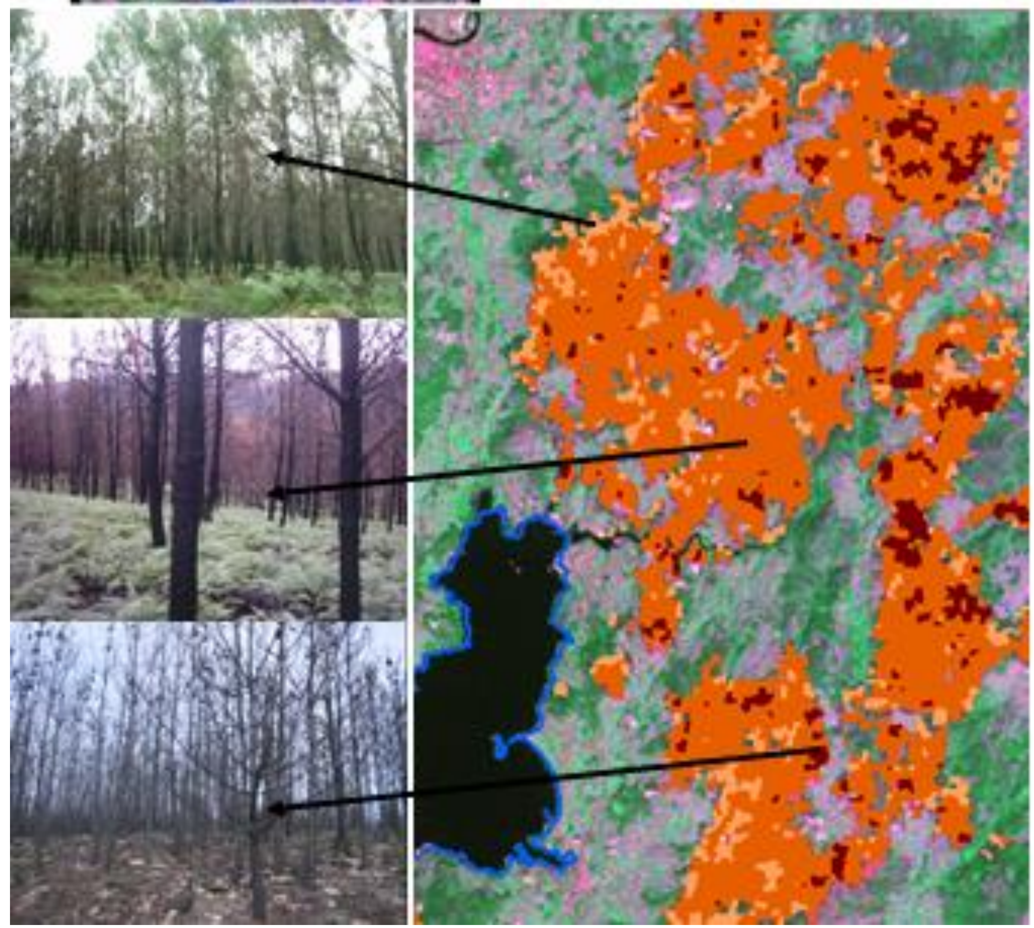
Orthophotographs

Geometric corrections
Spatial resolution (pixel size)
Radiometric resolution (12-bits)
Digital numbers

Qualitative thematic mapping

CLASSIFICATION AND QUANTIFICATION OF BURNT AREAS ACCORDING TO THEIR SEVERITY (2006)

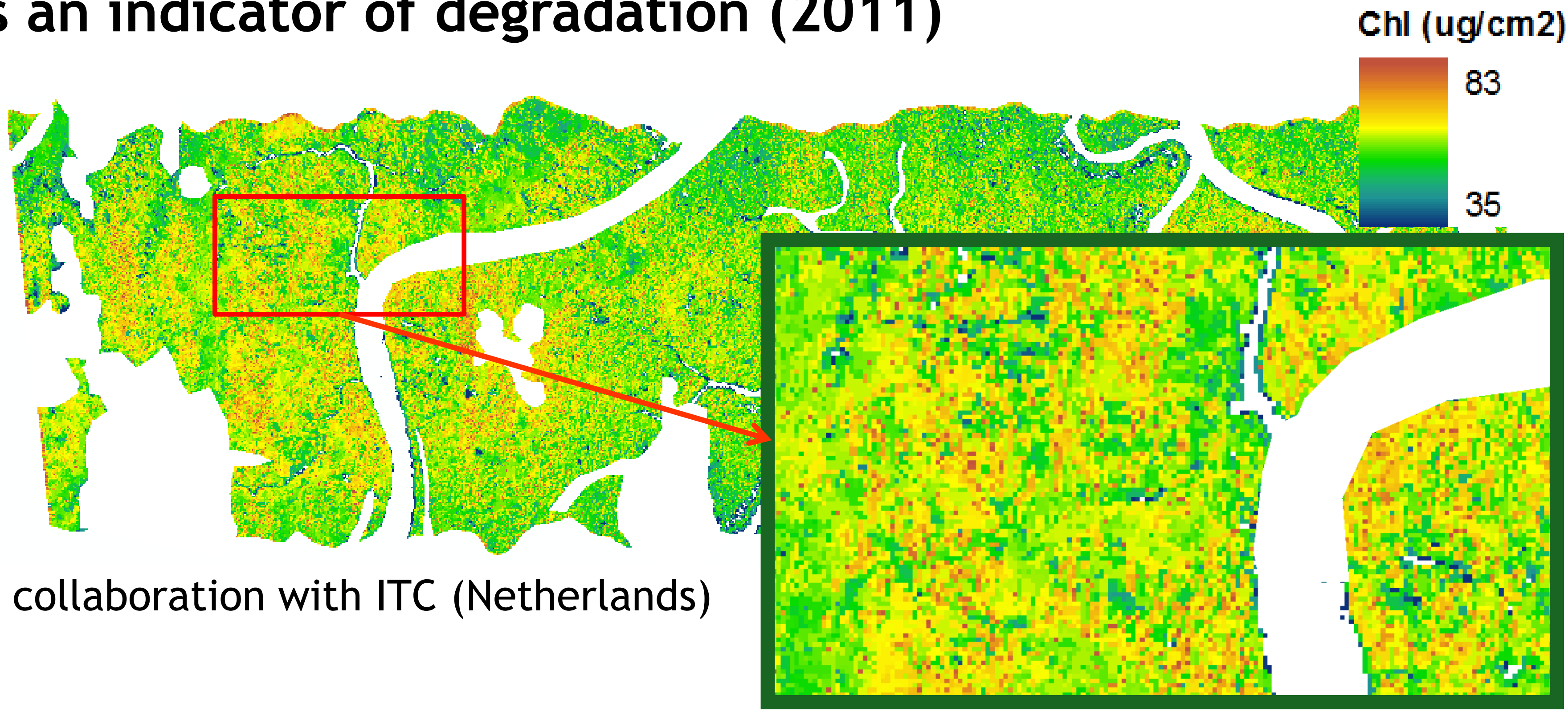




Radiometric corr.
Spectral resolution
Spatial resolution
Reflectances (better)

Quantitative thematic mapping

Mapping the chlorophyll content in mangroves in Indonesia as an indicator of degradation (2011)



In collaboration with ITC (Netherlands)

Radiometric corrections
Spectral resolution (++++)
Spatial resolution
ONLY at-surface reflectance

SUMMARY

Fundamentos:

- What is a remote sensing system?
- What do we use those images for?

Information extraction:

- **How do we process imagery?**

Applications:

- OBIA projects: 2004 – 2016

How can we process imagery? (quick guide)

1. RADIMETRIC CORRECTION
(modify the pixel values)

PHOTOGRAMMETRY: normalization and enhancement

REMOTE SENSING:**

1. Calibration:

   DN → at-sensor radiance/reflectance (ρ_{TOA})

2. Atmospheric correction:

   DN/Radiance →at-surface reflectance (ρ_{sup})

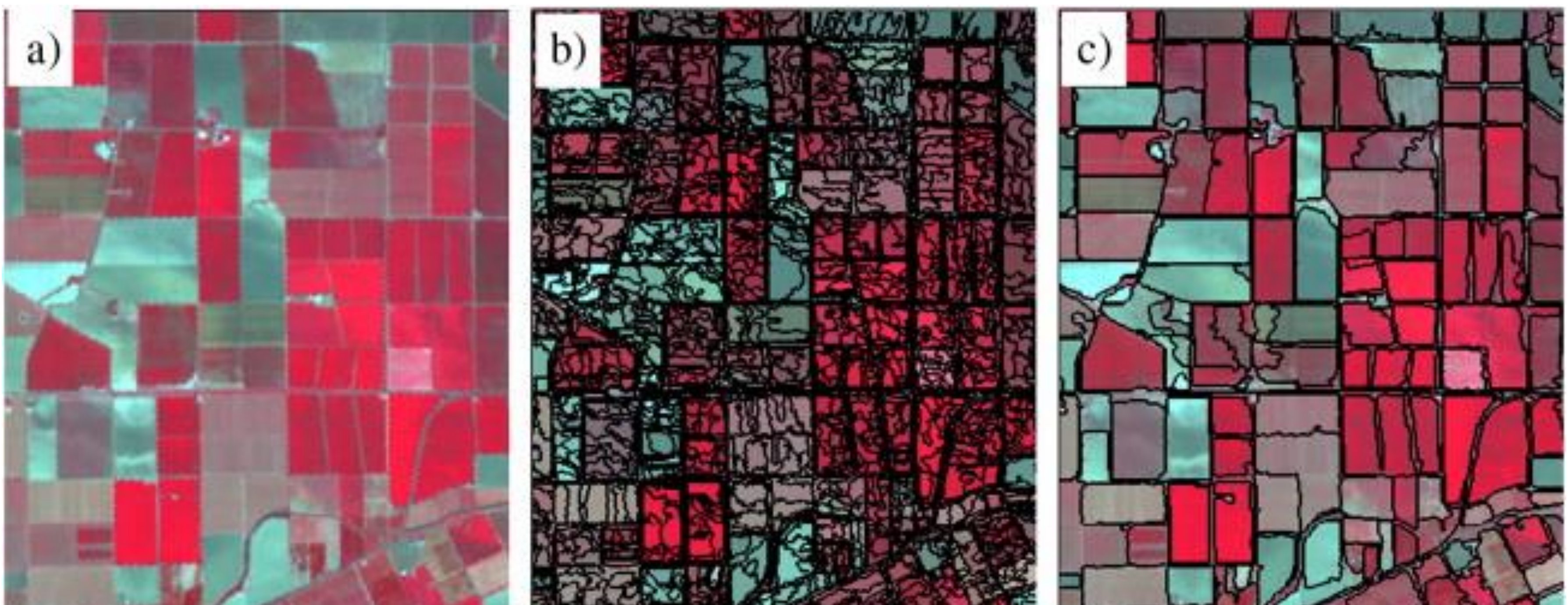
3. Topographic correction

2. GEOMETRIC CORRECTION
(transformation, interpolation, resampling)

3. EXTRACTION OF THEMATIC INFORMATION FROM IMAGERY

DATA SOURCES?

- Pixels
- Objects



http://www.sciencedirect.com/science/article/pii/S0034425711000290

A little example to help us decide…

What do you see here?

What can we learn from that example?

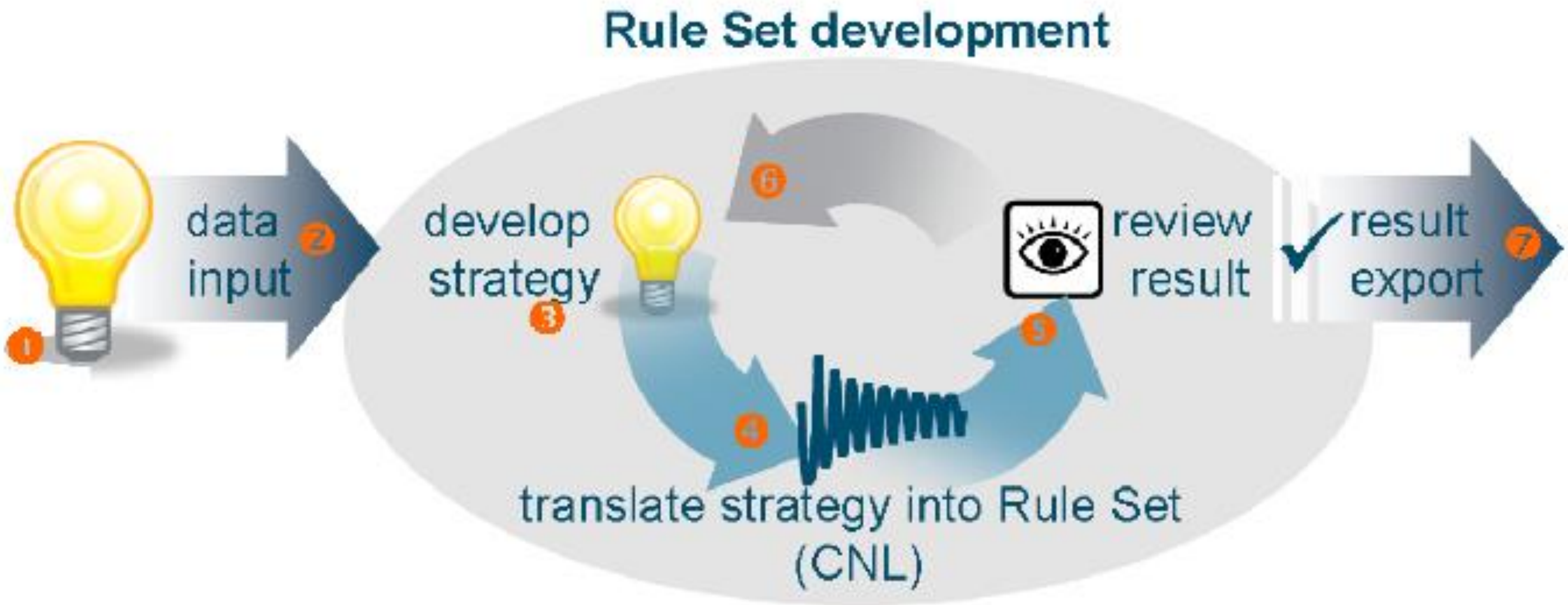
Human visual perception...

- works simultaneously at different scales
- uses context information
- and groups pixels into meaninful objects

... to interpret an image

And object based image analysis uses the same approach!!

3. OBJECT-BASED IMAGE ANALYSIS (OBIA)



1. Understand the general idea of the analysis
2. Choose the data
3. Develop a strategy
4. Translate the strategy into a rule set
5. Review the results
6. (Refine the strategy & rule set)
7. Export the results

3. OBJECT-BASED IMAGE ANALYSIS (OBIA)

3.1. SEGMENTATION

3.2. Clasification (algorithms/rules)

3.3. Validation

3.4. Export the results

eCognition®

3. OBJECT-BASED IMAGE ANALYSIS (OBIA)

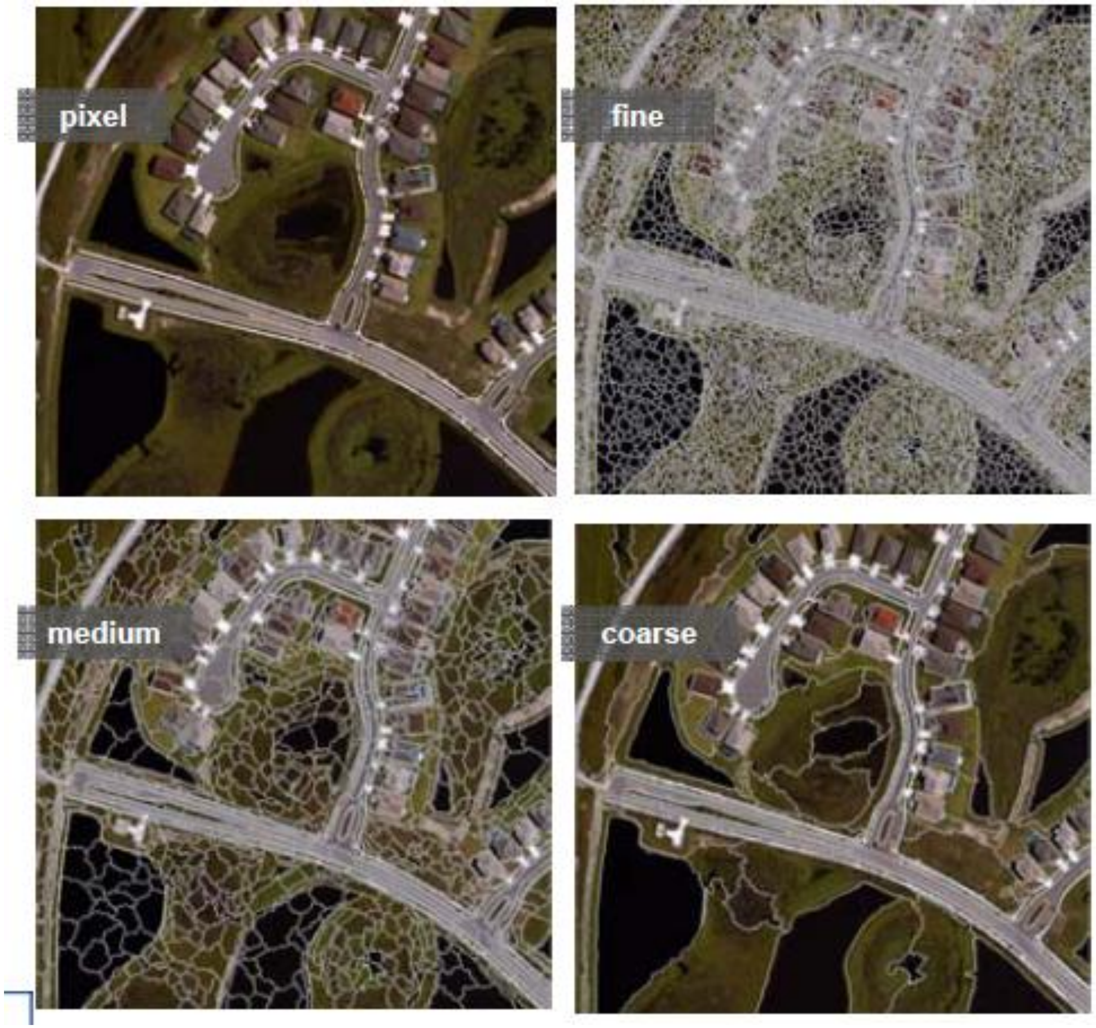
3.1. SEGMENTATION

(cresting homogeneous objects)

Object generation at multiple scales….

- fine
- medium
- coarse

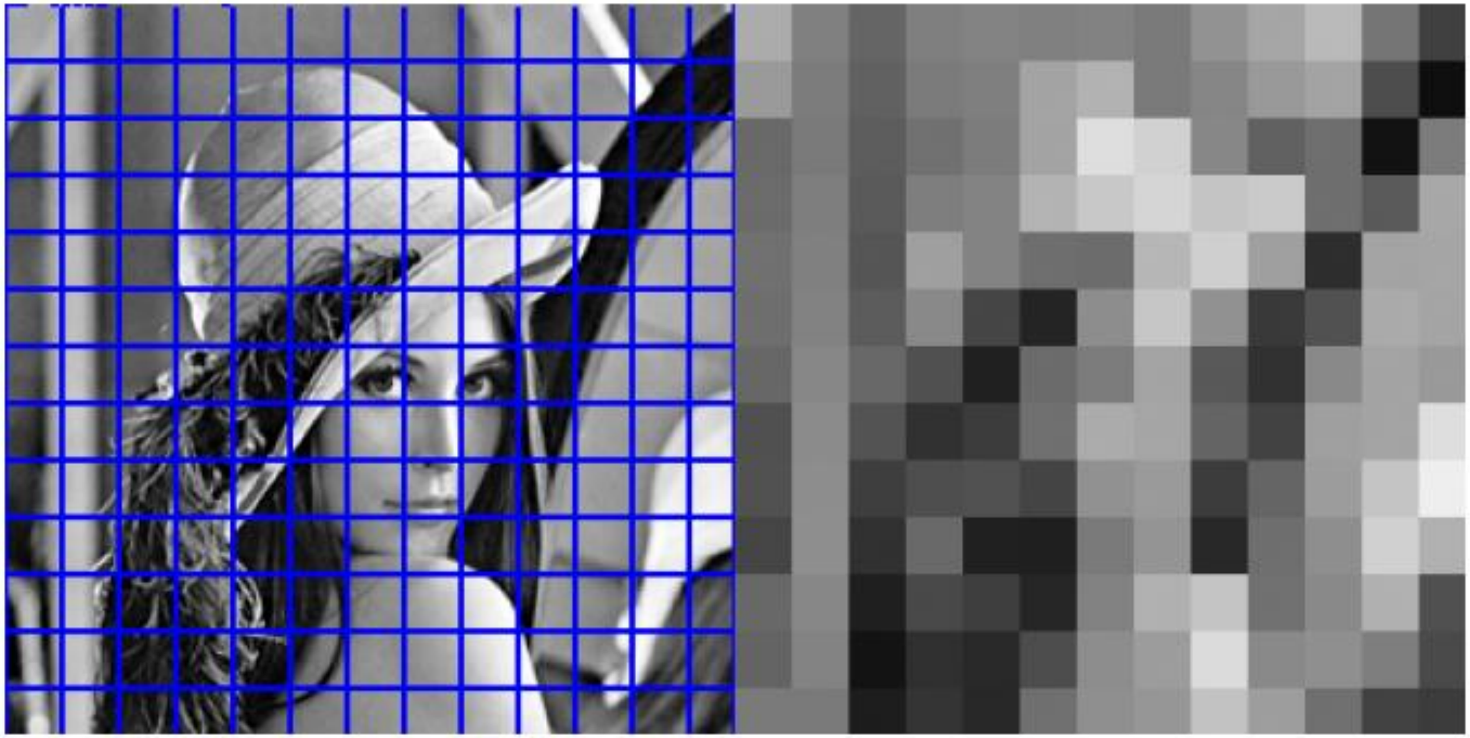
...for classification tasks at different scales in the same project



Segmentation

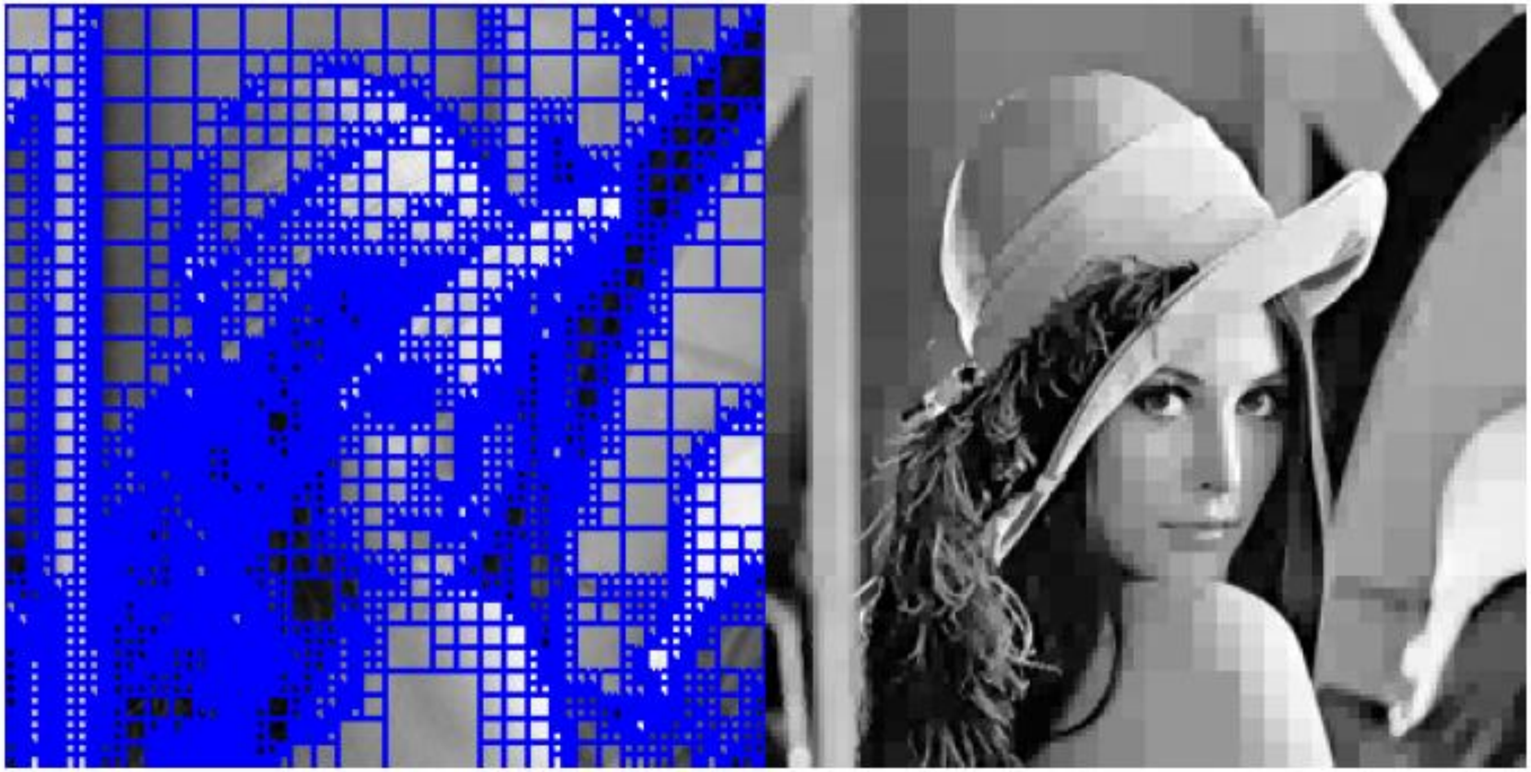
- chessboard segmentation
- quadtree based segmentation
- contrast split segmentation
- multiresolution segmentation
- spectral difference segmentation
- multi-threshold segmentation
- contrast filter segmentation

Chessboard segmentation

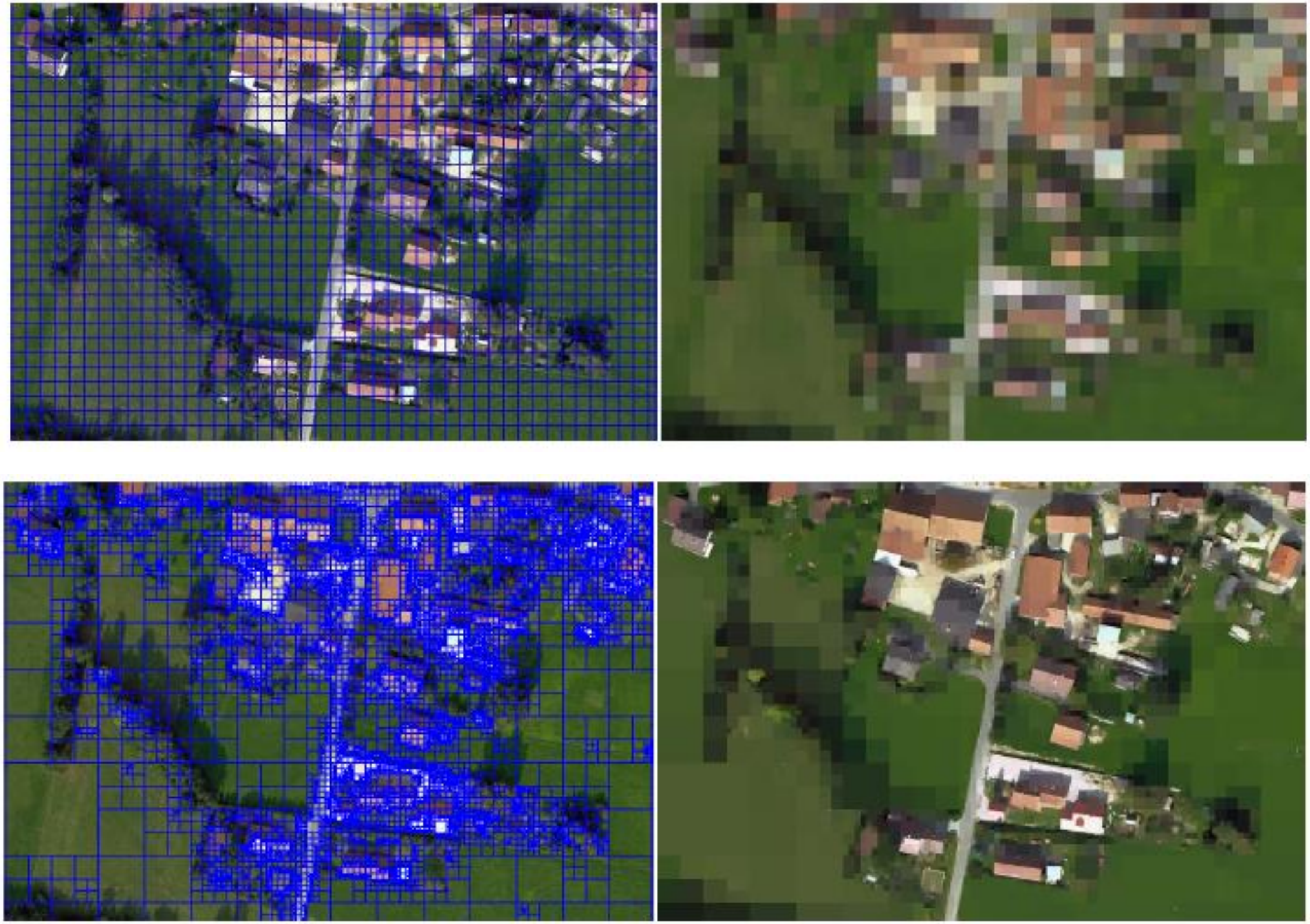


Object size: cell size in pixels (e.g. 10)
Vector layers can be used as a base

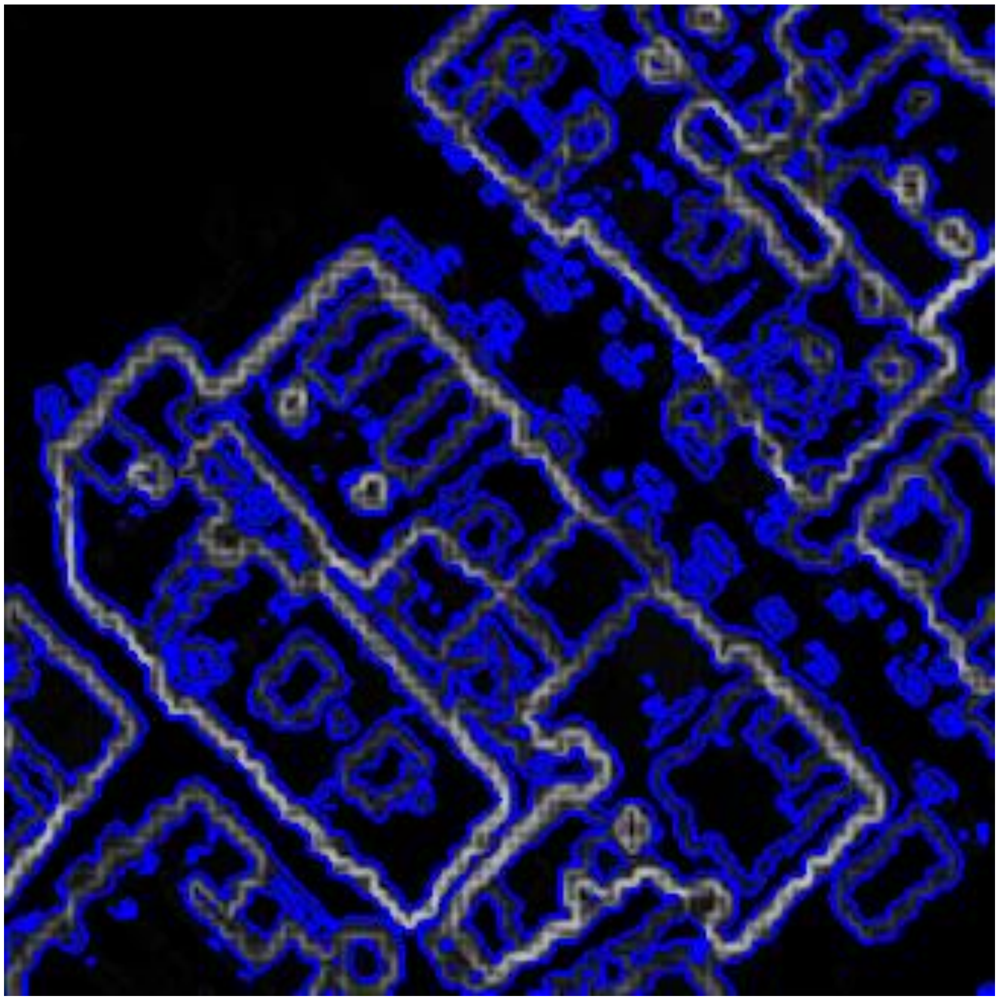
Quad tree segmentation



Divides the data into a quad tree grid (square objects)
Each square: maximum size and considering the homogenity criteria



Contrast split segmentation

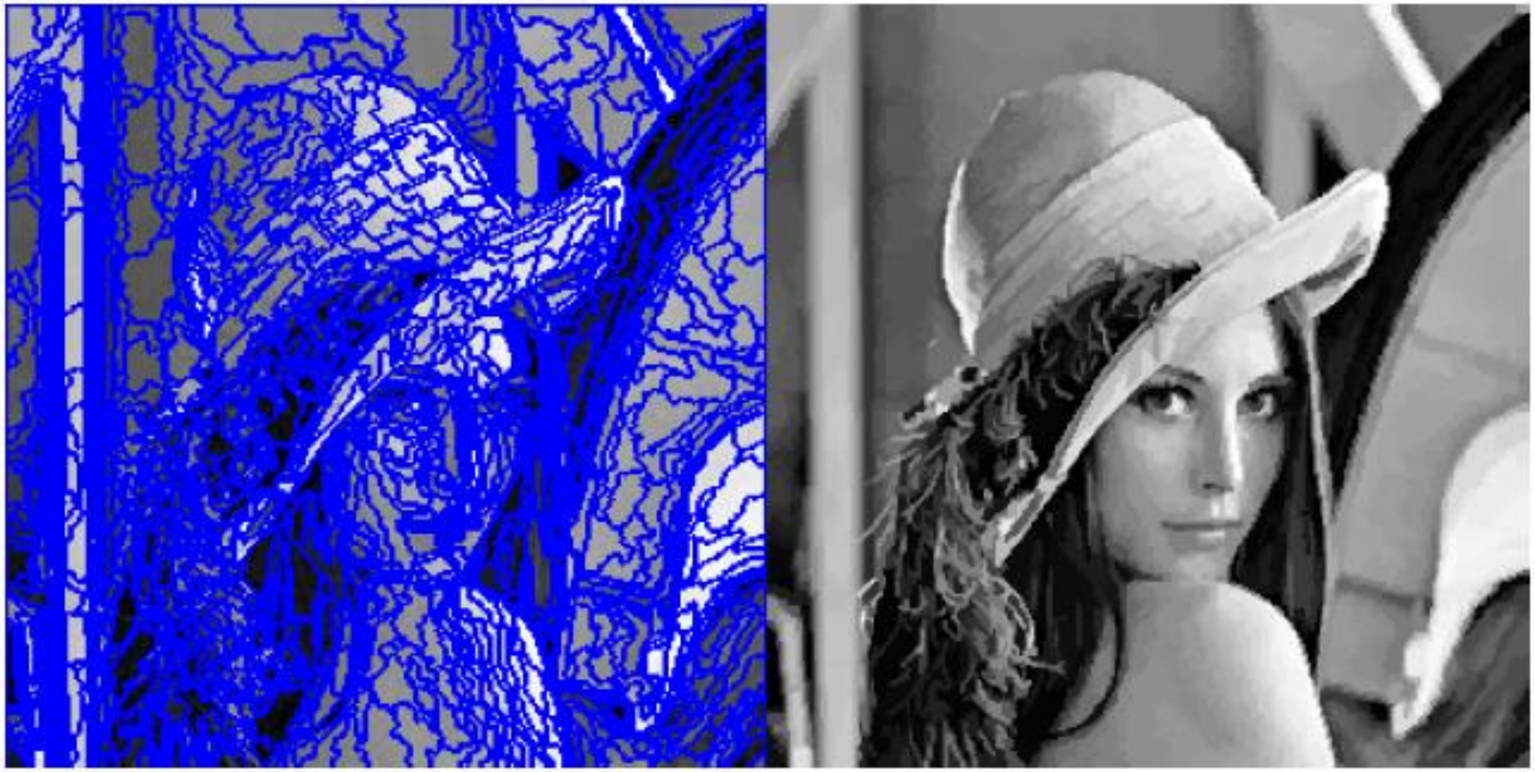


To segment an image into dark and bright regions

Based on a threshold
that maximizes the contrast between the resulting bright objects (pixel values above the threshold) and dark objects (below the threshold).

If it is run at the pixel level:
1st chessboard segmentation

Multiresolution segmentation

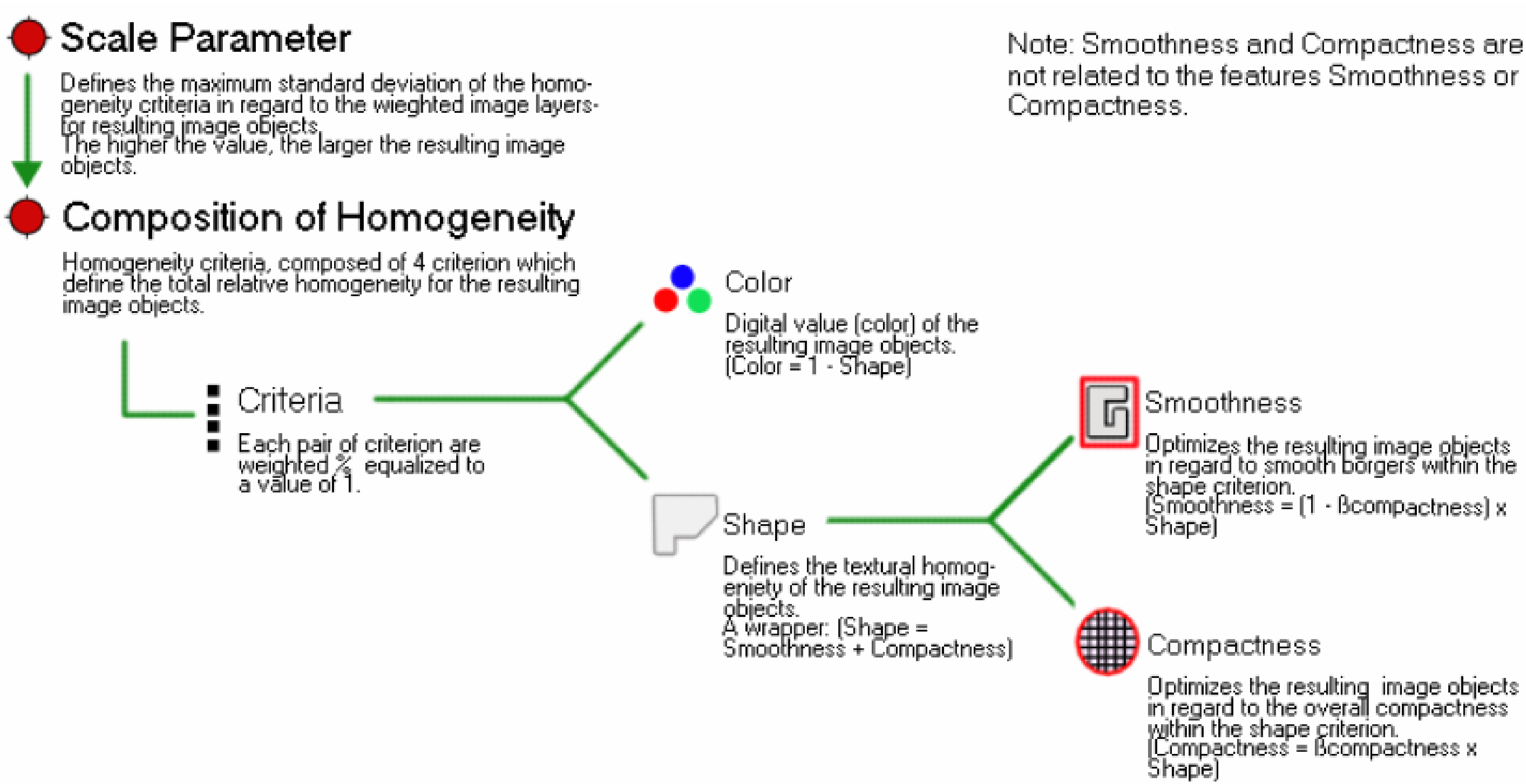


Minimizes locally the average heterogeneity of the image objects (scale)
KEY : input layers, scale parameter, homogenity criterion

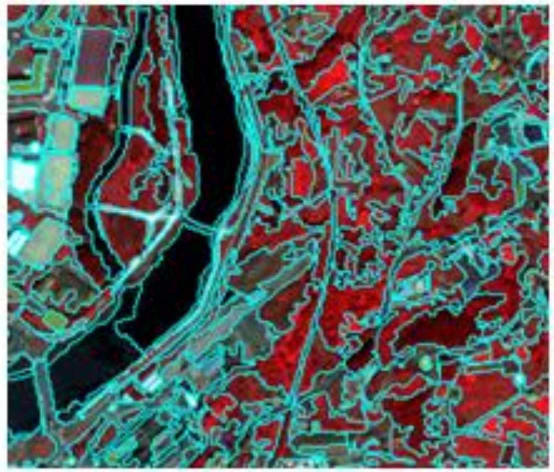
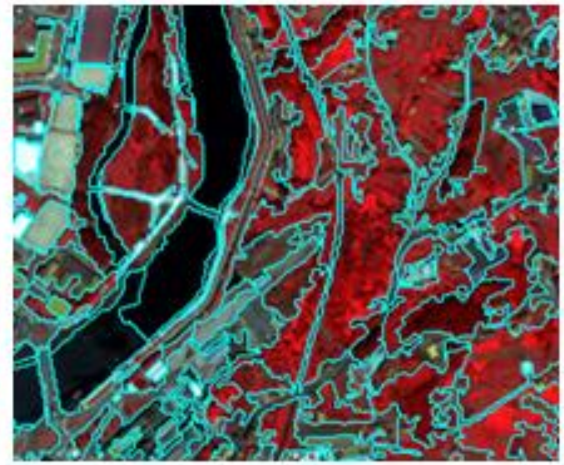
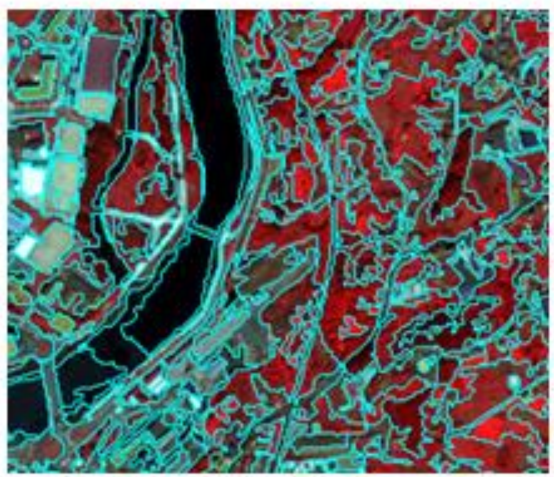
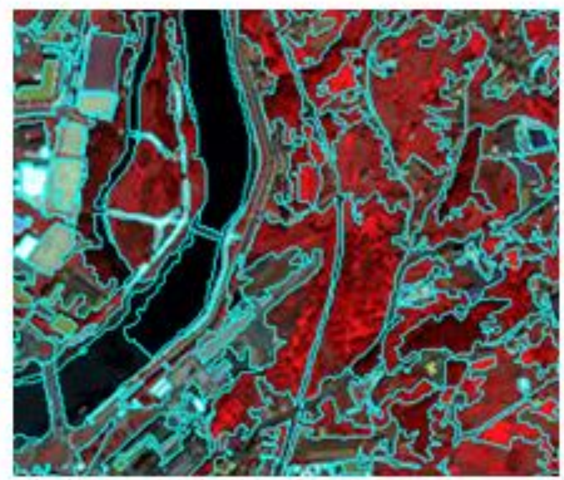
Multiresolution segmentation

Scale: 10
Homogenity: shape 0.1, compactness 0.5

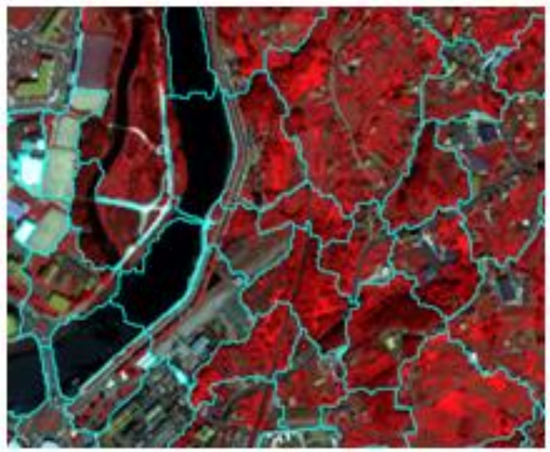
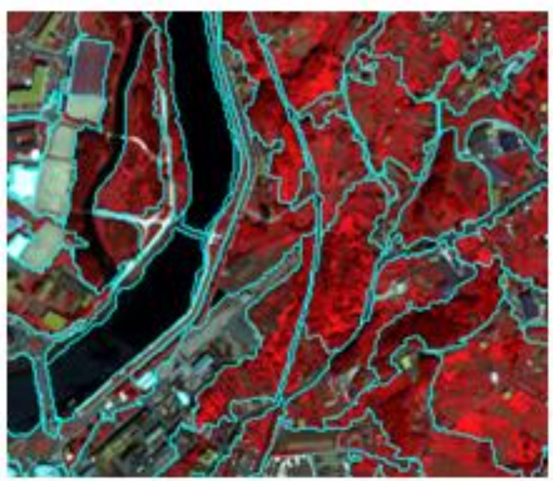
Multiresolution segmentation



Multiresolution segmentation

Segmentation criteria		Level 1: scale parameter 70	Level 2: scale parameter 100
Color: 0.9 ;Shape: 0.1	Compactness: 0.9 Smoothness: 0.1		
	Compactness: 0.1 Smoothness: 0.9		

Multiresolution segmentation

Segmentation criteria		Level 1: scale parameter 70	Level 2: scale parameter 100
Color: 0.1; Shape: 0.9	Compactness: 0.9 Smoothness: 0.1		
	Compactness: 0.1 Smoothness: 0.9		

Multiresolution segmentation

Multiresolution segmentation

1. Produce objects that suit the **purpose**

2. Image objects as **large as possible** and as **fine as necessary** (so you can distinguish regions/classes). Key: the separation of different regions.

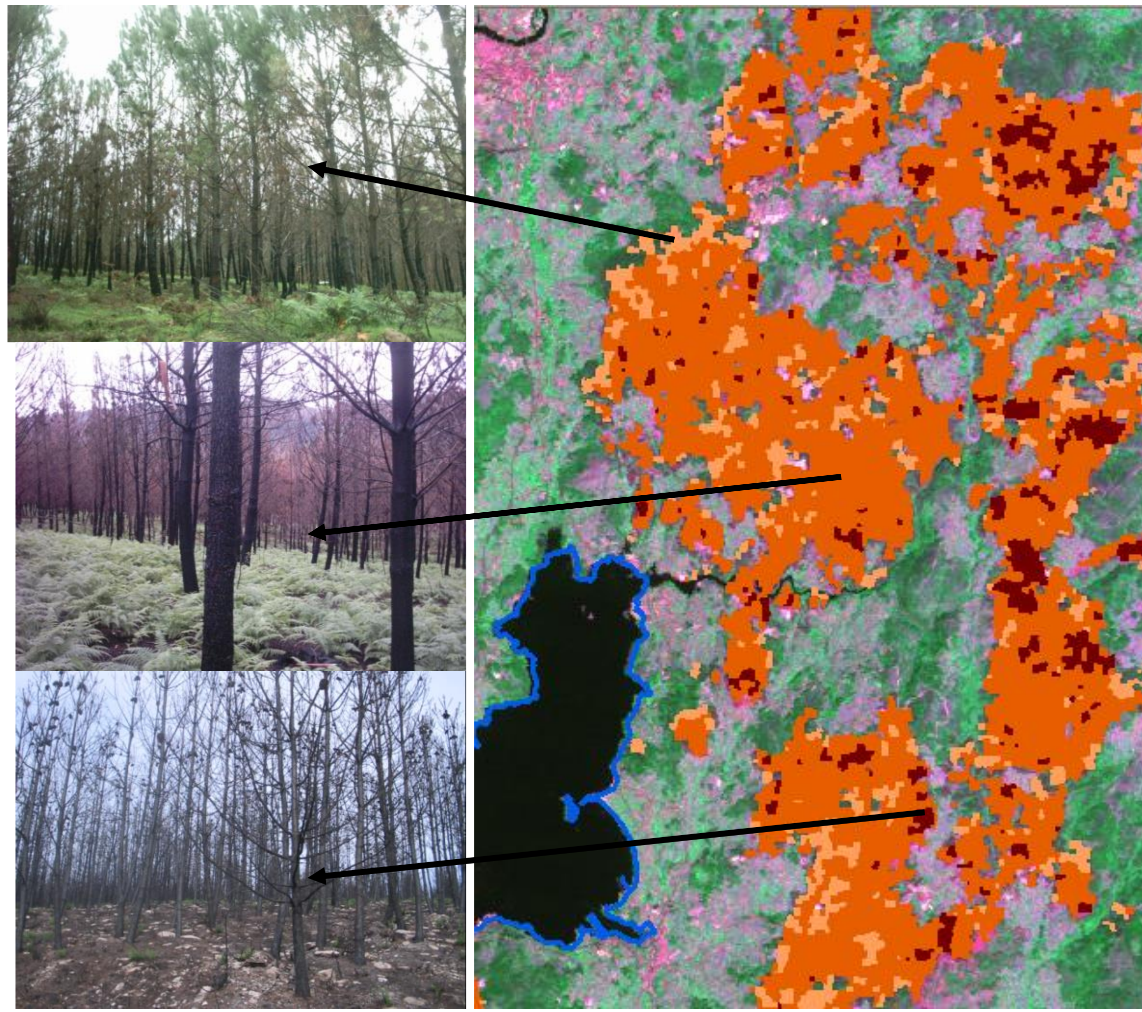
3. Use **as much "colour" as possible**, keeping the "shape" as high as needed to produce objects with an optimal edge (smoothness/compactness). A high degree of shape criterion works at the cost of spectral homogeneity.

4. Optimize **the processing time**.

3. OBJECT-BASED IMAGE ANALYSIS (OBIA)

3.2. Classification (algorithms/rules)

Classification algorithms analyze image objects according to defined **criteria** and **assign** them each to a **class** that best meets those criteria



3. OBJECT-BASED IMAGE ANALYSIS (OBIA)

3.2. Classification (algorithms/rules)

- Sample based:
  NN – Nearest neighbour (non-parametric)

- Rule based: knowledge integration

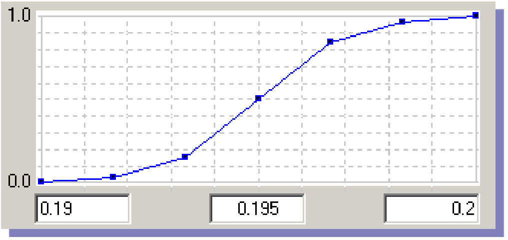
... And the combination of both

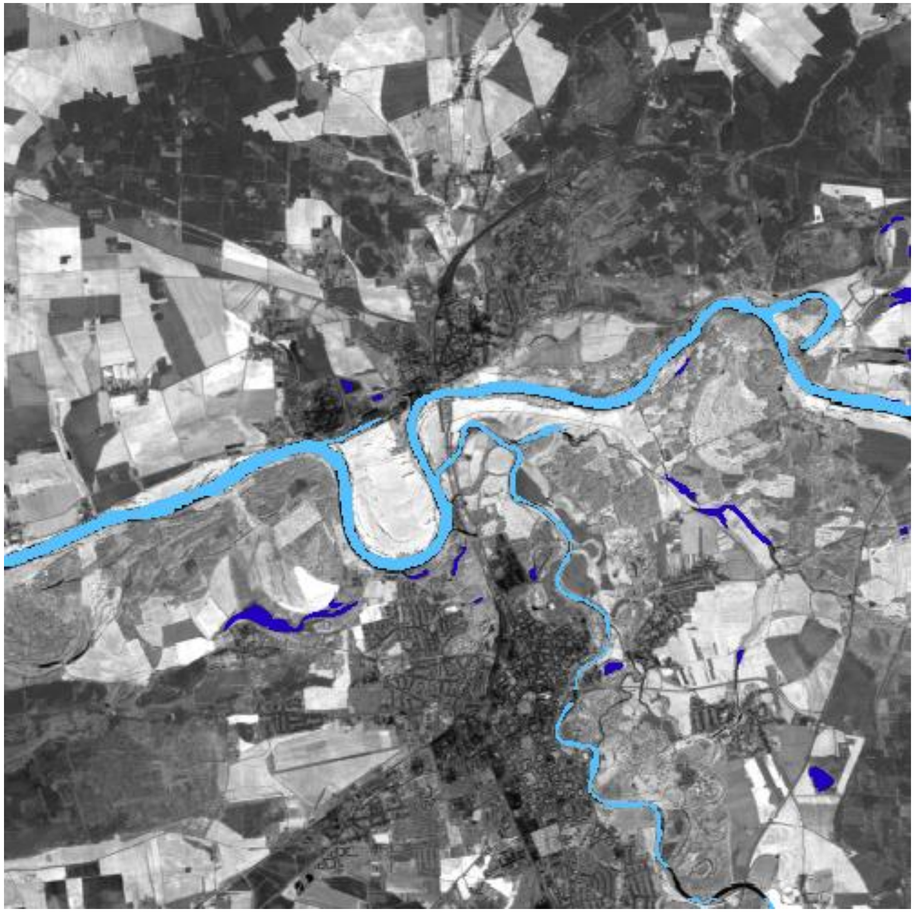
NN: non-parametric supervised classifier(samples)

- Forest
- Cultivated fields
- Infrastructures
- Water

Rule based: knowledge integration

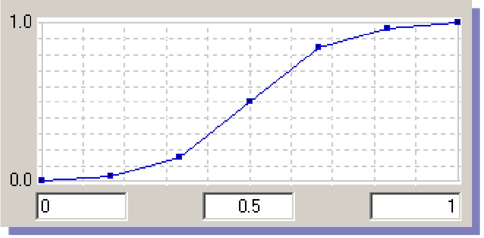
1. Classification of water based on spectral attributtes



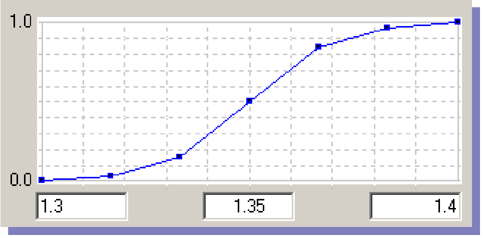


2. Differentiating between rivers and lakes

Shape index



Border with neighbouring objects which are classified as water



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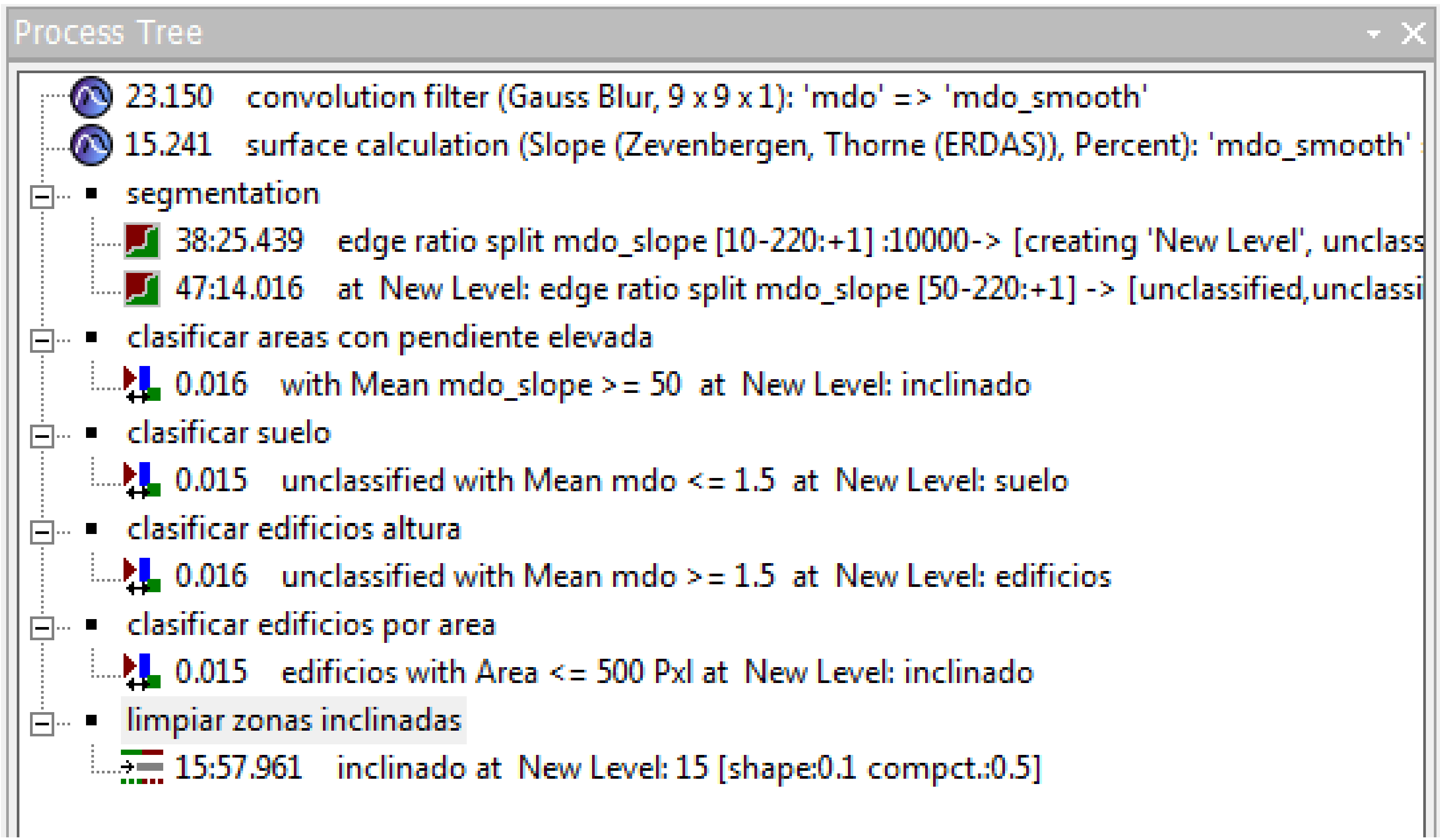
3.2. Classification (algorithms/rules)

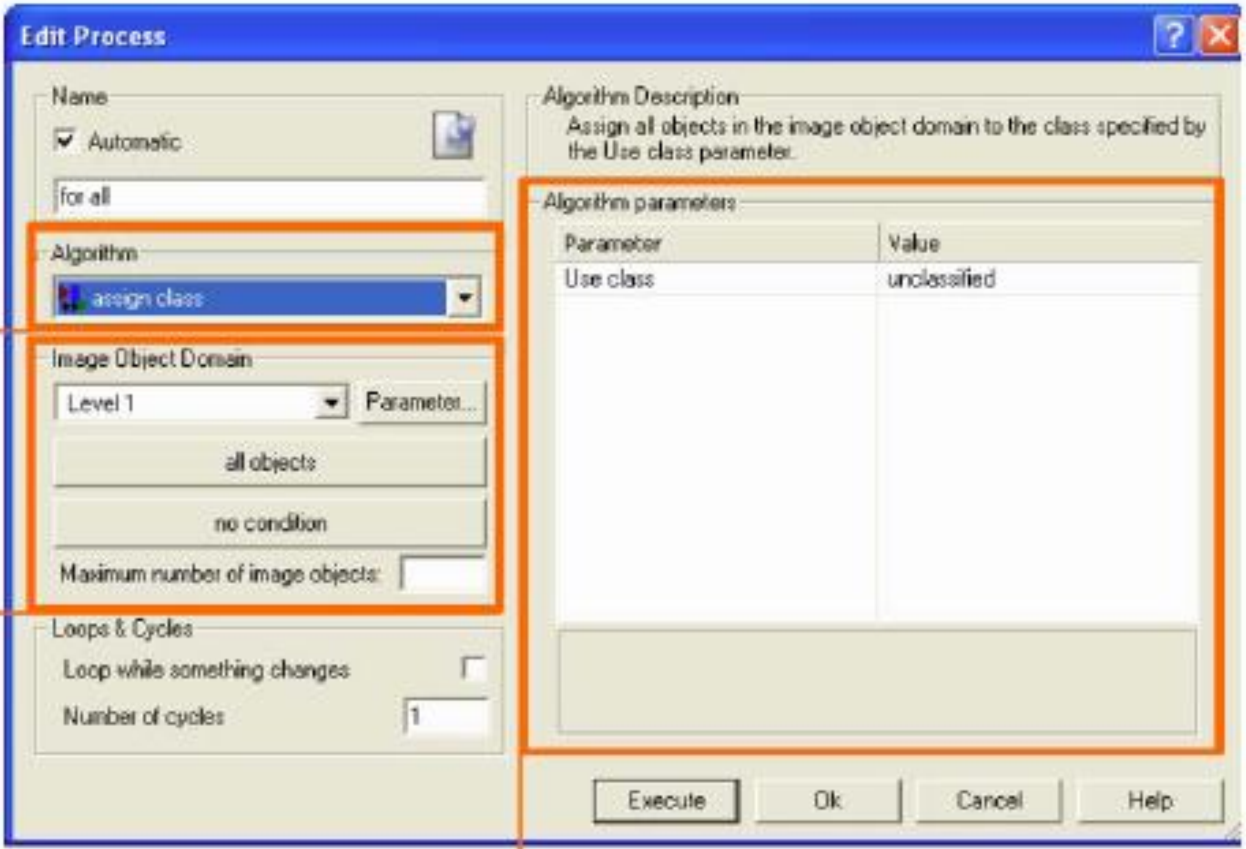


Process

Algorithm:
Define the method.

Image Object Domain:
Define the image objects of interest to be treated.

Algorithm Parameters:
Define the detailed settings of the algorithm.



SUMMARY

Fundamentals:

- What is a remote sensing system?
- What do we use those images for?

Information extraction:

- How do we process imagery?

Applications:

- **OBIA projects: 2004 - 2016**

In which projects have we used OBIA? (2004-2016)

- **FOREST RESOURCES MAPPING**
  - *Pinus radiata* mapping(2004); *Eucaliptus globulus* mapping in NW Spain (2006)
  - ***Eucaliptus globulus*** **mapping in NW Spain (2016): LiDAR, Landsat, Sentinel**

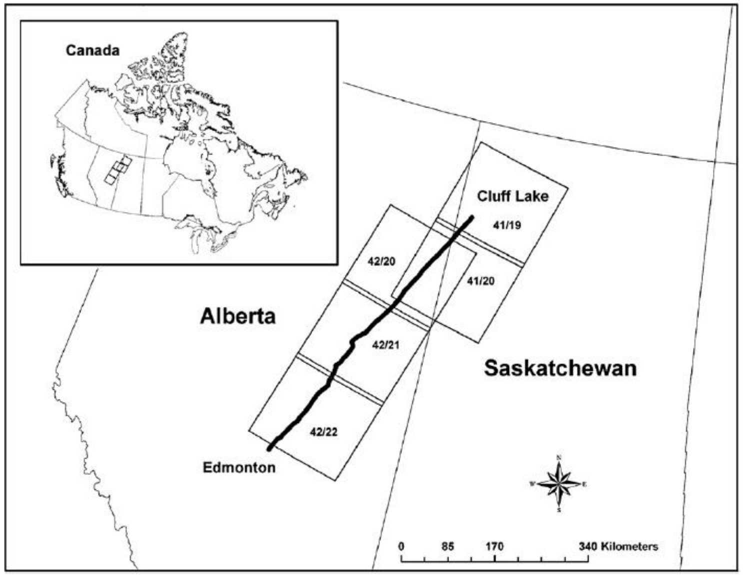
- **MONITORING NATURAL RESOURCES**
  - ***Mapping, classification and quantification of burnt areas (2006)***
  - **Characterization of post-fire forest structure changes by using LIDAR and Landsat 5 TM data (2009)**
  - ***Mapping the chlorophyll content in mangroves in Indonesia as an indicator of degradation (Hymap) (2011)***
  - **Monitoring damages in *Pinus radiata* stands due to defoliation (UAV) (2014)**
  - **Monitoring the invasive species *Hakea sericea* (UAV+ Worldview 2) (2014)**

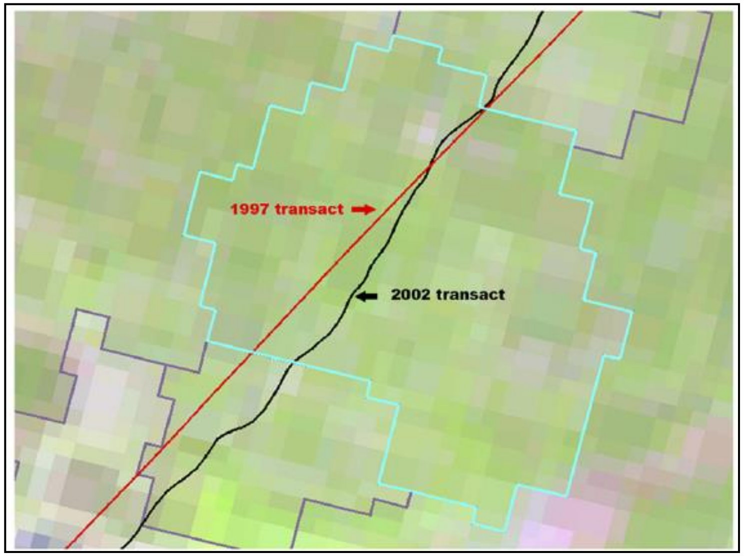
- **MONITORING MINING AREAS:**
  - Forest areas affected by mining activities (2005)
  - Vegetal regeneration in areas affected by mining activities (2013)

- **EROSION MODELLING: MAPPING OF IMPERVIOUS AREAS**
  - **Archival orthophotographs (2013)**
  - **Worldview-2 + Geoeye imagery (2014)**

- **MAPPING OF BIOMASS AND CARBON SEQUESTRATION USING DIGITAL AERIAL CAMERA**
  - **Biomass in grasslands(2009-2013)**

Characterization of post-fire forest structure changes by using LIDAR and Landsat 5 TM data **(Wulder et al., 2009)**



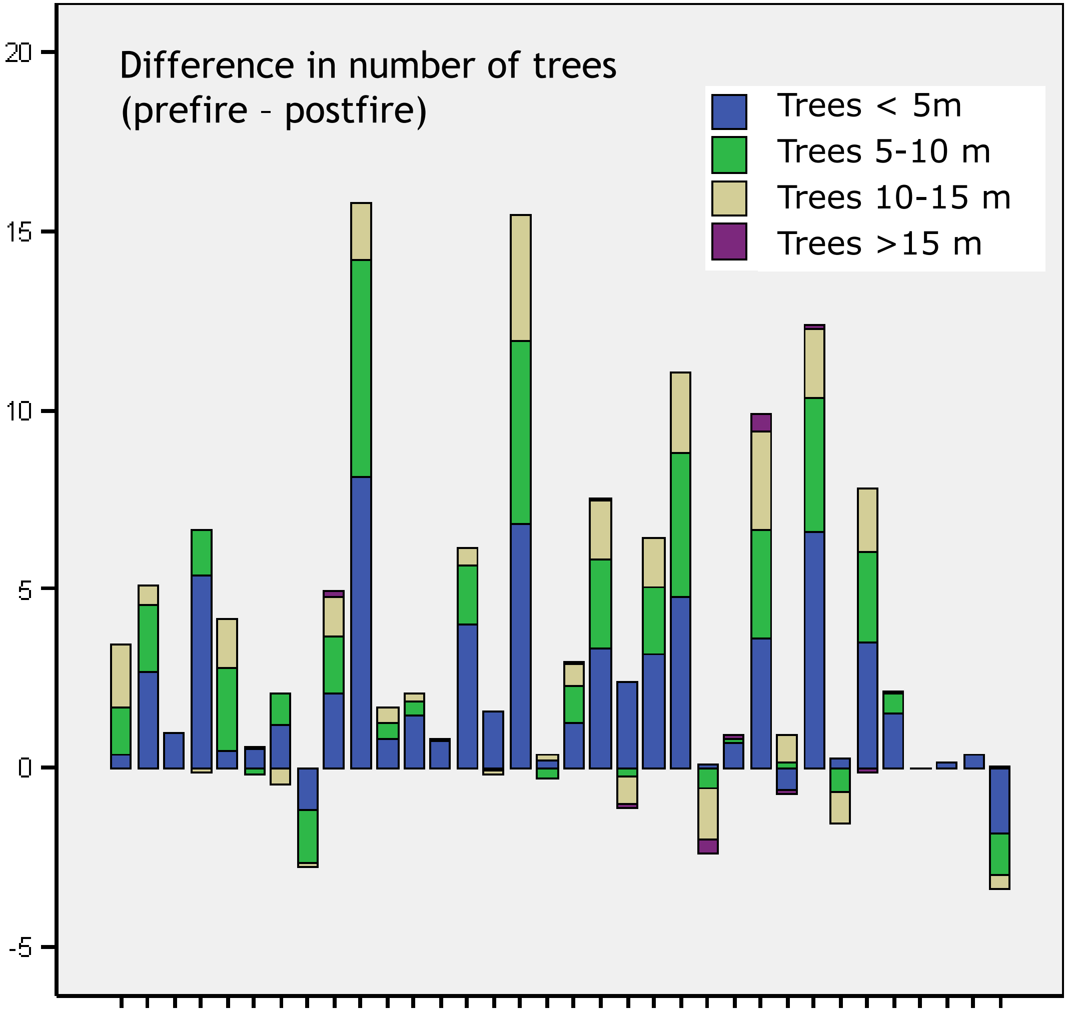


With: Canadian Forest Service

Segmentation

Combined analysis of optical data (Landsat)+ LIDAR

Correlation with changes in forest coverage, density…



Multi-sensor and multi-scale system for monitoring forest health in *Pinus radiata* stands defoliated by *Lymantria dispar* in NW Spain
(Alvarez Taboada et al., 2014)

OBJECTIVE: mapping defoliation at the individual tree scale

Data:

UAV (RGB + NIR)

GSD: 10 cm

Method: segmentation + NN

Results:

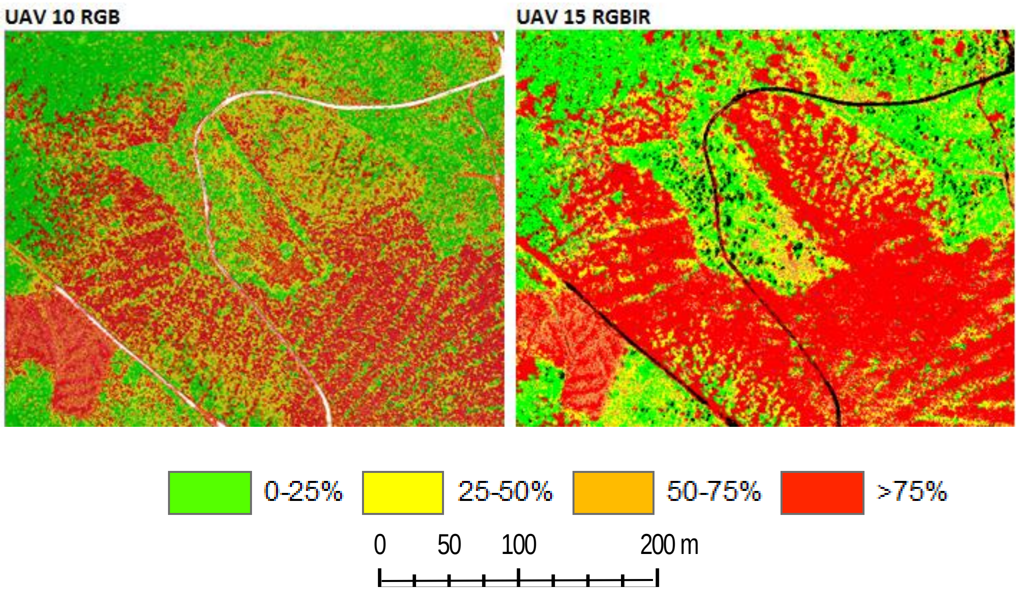
1. Individual tree: scale parameter 25 or 15

2. 2 defoliation classes: accuracy >90% (IR+RGB)

3. 4 clases: accuracy>67%

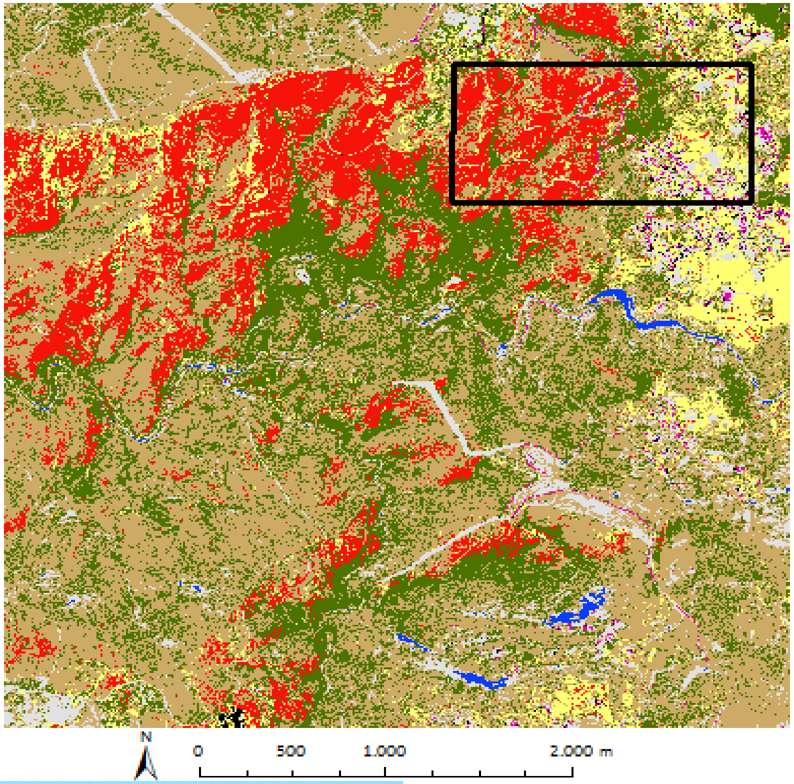
UAV 25 RGB	Validation					
Classification	0-25%	25-50%	50-75%	≥75%	Total	UA (%)
0-25%	25	5	1	2	33	75.76
25-50%	11	18	3	2	34	52.94
50-75%	2	1	1	1	5	20.00
≥75%	1	3		23	27	85.19
Total	39	27	5	28	99	-
PA (%)	64.10	66.67	20.00	82.14	**OA (%): 67.68**	

OA: Overall accuracy
PA: Producer's accuracy; UA: User's accuracy



http://ocs.agr.unifi.it/index.php/forestsat2014/ForestSAT2014/paper/view/245

UAV and Worldview-2 imagery for the object based mapping of the invasive species *Hakea sericea* in the North of Portugal
(Paredes et al., 2014)



OBJECTIVE: mapping the invasive species

Data:
UAV: RGB, RGBNir, GSD: 10 cm
Worldview-2

Method:
Segmentation
Textures, vegetation indices
Clasification: NN

Results:

1. WV-2: **User's & producer's accuracy >93 % (KHAT: 0,95). All bands.**

2. UAV: Accuracies> 75 % (KHAT: 0,51). RGB-NIR.

3. Textures: higher overall accuracy WV-2

3. Indices: do not improve the classifications

http://ocs.agr.unifi.it/index.php/forestsat2014/ForestSAT2014/paper/view/307

Non-Parametric Object-Based Approaches to Carry Out ISA Classification From Archival Aerial Orthoimages (Fernández et al., 2013)

With the University of Almería (Spain)

Objective: differentiate pervious/impervious areas

Data:

RGB orthoimages (scanned) 20 cm

Radiometric artifacts/issues (mosaic)

Method:

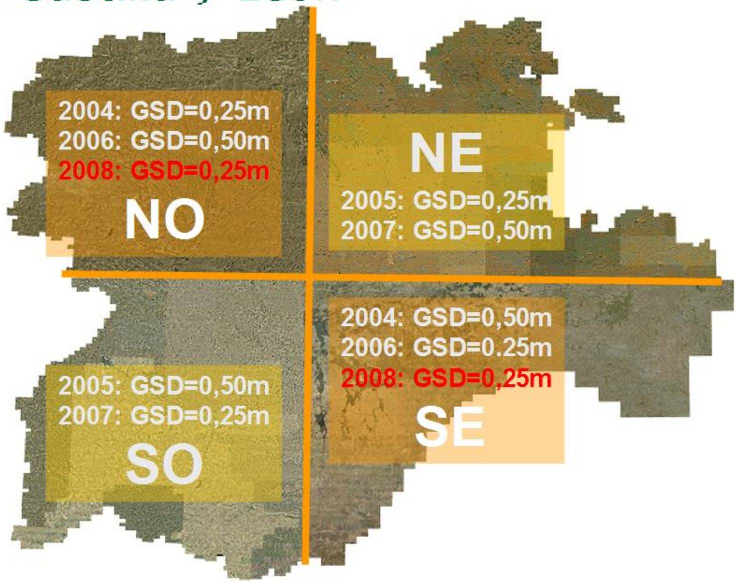
- **Segmentation**
- **Textures**
- **Classification: NN, SVM, CART**

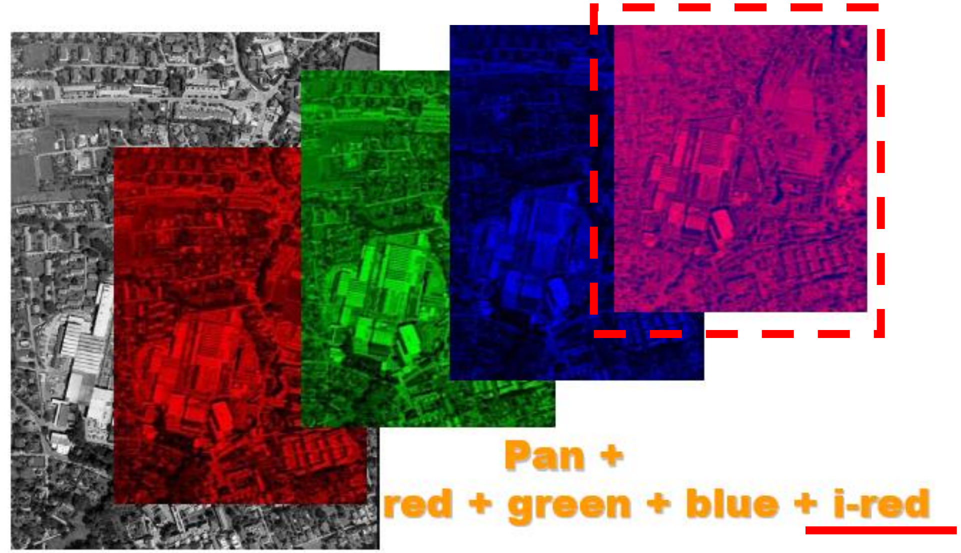
Results:

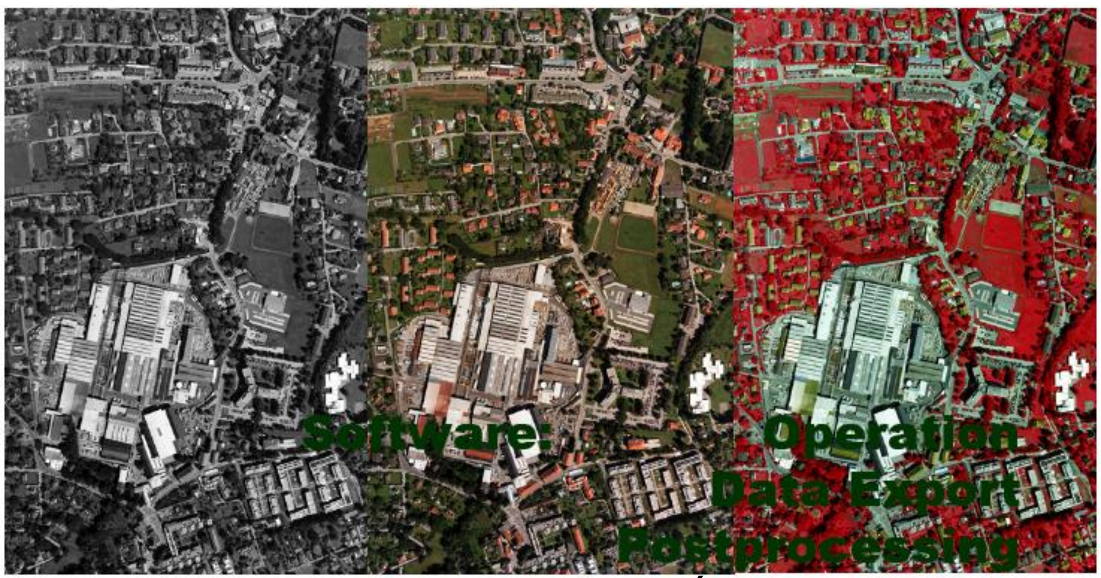
1. **+ accurate when using RGB+ indices+<u>texture</u>**
2. **NN and SVM better than CART**
3. **Overall accuracy with SVM (Support Vector Machine): 89.4%**

Biomass estimation using multispectral images from aerial digital camera **(Álvarez et al., 2010)**

PNOA Castilla y León





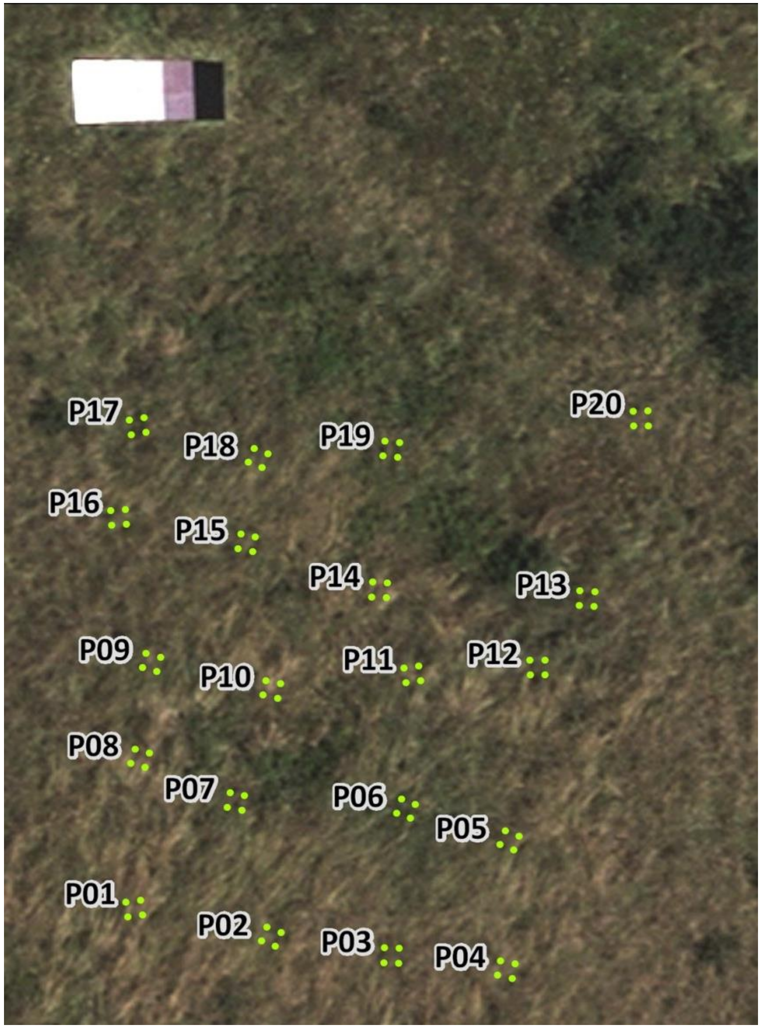


With the Junta de Castilla y León (Spain)

Making the most of the IR data from digital areal frame camaras: biomass and carbon estimation

(Álvarez et al., 2010a,b,c; Marabel & Álvarez, 2013)

2010 field campaign



With Wideworld Geographic

2012 field campaign

Making the most of the IR data from digital areal frame camaras: biomass and carbon estimation

(Álvarez et al., 2010a,b,c; Marabel & Álvarez, 2013)

✓ **Geometric correction:**

Orthorectification. Resampling: nearest neighbour

✓ **Radiometric correction:**

It is REQUIRED to use at-surface reflectance

How can we convert DN to at-surface REFLECTANCE?

Empirical line calibration:

Level 2 images (DN) (SEGMENTATION)

Target reflectance (spectroradiometer)

✓ **Regression:**

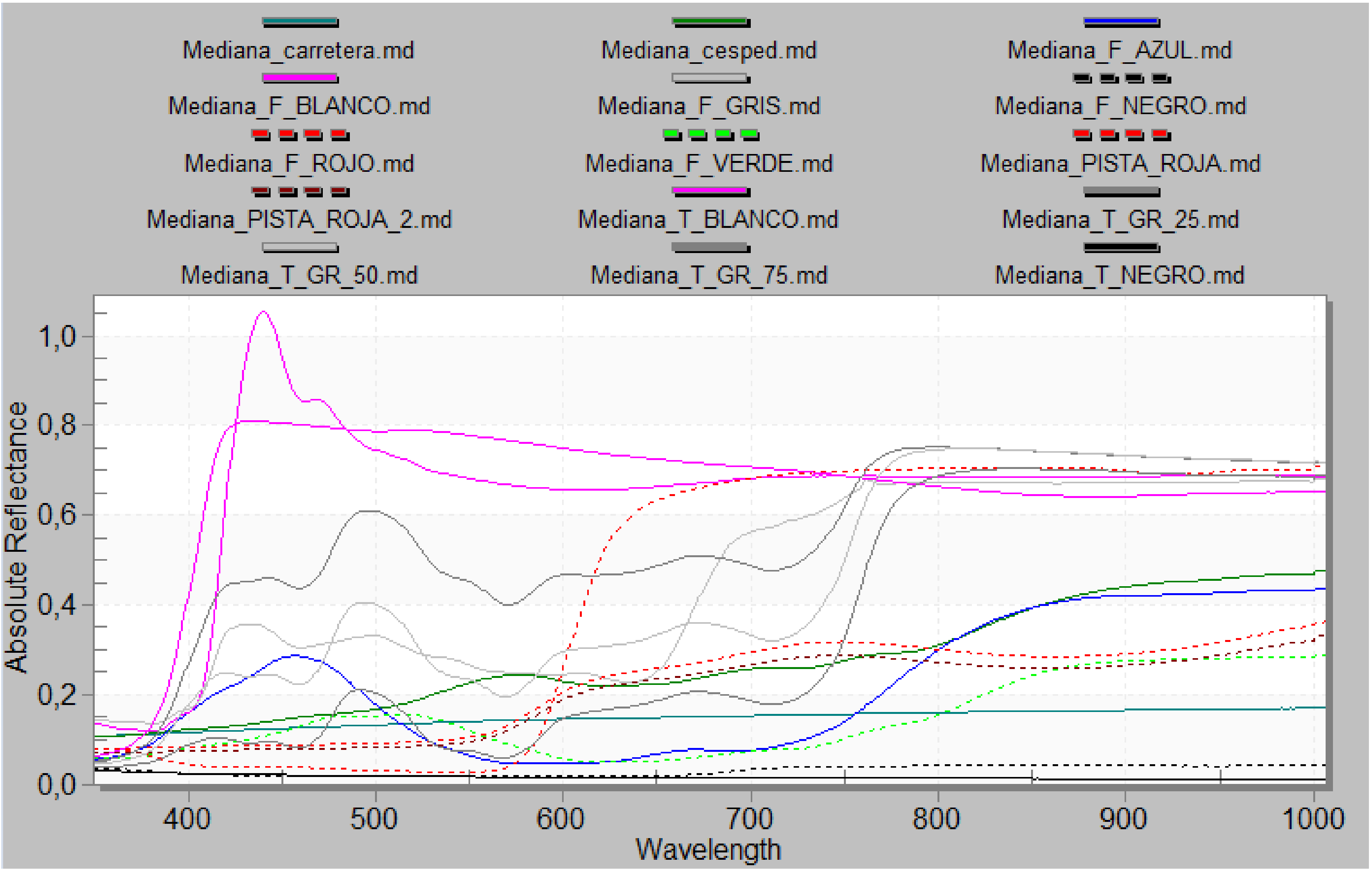
at-surface REFLECTANCE vs biomass (gr/cm^2) (PLS, OLS)

Validation

Mapping

✓ RESULTS (2012 field campaign):

Target reflectance (ASD Fieldspec4)



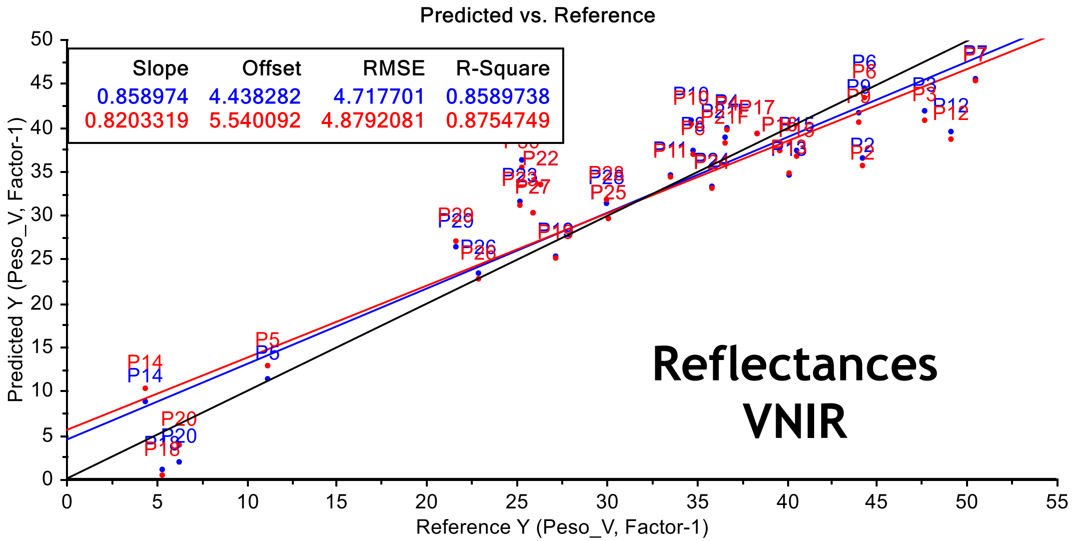
✓ RESULTS (2012 field campaign):

Biomass reflectance (ASD Fieldspec4) vs biomass

	PLSR				LSR			
					DM		AOM	
	Z	F	R^2	RMSE	R^2	RMSE	R^2	RMSE
PV	z1	2	0,752	6,396	0,728	6,483	0,722	6,549
	z2	4	0,877	4,506	0,669	7,146	0,719	6,587
	z3	1	0,888	4,295	0,725	6,517	0,750	6,208
	z4	**1**	**0,921**	**3,622**	**0,910**	**3,720**	**0,915**	**3,615**
	z5	2	0,859	4,859	0,742	6,307	0,797	5,593
	SCR	3	0,890	4,254	-	-	-	-

R^2 = 0,921

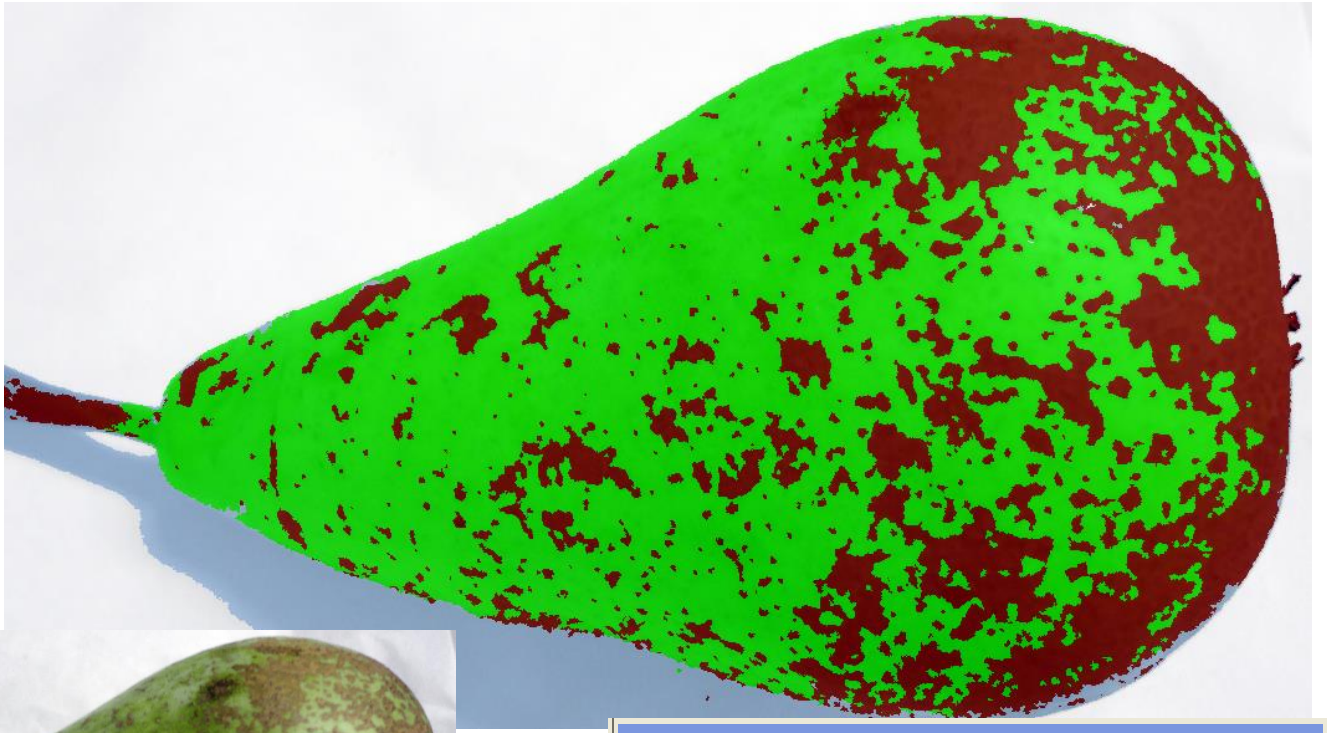
Error in the prediction <12%

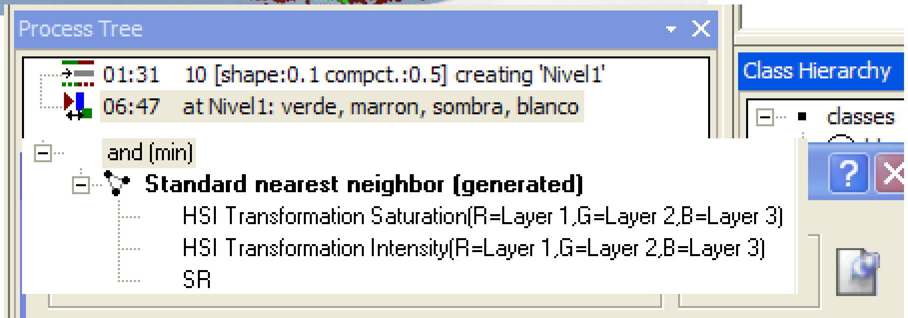


Precise fruticulture: quantification of the quality variable "russeting" in "Conference" pear **(Marabel, Álvarez y Guerra, in prep.)**

Segmentation of images (digital camera)

Classification and validation. Accuracy> 95%, kappa>0.90

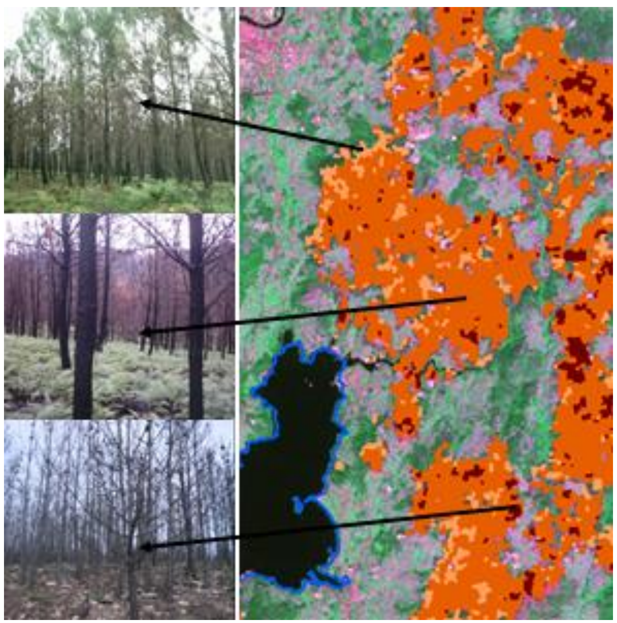


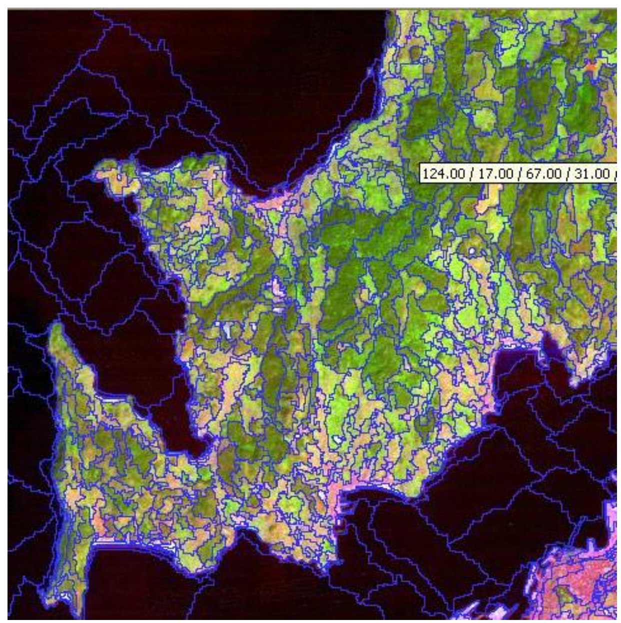


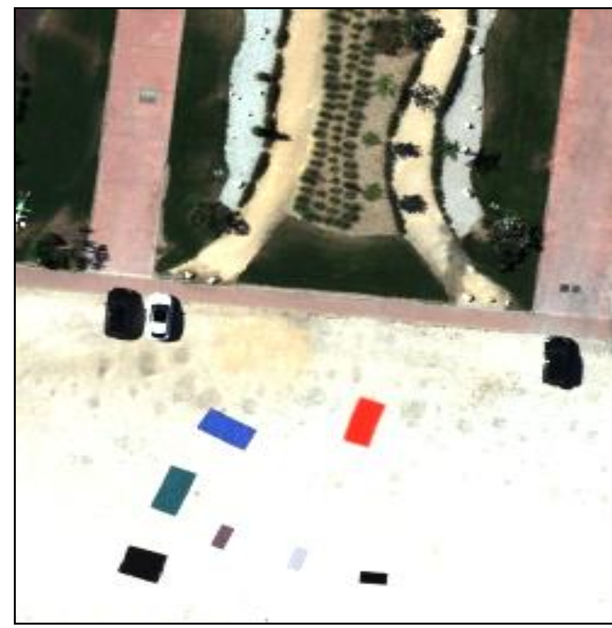
CONCLUSION

- OBIA  high spatial resolution, LIDAR, UAVs
- Make the most of geometry and radiometry
- + sensors= + opportunities= + challenges
- OBIA & multisensor projects:

Object Based Image Analysis (OBIA)







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